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STATE OF MINNESOTA
MINNESOTA POLLUTION CONTROL AGENCY

In the Matter of Proposed Rules Governing Solid Waste Management Facility Permits, and the Design, Construction and Operation of Solid Waste Management Facilities

STATEMENT OF NEED AND REASONABLENESS

Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, Minnesota 55155

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February 23, 1988

STATE OF MINNESOTA
MINNESOTA POLLUTION CONTROL AGENCY

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STATEMENT OF NEED AND REASONABLENESS

I. INTRODUCTION

The proposed rules in this rulemaking effort all relate to solid waste management facilities. The proposed rules are in two groups. The rules relating to permits for solid waste management facilities will appear in Minn. Rules ch. 7001. The rules regulating the design, construction and operation of solid waste management facilities will appear in Minn. Rules ch. 7035.

Since its creation in 1967, the The Minnesota Pollution Control Agency (hereinafter "Agency") has adopted a number of different rules which set forth the procedures for the issuance of permits to sources of air, water and land pollution. The existing permit rules all appear in chapter 7001 of Minnesota Rules and are divided as follows:

Parts 7001.0010 - 7001.0210	General Requirements
Parts 7001.0500 - 7001.0730	Hazardous Waste Facility Permits
Parts 7001.1000 - 7001.1100	NPDES Permits
Parts 7001.1200 - 7001.1220	Air Emission Facility Permits
Parts 7001.1250 - 7001.1350	Indirect Source Permits

The existing permit rules were consolidated into chapter 7001 in 1984 so that the permitting procedures for all Agency programs can be easily found without searching through rules setting technical standards. The chapter 7001 rules are designed to allow the public to easily find and understand the Agency's process for considering permit applications. The permit rules adopted in 1984, however, do not address procedures unique to solid waste management facility permits. Therefore, the Agency believes that it is essential to adopt rules setting out procedures for permitting solid waste management facilities consistent with all other Agency permit programs and to codify these rules in chapter 7001.

The proposed permit rules supplement the general requirements of parts 7001.0010 to 7001.0210 and include all new parts 7001.3000 to 7001.3550. These rules will add requirements uniquely applicable to potential solid waste pollution sources that the Agency will use to issue, deny or modify permits. The proposed rules describe the procedures for submitting a permit application and the procedure the Agency will use to issue closure documents for facilities that require monitoring and maintenance after closure.

The Agency also proposes to adopt rules, to be codified in chapter 7035, establishing specific requirements for the design, construction, and operation of solid waste management facilities. The proposed revisions, when adopted, will supplement existing rules with similar purpose, Minn. Rules pts. 7035.0110 to 7035.2500. Further, these rules will establish ground water standards for mixed municipal solid waste land disposal facilities. The rules will also require the use of specific financial instruments to demonstrate financial capability to properly close facilities, monitor their effect on the environment after closure, and take corrective actions when needed. The rules are proposed for adoption pursuant to the Agency's authority under Minn. Stat. §§ 115.03, subd. 1 and 116.07, subds. 2, 4, 4g and 4h (1986).

This statement is divided into ten parts. After this introduction, Part II provides an overview of the proposed rules. Part III discusses the legal and historical background of the solid waste management rules. Part IV contains the Agency's explanation of the need for the proposed rules as a whole. Part V constitutes the Agency's explanation, part by part, of the reasonableness of the proposed rules. Pursuant to Minn. Stat. § 14.115 (1986), Small Business Considerations in Rulemaking, Part VI documents how the Agency has considered methods for reducing the impact of the proposed rules on small businesses. Pursuant to Minn. Stat. § 116.07, subd. 6 (1986), Part VII documents the economic impacts of the proposed rules. Pursuant to Minn. Stat. § 14.11 (1986), Agricultural Land, Part VIII documents how the Agency has considered methods for reducing any adverse impact the proposed rules might have on agricultural lands in the State. Part IX contains the Agency's conclusion regarding adoption of the rules. Part X contains a list of exhibits relied on by the Agency to support the proposed rules. The exhibits are available for review at the Agency's offices at 520 Lafayette Road, St. Paul, Minnesota 55155.

II. OVERVIEW OF PROPOSED RULES

In general terms, the proposed permit rules establish the procedures to be followed by applicants in obtaining solid waste management facility permits from the Agency. The rules also set out the Agency's procedure for reviewing permit applications, publishing public notices and issuing or denying these permits.

The proposed permit rules will modify seven existing rules and add 19 new rules pertaining only to solid waste management facilities. Part 7001.0020, an existing rule, indicates how the Agency permit rules apply to solid waste management facilities. The amendment modifies the time period for submittal of permit applications for certain facilities, i.e., solid waste transfer facilities, recycling facilities, compost facilities, and refuse-derived fuel processing facilities.

Part 7001.0040 is an existing rule regulating application deadlines for permit applications. This rule is amended by adding a subpart that requires applicants for new mixed municipal solid waste land disposal facilities to submit a preliminary application at least 90 days before work begins on a detailed site investigation.

Part 7001.0050 is an existing rule that is modified to add references to permit application requirements specific to solid waste management facilities. Part 7001.0060 is an existing rule regarding signatures required on permit applications and supporting documents. This part is modified to require that, if a solid waste management facility owner is different from the landowner, both must sign the permit application, and that all reports and plans prepared for a solid waste management facility permit application must be signed by an engineer registered in Minnesota.

Part 7001.0140 is an existing rule that is modified to require that Minn. Stat. § 473.823 be satisfied before the Agency may issue a permit for solid waste management facilities in the metropolitan area. This provision acknowledges the authority of the Metropolitan Council for permit review in the seven-county metropolitan area.

Part 7001.0170 is an existing rule stating the conditions under which the Agency Commissioner (hereinafter Commissioner) may commence proceedings to modify a permit or to revoke and reissue a permit. The rule is revised to include conditions specific to solid waste management facilities.

Part 7001.0190 is an existing rule establishing the conditions for modification, revocation and reissuance, and revocation without reissuance of permits. This rule addresses changes to permits considered to be minor modifications. These modifications require no public notice. The proposed modification to this rule adds a reference particular to solid waste management facilities.

Parts 7001.3000 to 7001.3550 are proposed new rules regarding the permitting of solid waste management facilities. These proposed rules contain provisions for the administrative procedures and permit application requirements for solid waste management facilities. Each part is further explained below.

Part 7001.3000 sets out the scope of the permit rules (parts 7001.3000 to 7001.3550) and explains which administrative procedural rules and permit rules complement each other for use during the permitting of solid waste management facilities.

Part 7001.3025 states where the definitions of terms used in parts 7001.3000 to 7001.3550 may be found.

Part 7001.3050 states when permits will be required, what facilities are not required to be permitted, what facilities will be permitted by rule and the circumstances under which permit-by-rule status may be terminated.

Part 7001.3055 requires the Agency to issue a closure document at the time a solid waste management facility is closed. The closure document would specify: the length of the postclosure care period; monitoring, testing and reporting requirements; and site maintenance requirements, as appropriate.

Part 7001.3060 requires that the landowner, facility owner, and facility operator be designated co-permittees for any solid waste management facility.

Part 7001.3075 identifies the major components to be included in a solid waste management facility permit application and the timing for submittal of new applications, applications for reissuance, and preliminary applications.

Part 7001.3125 contains the conditions under which the Agency may deny the owner or operator of an existing land disposal facility a permit to operate the facility, i.e., inability to meet financial assurance requirements; locational, operational and design requirements; or ground water, surface water, land, or air quality standards. If the Agency denies the permit, a closure document must be issued that may allow up to five years to comply.

Part 7001.3150 requires that anyone signing a permit application or any portion must also certify that the information provided in the application is accurate and truthful. An engineer registered in Minnesota who signs a permit application or technical documents would make the same certification. This part proposes that someone knowledgeable in the field of hydrogeology sign all documents regarding the site evaluation and ground water monitoring program.

Part 7001.3175 lists the information that must be included in a preliminary application for new mixed municipal solid waste land disposal facilities.

Part 7001.3200 lists the information required to be obtained during the preliminary site evaluation. The information will be submitted in a report describing the process used to select a site for use as a mixed municipal solid waste land disposal facility. The report must discuss how candidate sites were chosen and include supporting technical documentation.

Part 7001.3275 specifies the contents of the detailed site evaluation report, information that supports the use of a site as a mixed municipal solid waste land disposal facility.

Part 7001.3300 contains the general information requirements for all solid waste management facility permit applications. Four copies of the application and supporting documentation are required to be submitted to the Commissioner for review.

Proposed parts 7001.3375, 7001.3400, 7001.3425, 7001.3450 and 7001.3475 set out specific information required in permit applications for, respectively, compost facilities, transfer facilities, demolition debris land disposal facilities, refuse-derived fuel processing facilities and mixed municipal solid waste land disposal facilities.

Part 7001.3500 contains the terms and conditions the Agency will include in all solid waste management facility permits, such as the term (in years) for which each facility permit granted by the Agency will be effective and the design capacity. General conditions to be included in all facility permits are also set out.

Part 7001.3550 sets out the conditions that must be met to justify the modification, or revocation and reissuance, of solid waste management facility permits and establishes the actions considered minor permit modifications. Minor modifications may be made by the Commissioner in agreement with the permittee without completing the formal permitting process, e.g., public notice.

In general, the proposed new and amended technical rules in chapter 7035 cover the design, construction and operation of solid waste management facilities. The proposed technical rules establish standards to be applied to all solid waste management facilities. The proposed technical rules have been divided into 50 parts. This rulemaking covers amendments to existing rules and proposed new rules.

Part 7035.0300 is an existing rule that is amended to include 120 definitions of specific terms used in the existing and proposed technical rules for solid waste management facilities. Ninety-two new definitions are proposed and many others are deleted to make the part better address the proposed and existing rules.

Part 7035.0400 is an existing rule that specifies the general conditions by which solid waste must be stored, collected, transferred, transported, utilized, processed, disposed or reclaimed. These conditions ensure that solid waste is managed in a consistent manner throughout the State. This rule is amended to update references to its applicability.

Part 7035.0600 is an existing rule that establishes the conditions for requesting and issuing variances from the rules. This part is proposed to be modified to reflect administrative changes in the variance procedures.

Part 7035.0605 is a newly proposed rule that indicates where documents referred to, but not included, in the rules may be found.

Part 7035.0700 is an existing rule that addresses the storage of solid waste at individual properties. This rule establishes the minimum standards for containers used to store solid waste at individual properties to prevent public health problems. It is amended to clarify its language.

Part 7035.0800 is an existing rule relating to the collection and transportation of solid waste to a management facility. The requirements of this rule are designed to prevent spills and leaks that could lead to nuisance conditions, pollution problems, and public health concerns. It is proposed to be amended with clarifying language.

Part 7035.1590 is a new rule introducing a series of requirements, parts 7035.1590 to 7035.2500, applicable to industrial solid waste land disposal facilities. This series of rules currently addresses all landfills, but is being modified to apply to only industrial solid waste land disposal facilities. Part 7035.1590 identifies the relationship among the rules relating to the disposal of industrial solid waste. Additionally, this rule describes the information to be used by the Agency in approving or disapproving permits for these facilities.

Part 7035.1600 is an existing rule proposed to be retained and modified for industrial solid waste land disposal facilities. This rule describes those areas considered unacceptable for use as industrial solid waste disposal sites.

Part 7035.1700 is an existing rule proposed to be retained and modified for industrial solid waste land disposal facilities. This rule describes the maintenance and operation standards that will be applied to industrial solid waste land disposal facilities.

The contents of an industrial solid waste land disposal facility permit application are specified in part 7035.1800. This rule is an existing rule proposed to be retained and modified to describe the information needed by the Agency to determine the suitability of a proposed site for use as an industrial solid waste land disposal facility. The rule describes the specific areas that must be addressed and the format for the application.

Part 7035.1900 is an existing rule proposed to be retained and modified for industrial solid waste land disposal facilities. This rule establishes the conditions an owner or operator of an industrial solid waste land disposal facility must satisfy to initiate operations and start accepting industrial solid waste for disposal.

Part 7035.2500 is an existing rule proposed to be retained and modified specifically to establish who has the duty to properly close a facility and the procedure to be followed in the closure of industrial solid waste land disposal facilities.

Parts 7035.0100, 7035.0200, 7035.0500, 7035.0900, 7035.1000, 7035.1500, 7035.2000, 7035.2100, 7035.2200, 7035.2300 and 7035.2400 are repealed by this rulemaking process. These rules have been repealed because the proposed new technical rules will replace the standards contained in these existing rules.

Parts 7035.2525 to 7035.2875 are proposed new technical rules for the management of solid waste. These rules propose standards that would apply to land disposal facilities, compost facilities, recycling facilities, transfer facilities and refuse-derived fuel processing facilities. The rules propose requirements for financial assurance, ground water monitoring, ground water performance standards, personnel training, and design of each facility type. Each part is further explained below.

Parts 7035.2525 through 7035.2655 are requirements generally applicable to all solid waste management facilities. Parts 7035.2665 to 7035.2805 apply only to financial assurance requirements of owners and operators of mixed municipal solid waste land disposal facilities. Parts 7035.2815 to 7035.2875 each address technical standards applicable to a specific type of solid waste management facility.

Part 7035.2525 specifies the facility owners and operators who must comply with the standards contained in the solid waste rules and the facilities exempt from compliance with the standards. The exempted facilities either have low potential for causing pollution or are regulated by other rules.

Part 7035.2535 contains general solid waste management requirements applicable to all facility types. This rule contains a list of wastes that are unacceptable for management at solid waste management facilities. The rule also establishes requirements for notification of the Agency when facility ownership is intended to be transferred and for establishment of security and inspection arrangements. The rule requires development of an industrial solid waste management plan for all facilities and describes the contents of the plan.

Part 7035.2545 describes the personnel training required at all solid waste management facilities. The rule proposes that all personnel complete the training program approved by the Agency within six months after the effective date of the rules or employment at the facility. The rule describes the minimum training program requirements needed to provide facility personnel sufficient knowledge to handle problems that develop at the site and prevent avoidable problems.

Part 7035.2555 prohibits the construction and operation of a solid waste management facility in a 100-year floodplain, a wetland area, a shoreland area, or in special air quality zones.

Part 7035.2565 establishes the duty of facility owners to protect ground water, surface water, land, and air from pollution. The rule also proposes criteria for the Commissioner to set compliance boundaries, standards, and intervention limits in permits, orders, or stipulation agreements.

The information an owner or operator must collect and record at a facility is specified in part 7035.2575. The contents of an operating record are detailed in this rule.

Part 7035.2585 specifies the information to be contained in the annual report of all facility activities submitted to the Agency by each facility owner. The annual report will be submitted by February 1 of each year for the preceding calendar year.

Part 7035.2595 requires that every facility owner or operator design, construct and operate the facility in a manner that minimizes the potential for fires, explosions, or other incidents that may release pollutants to the air, water or land. The procedures to minimize the potential for emergencies include maintaining communication devices and fire extinguishers and making arrangements with the local authorities for the potential services needed at a facility. Included are a procedural manual and hazard assessment.

Specific procedures to prepare for emergencies at the facility are set out in part 7035.2605. Containment measures are the critical factors in controlling impacts during emergency situations. The rule also requires facility owners to report all emergency incidents to the Agency within two weeks of occurrence.

Part 7035.2610 requires the facility owner or operator of any solid waste management facility to submit a construction certification to the Commissioner upon completion of any project. Before the facility owner or operator may open or put any portion of a facility into operation, the Commissioner must inspect the facility and approve the construction certification.

Part 7035.2615 requires all facility owners or operators to prepare a contingency action plan. The rule prescribes the contents and implementation of the plan and how it is amended and approved.

Part 7035.2625 specifies when facility owners or operators must cease to accept waste and close a facility. It sets out the contents of a closure plan and how the plan is amended.

Part 7035.2635 sets the schedule to complete closure activities and the procedures to be followed during closure. These procedures include the activities outlined in the closure plan and a series of required notifications. The rule requires the facility owner or operator to place a notation on the property deed and submit a closure certification to the Agency.

Part 7035.2645 requires submittal of a postclosure care plan with a permit application and specifies the information that must be included in the plan. The postclosure care plan sets out the schedule for monitoring the facility after closure. The rule provides that the postclosure care plan be amended whenever the facility is modified. The original postclosure care plan and all modifications and cost estimates are used in establishing the level of financial assurance for the facility.

Part 7035.2655 establishes minimum requirements for care and use of the facility property after closure. Postclosure care, when required, must continue for at least 20 years after closure. The rule allows use of the property after closure in a manner that will not impair the integrity of a closed facility.

Part 7035.2665 introduces a series of 14 new rules that require owners and operators of mixed municipal solid waste land disposal facilities to meet certain financial assurance requirements.

Part 7035.2685 establishes the requirements for cost estimates for closure, postclosure care, and contingency actions at mixed municipal solid waste land disposal facilities. All cost estimates must be made in current dollars, based on the closure, postclosure care, and contingency action plans, and updated yearly and whenever each of the respective plans is modified.

This rule provides two methods for calculating the expected value of the probable events that may cause the contingency action plan to be implemented. A facility owner or operator may elect to complete either a site-specific risk analysis or use the normal distribution-expected value procedure included in the rule.

Part 7035.2695 requires that a facility owner or operator use one of the instruments included in the proposed rules as the means to establish financial assurance.

Part 7035.2705 establishes the requirements to be met in developing a trust fund, including the schedule by which a trust fund must be established.

This rule requires that a trust agreement be updated after any change in the cost estimates and that monthly payments be made into the trust fund. The owner or operator of a new facility must make the initial payment before any waste is accepted at the facility. The amount of each payment is determined by procedures outlined in the rule.

This rule also proposes a method for a facility owner or operator to show that the monthly payments calculated in accordance with the rule exceed the financial ability of the facility owner or operator. Separate methods of determination are provided for public and private sector owners or operators. The Commissioner, in consultation with the owner or operator, will determine if sufficient funds can be generated to meet the cost estimates.

Annual reviews of the cost estimates are required. A facility owner or operator may request the release of funds in excess of the cost estimates. This rule also proposes procedures by which the Commissioner will authorize reimbursement to a facility owner or operator for work completed in accordance with the closure, postclosure care, or contingency action plan.

Part 7035.2715 establishes how a trust fund may be established to receive payments by more than one owner or operator for financial assurance at different sites. The trustee must maintain a separate account for each site and the

Commissioner may only authorize withholding or reimbursements from the specific account designated for a site.

Part 7035.2720 establishes how a local government or authority may comply by setting up a special fund within its municipal treasury. The fund must be dedicated to facility closure, postclosure care and/or contingency action. The funds may be used only after the Commissioner has given permission for disbursement.

Part 7035.2725 establishes the criteria by which a facility owner or operator may satisfy the requirements for financial assurance using a surety bond to guarantee payment into a trust fund. A facility owner or operator using a surety bond to guarantee payment must establish a standby trust fund in the same manner a trust fund would be established.

Part 7035.2735 addresses the requirements that apply when a facility owner or operator uses a surety bond to guarantee performance. The requirements for submittal of the surety bond and standby trust agreement are the same as those described for the trust fund. The surety company issuing the bond must be listed as an acceptable surety on federal bonds in Circular 570, issued by the United States Department of Treasury as published in the Federal Register on July 1 of each year. The bond must guarantee that the owner or operator will perform closure, postclosure care, and corrective actions in accordance with the appropriate plan; or provide alternate financial assurance. The surety becomes liable on the bond obligation if the owner or operator does not perform as guaranteed by the bond. The surety will not be liable for deficiencies in the performance of closure, postclosure care, or corrective actions after the Agency releases the owner or operator from the financial assurance requirements.

Part 7035.2745 establishes the requirements to be met by a facility owner or operator who uses a letter of credit to comply with the financial assurance rules. The facility owner or operator must submit the letter of credit to the Commissioner under the same schedule as for a trust fund agreement. The facility owner or operator must also establish a standby trust fund into which payments are made if the Commissioner draws on the letter of credit. Whenever the facility owner or operator fails to perform the appropriate action, the Commissioner would draw on the letter of credit to obtain the necessary funds to complete the actions.

Part 7035.2750 proposes criteria by which a facility owner or operator may show sufficient security to self-insure for closure, postclosure care and contingency actions. Under this part, corporate bonds, municipal bonds or warrants would be used to provide collateral for self-insured facility owners and operators. As with other instruments, the user of self-insurance must establish a standby trust fund.

Part 7035.2755 allows a facility owner or operator to use more than one mechanism to comply with the financial assurance requirements. The combination of mechanisms must provide financial assurance for an amount equal to the sum of the cost estimates determined in the closure, postclosure care, and contingency action plans.

Part 7035.2765 provides a facility owner or operator with the option to use a single mechanism to meet the financial assurance requirements for more than one facility. The amount of funds included in the mechanism must equal the amount of funds that would be available if a separate mechanism were used for each facility. The Commissioner would be able to direct expenditures for a facility only in the amount of funds set aside in the mechanism for that facility.

Part 7035.2775 prescribes the conditions under which the Agency will release a facility owner or operator from financial assurance requirements for closure, postclosure care, or corrective actions at a facility.

Part 7035.2785 allows a facility owner or operator to use only one mechanism to establish financial assurance for closure, postclosure care, and corrective actions. The amount of funds available through the mechanism must be no less than the sum of funds that would be available if separate mechanisms had been established and maintained for closure, postclosure care, and corrective actions.

Part 7035.2795 proposes procedures to be followed if owners or operators, guarantors, or financial institutions fail to maintain financial assurance because of, for example, the commencement of a voluntary or involuntary bankruptcy proceeding or suspension or revocation of the institution's authority to issue the acceptable financial instrument.

Part 7035.2805 proposes specific language required to be used for: a trust agreement; a certification acknowledgement; a surety bond guaranteeing payment into a trust fund; a surety bond guaranteeing performance; a letter of credit; a self-insurance letter from the chief financial officer of a private firm; a self-insurance letter from the head of a public body; and a resolution that establishes a dedicated fund within a municipal treasury.

Parts 7035.2815 through 7035.2875 set out the facility standards or specific technical requirements for seven different types of solid waste management facilities.

Part 7035.2815 proposes the design, construction, and operational requirements specifically developed for mixed municipal solid waste land disposal facilities. This rule addresses the location, ground water performance, leachate collection and treatment, and gas management standards that will be used in evaluating a proposed facility for use as a land disposal site. Standards for completion of a hydrogeologic evaluation of disposal sites and for the engineering report addressing the design considerations are included in this rule.

The location standards are contained in subpart 2.

Subpart 3 provides that the hydrogeologic evaluation of a mixed municipal solid waste land disposal facility must be completed in phases and specifies those phases in detail.

Ground water performance standards are proposed in subpart 4 of this rule. They include, among other things, compliance boundaries and pollutant concentrations.

Under subpart 5, a facility owner or operator must submit an engineering report to explain and substantiate the proposed design of a mixed municipal solid waste land disposal facility. The report must address all facility features including surface drainage control structures, entrance and access roads, leachate collection and treatment system, and gas and water monitoring systems.

A facility owner or operator must design and maintain a cover system that minimizes infiltration into the fill areas, retains slope stability, maintains vegetative growth on the final cover, and prevents nuisance conditions. The cover system will consist of intermittent, intermediate, and final covers. The standards to be followed in designing a cover system are contained in subpart 6.

Subpart 7 proposes requirements for the design of liners to be used in mixed municipal solid waste land disposal facilities. The Commissioner may grant the facility owner or operator of an existing facility up to 18 months after the effective date of the rules to comply with the requirements. The Commissioner's decision will be based on subsurface geologic conditions, ground water flow patterns, ground and surface water quality, remaining site capacity, and the design and construction techniques used to mitigate leachate generation and migration.

A liner is not proposed for disposal areas at existing facilities that are vertically expanded. However, vertical expansions will be granted only if the facility owner or operator can show no increase in environmental damage because of design and operation techniques used at the facility.

Subpart 8 contains a list of analyses that must be conducted on soils to determine the soils' suitability for use as a liner or final cover material.

Subpart 9 provides the facility owner or operator with the minimum design standards for the leachate detection, collection and treatment systems to be constructed at a disposal site. The leachate management system must be capable of detecting leachate build-up on the liner, determining the effectiveness of the liner, and collecting and treating the leachate.

The leachate treatment system may consist of on-site treatment facilities or off-site treatment facilities. In either case, the treatment system must be designed and approved for the leachate generated at a facility.

The water monitoring system for a facility must be designed, installed, and maintained as required in subpart 10. The monitoring system includes both ground and surface water points and will serve as an early detection of the release of pollutants from a facility as well as a tracking system for the movement of pollutants. The numbers, types, depths, and separation distances of monitoring points will be based on specific site conditions.

Subpart 11 contains the standards for the design and construction of a gas monitoring system. The concentration of any explosive gas may not exceed its lower explosive limit at the property boundary or 25 percent of its lower explosive limits in buildings or at any other on-site monitoring point. This subpart proposes that all disposal areas be ventilated to the atmosphere, and that monitoring probes be placed between the disposal area and the property boundary and facility structures. A gas collection system would not be required at every facility. The need for a gas collection system would be based on analysis of the waste accepted at the facility, the size of the facility, and the proximity to residential or business property and other factors used to determine the potential impact of gas on human health and the environment.

Subpart 12 contains the minimum construction requirements that must be incorporated into the project specifications. A construction record including pictures, field notes, and all test results must be compiled and submitted with the as-built plans. A quality control and quality assurance program must be established for all construction projects. The program must address type and frequency of tests to be performed, schedule for inspecting construction activities, procedures for sampling, when appropriate, and methods for documentation of the construction activities.

The operation and maintenance requirements for a mixed municipal solid waste land disposal facility are proposed in subpart 13.

Subpart 14 contains the requirements for sampling and analyses for pollutants. Ground water quality, leachate quality, and surface water quality, where appropriate, will be monitored at all facilities. The Commissioner will establish in the facility permit the sampling locations, sampling schedule, substances to be analyzed, and other sampling procedures. The monitoring requirements will be established based on existing ground water conditions and specific facility design factors.

The Commissioner may establish in the facility permit specific procedures and quality control requirements including acceptable limits for precision and accuracy, frequencies for quality control samples, and the use of specific equipment. A quality control and quality assurance program is proposed to be developed for the analyses to be conducted on each sample. A facility owner or operator must submit annual reports of monitoring results.

Subpart 15 requires a facility owner or operator to repair features that are designed improperly or not functioning correctly and to control, recover, or treat polluted ground water or surface water and explosive or toxic gases. The actions must be consistent with those outlined and approved in the contingency action plan. A facility owner or operator may be required to go beyond the described procedures if necessary to comply with the rules.

Subpart 16 contains the requirements for closure and postclosure care at mixed municipal solid waste land disposal facilities. The closure plan must contain the procedures for closure of fill phases as well as final closure. Postclosure care requirements will include: access restriction, maintenance of final cover integrity and effectiveness, maintenance of monitoring systems, ground water monitoring and operation of the leachate collection and removal systems. During the postclosure care period, the site must be surveyed annually to determine settling, subsidence, erosion, or other potential problems. The closure document proposed for issuance by the Agency will detail postclosure care requirements based on the postclosure care plan.

Part 7035.2825 contains technical requirements for demolition debris land disposal facilities. Separate requirements are proposed for permit-by-rule facilities and facilities permitted through the formal permitting process. The owner or operator of a demolition debris land disposal facility that must be permitted through formal procedures must follow subparts 7 to 14. These procedures require evaluation of the type of waste to be accepted and the facility capacity in designing the site for development. A study of the site topography, geology, soil, and hydrogeology may be required by the Commissioner depending on the facility size and waste to be received. The Commissioner may also require financial assurance from a facility owner or operator depending on the facility size, operational practices, operating life, and types of waste accepted at the facility. The closure and postclosure care plans must contain the specific requirements approved by the Commissioner.

Part 7035.2835 proposes the requirements for designing, constructing, and operating a facility for composting solid waste or yard waste. Backyard composting at individual residences or businesses is not regulated under this rule. Yard waste compost sites are permitted by rule. The owner or operator of a yard waste compost site must notify the Commissioner before starting operation and submit an annual report to the Commissioner.

The owner or operator of a solid waste compost facility must design the composting area to contain all leachate generated during the composting process and divert surface water from entering the composting and storage areas, must develop a training program and operations manual, and must maintain a record of the waste characteristics, sewage sludge, and other bulking agents being composted.

This rule proposes standards to be used in determining the type of compost produced at a facility. All compost must be produced by a process to further reduce pathogens. The allowable limits for heavy metal and polychlorinated biphenyls found in the compost are described in this rule.

Part 7035.2845 proposes requirements for the design, construction, and operation of recycling facilities. A recycling facility accepting or processing source-separated wastes in quantities less than 10 cubic yards per day must comply with minimum requirements. These requirements would include notifying the Agency that the recycling facility is in existence, provide for adequate storage, and prevent spills.

The owner or operator of a recycling facility for large quantities of mixed municipal solid waste must design and operate the facility to prevent surface water drainage through the materials, contain all spills or releases, and provide adequate storage for the recycled materials and the residuals. The facility owner or operator must develop a contingency action plan that addresses the actions to be taken should a fire, spill, or release occur at the facility and identify back-up systems if the facility is shut down for a period of time. Final closure at a recycling facility must include the removal of all waste and contaminated soil.

Part 7035.2855 proposes requirements for the design, construction, and operation of a storage area at any solid waste management facility. Facilities used to store only waste tires are not covered by this rule. If the waste is stored indoors, the facility owner or operator is not required to meet the liner and leachate collection system design requirements. Outside storage areas must consist of a lined area and a leachate collection system capable of handling the leachate generated and any precipitation collected in the storage area. All liquids collected in the storage area must be properly tested and treated before disposal. The rule includes standards for inspection, waste removal and certification of repairs.

Part 7035.2865 proposes requirements applicable to solid waste transfer facilities. All solid waste disposed of or processed within the State and transported from a solid waste transfer facility must be delivered to an Agency-permitted facility. A facility must be designed with all-weather roads and truck wheel curbs and tiedowns for elevated unloading areas. The tipping areas, loading and unloading areas, storage areas, and processing areas must be constructed of impervious materials that are cleanable and capable of collecting free moisture. All residuals must be removed from the site at least monthly with putrescible wastes removed at least weekly.

Part 7035.2875 proposes requirements for the design, construction, and operation of refuse-derived fuel processing facilities. A facility must be designed to divert surface water drainage from outdoor storage areas; minimize the risk for explosions, spills, leakages, or releases; control odors; and produce the desired fuel product. Uncovered waste material, processed or unprocessed, must be stored on a low permeability surface. The facility must be capable of processing incoming solid waste within 24 hours based on the materials flow and balance calculations. The facility owner or operator must submit an annual report describing how much waste was received, how the waste was processed, and the amount of various products produced.

III. LEGAL AND HISTORICAL BACKGROUND OF THE RULES

This part begins by outlining the Agency's statutory authority, other legislative direction, and federal law regarding solid waste. After a brief introduction to the reasons for the current rulemaking, the history of the rulemaking effort is described.

In 1969, the Minnesota Legislature amended the Agency's authorities to add control of solid waste disposal methods and practices. Minn. Laws 1969, ch. 1046. Among other things, the Legislature directed the Agency to adopt standards and regulations regarding solid waste. Minn. Laws 1969, ch. 1046, § 6 (amending Minn. Stat. § 116.07, subd. 4). This solid waste authority in chapter 116 was added to the Agency's previous, more general, authorities under chapter 115, the Water Pollution Control Act, namely, to administer and enforce all laws relating to the pollution of any of the waters of the State, and to establish and alter standards and regulations to prevent, control, or abate water pollution. Minn. Stat. § 115.03, subd. 1.

Minn. Stat. § 115.03, subd. 1(e) (1986) grants the Agency the following powers and duties:

> To adopt, issue, reissue, modify, deny, or revoke, enter into or enforce reasonable orders, permits, variances, standards, rules, schedules of compliance, and stipulation agreements, under such conditions as it may prescribe, in order to prevent, control or abate water pollution, or for the installation or operation of disposal systems or parts thereof, or for other equipment and facilities;. . .

The authority to adopt rules governing solid waste is given in Minn. Stat. § 116.07, subd. 4 (1986), as follows:

> Subd. 4. Rules and standards. . . . Pursuant and subject to the provisions of chapter 14, and the provisions hereof, the pollution control agency may adopt, amend, and rescind rules and standards having the force of law relating to any purpose within the provisions of Laws 1969, chapter 1046, for the collection, transportation, storage, processing, and disposal of solid waste and the prevention, abatement, or control of water, air, and land pollution which may be related thereto, and the deposit in or on land of any other material that may tend to cause pollution. . . . Any such rule or standard may be of general application throughout the state or may be limited as to times, places, circumstances, or conditions in order to make due allowance for variations therein. Without limitation, rules or standards may relate to collection, transportation, processing, disposal, equipment, location, procedures, methods, systems or techniques or to any other matter relevant to the prevention, abatement or control of water, air, and land pollution which may be advised through the control of collection, transportation, processing, and disposal of solid waste . . . and the deposit in or on land of any other material that may tend to cause pollution.
> . . .

Minn. Stat. § 116.07, subd. 4 (1986).

The 1969 Legislature also enacted the Metropolitan Solid Waste Disposal Act. Minn. Laws 1969, ch. 847 (originally codified as Minn. Stat. ch. 473D and now codified as Minn. Stat. §§ 473.801 et seq.). This act authorized the Metropolitan Council to conduct long-range comprehensive planning and to approve permits for solid waste disposal sites and facilities in the metropolitan area. It further authorized counties in the metropolitan area to construct, operate, maintain and regulate solid waste disposal sites and facilities. This provision continued the direction the Legislature had taken in the 1967 session, when similar solid waste management authorities were granted to Anoka and Washington Counties, Olmsted County and Wright County. Minn. Laws 1967, chs. 413, 860, and 466.

The Agency adopted solid waste disposal regulations SW-1 to SW-11 in January 1970 (recodified in Minn. Rules pts. 7035.0100 to 7035.2400 (1987)). These rules cover solid waste storage, collection, transportation, land disposal, permitting, incineration, composting, closure of nonconforming disposal sites, and county solid waste management plans. Reflecting the concerns of the day, these rules were and remain heavily oriented toward preventing visible operational problems and aesthetic and nuisance conditions.

In 1971, the Legislature enacted the County Solid Waste Management Act of 1971. Minn. Laws 1971, ch. 403 (codified as Minn. Stat. ch. 400). This act extended solid waste management authorities similar to those previously granted to metropolitan area counties and certain nonmetropolitan counties, to all nonmetropolitan counties. Minn. Stat. ch. 400 (1986).

The existence of few environmental protection requirements in the solid waste rules led the Agency to revise the rules in 1973. Already the Agency was encountering problems with leachate generation and inadequate closure procedures; and the revisions corrected a few omissions. Some of the definitions in SW-1 were changed, and several new definitions were added. Minn. Rules pt. 7035.0300 (1987).

Many changes were made in regulation SW-6, governing sanitary landfills. Only the most significant of these will be described. They included requirements for landfills to maintain a minimum separation distance of five feet between the lowest portion of the landfill and the historical high water table elevation, to establish a water monitoring system, to control decomposition gases, to file a plat describing the landfill with the county register of deeds upon closure of the landfill, and to have the project engineer sign a construction certification before beginning operation. Also added were prohibitions on landfill siting in wetlands and on landfill disposal of liquids, certain sludges, special infectious waste, and other substances that may be deemed unacceptable by the Agency. Provisions laying out procedures for disposal of toxic and hazardous wastes in landfills were deleted from the rule. Hazardous wastes were now prohibited for disposal at landfills. SW-6 is now recodified as Minn. Rules pts. 7035.1600 to 7035.1800 (1987).

Finally, a new regulation SW-12, now known as Minn. Rules pt. 7035.2500 (1987), was added. SW-12 required the operators of all solid waste land disposal sites, including abandoned dumps, to close the sites according to specified procedures. Even after these revisions, the rules remained predominantly oriented toward control of nuisance conditions.

The Minnesota Legislature also strengthened State environmental policy in 1973 with the passage of the Minnesota Environmental Policy Act, Minn. Laws 1973, ch. 412 (codified as Minn. Stat. ch. 116D). Minn. Stat. ch. 116D directed all State agencies and departments, including the Agency, to improve and coordinate State plans, functions, programs, and resources so as to act as a trustee of the environment for future generations; assure for all people of the State safe, healthful, and productive surroundings; discourage ecologically unsound aspects of population, economic and technological growth; and encourage advanced waste treatment in abating water pollution. Specific directives were contained in Minn. Stat. § 116D.02, subd. 2.

In 1976, Congress amended the Solid Waste Disposal Act (42 U.S.C. §§ 3251 et seq.) by enacting the Resource Conservation and Recovery Act (RCRA) (42 U.S.C.

§§ 6901 et seq.). RCRA was enacted to promote resource recovery and conservation and to increase the development of environmentally-sound waste disposal. Subtitle D of RCRA, titled "State or Regional Solid Waste Plans," required states to develop and implement solid waste management plans. These plans in turn were to require disposal of all solid waste in sanitary landfills having "no reasonable probability of adverse effects on health or the environment from the disposal of solid waste at such facility." 42 U.S.C. § 6944. Subsequent regulations, codified as 40 CFR part 257, contained criteria for classifying disposal sites as either sanitary landfills, which fulfilled this requirement, or as open dumps, which did not. Among these criteria were restrictions on floodplain siting, surface water quality impacts, ground water quality impacts, landspreading of sludges and other wastes, open burning and air quality impacts, explosive gases, bird hazards to aircraft, and access. States were to classify disposal sites for publication in an inventory of open dumps, and to require closure or upgrading of sites that failed the criteria of 40 CFR part 257.

In 1980, the Agency amended regulation SW-11 in response to objections to the rules by the Legislative Commission to Review Administrative Rules (LCRAR). SW-11 had allowed land disposal sites that served small populations and did not conform to regulations SW-1 to SW-10 to continue operating with annual exemptions, but only during a transition period ending July 1, 1972. LCRAR asserted that the solid waste rules were not consistent with language in Minn. Stat. § 116.07, subd. 2:

> Subd. 2. Adoption of standards. . . . The agency shall also adopt standards for the control of the collection, transportation, storage, processing, and disposal of solid waste . . . for the prevention and abatement of water, air and land pollution, recognizing that due to variable factors, no single standard of control is applicable to all areas of the state. In adopting standards, the pollution control agency shall give due recognition to the fact that elements of control which may be reasonable and proper in densely populated areas of the state may be unreasonable and improper in sparsely populated or remote areas of the state, and it shall take into consideration in this connection such factors, including others which it may deem proper, as existing physical conditions, topography, soils and geology, climate, transportation, and land use. Such standards of control shall be premised on technical criteria and commonly accepted practices. . . .

Minn. Stat. § 116.07, subd. 2 (1986).

In response, the Agency amended SW-11, Minn. Rules pt. 7035.2400, subp. 1 (1987), to authorize issuance of modified landfill permits for the operation of land disposal sites located in sparsely populated areas, provided a number of conditions were met, including a requirement that "the proposed modified landfill will not cause pollution, impairment, or destruction of the environment . . . ." The requirements governing modified landfills were less restrictive than for sanitary landfills including less frequent cover and other relaxed operational requirements.

Growing concerns about solid and hazardous waste led to enactment of the Waste Management Act of 1980. Minn. Laws 1980, ch. 564 (codified as Minn. Stat. ch. 115A). This act dealt largely with hazardous waste management and with solid waste planning, but some provisions had a direct or indirect effect on the current rules revisions. The Act's section entitled "Legislative Declaration of Policy; Purposes" states that it is the goal of the Act to serve the following purposes:

(a) Reduction in waste generated;
(b) Separation and recovery of materials and energy from waste;
(c) Reduction in indiscriminate dependence on disposal of waste;
(d) Coordination of solid waste management among political subdivisions;
(e) Orderly and deliberate development and financial security of waste facilities including disposal facilities.

Minn. Stat. § 115A.02 (1986).

This declaration made it clear that the Legislature regarded land disposal as an undesirable waste management option, and that it was necessary to assure the financial security of land disposal facility operations, corrective actions, closure, and postclosure care.

The 1983 Environmental Response and Liability Act created an environmental response, compensation and compliance fund to finance the cleanup of releases of hazardous substances or pollutants and contaminants when the responsible person was unwilling or unable to take adequate response actions. Minn. Laws 1983, ch. 121 (codified as Minn. Stat. ch. 115B). The facility owner or operator was declared to be responsible for the release or threatened release of a hazardous substance, or a pollutant or contaminant, from the facility. Minn. Stat. § 115B.03, subd. 1 (1986). Subject to an exclusion for response costs or damages resulting from the release of a pollutant or contaminant, the Agency was empowered to recover all reasonable and necessary expenses, including response costs. Minn. Stat. §§ 115B.04, subds. 1 and 2, and 115B.17, subd. 6 (1986).

The Waste Management Act of 1980, chapter 115A, was amended every year from 1981 through 1986. In 1984, the following provisions were added to Minn. Stat. § 116.07:

> Subd. 4f. Closure and postclosure responsibility and liability. An operator or owner of a facility is responsible for closure of the facility and postclosure care relating to the facility. If an owner or operator has failed to provide the required closure or postclosure care of the facility the agency may take the actions. The owner or operator is liable for the costs of the required closure and postclosure care taken by the agency.
>
> Subd. 4g. Closure and postclosure rules. The agency shall adopt rules establishing requirements for the closure of solid waste disposal facilities and for the postclosure care of closed facilities. The rules apply to all solid waste disposal facilities in operation at the time the rules are effective. The rules must provide standards and procedures for closing disposal facilities and for the care, maintenance, and monitoring of the facilities after closure that will prevent, mitigate, or minimize the threat to public health and the environment posed by closed disposal facilities.
>
> Subd. 4h. Financial responsibility rules. The agency shall adopt rules requiring the operator or owner of a solid waste disposal facility to submit to the agency proof of the operator's or owner's financial capability to provide reasonable and necessary response during the operating life of the facility and for 20 years after closure, and to provide for the closure of the facility and postclosure care required under agency rules. Proof of financial responsibility is required of the operator or owner of a facility receiving an original permit or a permit for expansion after adoption of the rules. Within 180 days of the effective date of the rules, proof of financial responsibility is required of an operator or owner of a facility with a remaining capacity of more than five years or 500,000 cubic yards that is in operation at the time the rules are adopted. Compliance with the rules is a condition of obtaining or retaining a permit to operate the facility.

Minn. Laws 1984, ch. 644, § 49.

The 1984 amendments to the Waste Management Act also created the metropolitan contingency action fund. Minn. Laws 1984, ch. 644, § 75 (codified as Minn. Stat. § 473.845 (1986)). This fund is financed by a fee on solid waste disposed of in the metropolitan area. The fund can be used at metropolitan area mixed municipal solid waste land disposal facilities to cover the costs of closure and postclosure care, and response costs at facilities that have been closed for 20 years in compliance with Agency rules. The fund can also be used if the facility operator or owner cannot or will not take adequate or timely action, in which case the Agency may sue to recover incurred costs. The fund was created to enable the Agency to take action at abandoned sites and at sites where costs exceeded the site's financial assurance funds. The attorney general may bring an action to recover Agency expenditures.

Finally, the 1984 amendments included a provision intended to provide close State oversight on the use of land disposal facilities outside the metropolitan area:

> No new capacity for disposal of mixed municipal solid waste may be permitted in counties outside the metropolitan area without a certificate of need issued by the agency indicating the agency's determination that the additional disposal capacity is needed in the county. A certificate of need may not be issued until the county has a plan approved under section 115A.46. If the original plan was approved more than five years before, the agency may require the plan to be revised before a certificate of need is issued under this section. The agency shall certify need only to the extent that there are no feasible and prudent alternatives to the additional disposal capacity, including waste reduction, source separation, and resource recovery, that would minimize adverse impact upon natural resources. . . .

Minn. Laws 1984, ch. 644, § 45 (codified as Minn. Stat. § 115A.917 (1986)).

A similar law passed in 1980 required new mixed municipal solid waste land disposal facilities in the metropolitan area to obtain a certificate of need from the Metropolitan Council. Minn. Laws 1980, ch. 564, art. X, §§ 11-13 (codified in Minn. Stat. § 473.823). The law was extended in 1984 to require a certificate of need for all new disposal capacity. Minn. Stat. § 473.823, subd. 6 (1986). Also in 1986, the Agency adopted rules, titled "Comprehensive Solid Waste Management Planning and Certificate of Need." Minn. Rules pts. 7035.1100 to 7035.1115 (1987). These rules established a ten-year planning period for county solid waste management plans, with a review and possible update required every five years.

The Legislature amended the Waste Management Act again in 1985, and directed the Legislative Commission on Waste Management (LCWM) to recommend to the Legislature mechanisms that would enable mixed municipal solid waste land disposal owners and operators to comply with the impending financial assurance rules mandated in Minn. Stat. § 116.07, subd. 4h. Minn. Laws 1985, ch. 274, § 43.

The 1985 amendments also delayed the deadline for owners and operators to comply with the financial assurance rules. The third sentence of Minn. Stat. § 116.07, subd. 4h, quoted above, was amended to require proof of financial responsibility "within 180 days of the effective date of the rules <u>or by</u>

January 1, 1987, whichever is later . . . ." Minn. Laws 1985, ch. 274, § 14. Further amendments in 1986 changed that date to July 1, 1987. Minn. Laws 1986, ch. 425, § 28.

The 1986 amendments also added a State policy for the protection of potable water. Minn. Laws 1986, ch. 425, § 6 (codified as Minn. Stat. § 115.063 (1986)). These amendments apply to hazardous and radioactive waste rather than solid waste. However, the Legislature's findings cited in the policy are equally relevant to land disposal of solid waste since the impacts of polluting potable waters are the same regardless of the pollutant source. The policy reads as follows:

> 115.063. Hazardous and radioactive waste; state potable water protection policy.
>
> The legislature finds that:
>
> (1) the waters of the state, because of their abundant quantity and high natural quality, constitute a unique natural resource of immeasurable value which must be protected and conserved for the benefit of the health, safety, welfare, and economic well-being of present and future generations of the people of the state;
>
> (2) the actual or potential use of the waters of the state for potable water supply is the highest priority use of that water and deserves maximum protection by the state; and
>
> (3) the disposal of hazardous waste and radioactive waste in Minnesota may pose a serious risk of pollution of the waters of the state, particularly potable water.
>
> It is therefore the policy of the state of Minnesota, consistent with the state's primary responsibility and rights to prevent, reduce, and eliminate water pollution and to plan for the preservation of water resources, that depositories for hazardous waste or radioactive waste should not be located in any place or be constructed or operated in any manner that can reasonably be expected to cause pollution of potable water.

Minn. Stat. § 115.063 (1986).

In addition to the growing legislative concerns about solid waste, there were many other reasons the Agency undertook the current rules revisions. These reasons will be developed more fully in the following section on the need for the rules, but a brief account now, before recounting the history of the current rules revisions, will explain why the Agency believes so large and involved an undertaking is necessary.

The central need for the revisions is environmental protection. The current rules, Minn. Rules pts. 7035.0100 to 7035.2500, are brief, non-specific, and oriented toward operational considerations and aesthetic or nuisance conditions. Their inadequacy in environmental protection became apparent in the early

1980's.

In 1980, the Agency conducted the open dump inventory required by Subtitle D of RCRA. The Agency inventoried more than 1,600 sites. All but 135 of the sites were active or historical municipal waste disposal sites or dump sites. After review of file information and site inspections, the Agency reported that 86 sites, including eight permitted mixed municipal solid waste land disposal facilities, should be rated as "top priorities" for pollution potential; 131 more sites were listed as "high priority." See Exhibit I.

In 1980-1982, the disposal of industrial and commercial quantities of hazardous waste was discovered or more fully explored at several solid waste landfills, including Ironwood in Fillmore County, Waste Disposal Engineering in Anoka County, and Winona in Winona County. Ground water contamination was found at each site. These incidents, coupled with the knowledge that household quantities of hazardous waste were entering every site, raised further concerns about the adequacy of facility design, monitoring and siting under the current rules.

In the early 1980's, ground water monitoring at facilities began to include testing for volatile organic chemicals (VOC's), many of which are toxic or carcinogenic at very low concentrations. To date, VOC's have been found in ground water at nearly every permitted mixed municipal solid waste land disposal facilities tested (60 of 61 facilities), regardless of size or remoteness. See Appendix I.

The Agency had developed a voluntary program in 1980 for review of industrial solid waste proposed for disposal at mixed municipal solid waste disposal facilities (codisposal). It became evident that this codisposal program should be restructured and included in the rules. The staff time required for review of individual wastes was substantial, and the staff's knowledge of the subsurface conditions at existing facilities was incomplete, hindering codisposal evaluations. The voluntary program covered only a small portion of the industrial solid waste disposed of in mixed municipal solid waste land disposal facilities.

A shortage of disposal capacity at land disposal facilities in the metropolitan area and St. Cloud between 1978 and 1981 resulted in several facility closures and applications for expansion of permitted facilities. As the Agency reviewed these proposals and began to develop permit conditions appropriate to protect the environment, the current rules provided little guidance or support.

The Agency had to wrestle with the complex issues of siting and design again when the Waste Management Act of 1980 established a metropolitan area facility siting program. Each metropolitan area county was directed to adopt an inventory of three or four proposed sites, depending on the county's population. The Metropolitan Council could not approve or disapprove these sites until the Agency certified the intrinsic suitability of the sites for use as land disposal facilities. Minn. Stat. § 473.803, subd. 1a (1986).

The Agency also became aware that existing provisions for financial security for closure, postclosure care, and corrective actions were inadequate. Faced with correcting the ground water problems caused by their acceptance of hazardous wastes, the owners of Ironwood Landfill simply closed the gates. After the Hansen Landfill in Blue Earth County ceased activities without properly closing the site, the county board refused to call in the performance bond that was held in its favor to guarantee payment of closure expenses. Funds were also insufficient for proper closure of the St. Augusta Landfill in Stearns County, the Waste Disposal Engineering site in Anoka County, and others.

Developments elsewhere provided a stark contrast to the problems the Agency was experiencing with the solid waste rules. Other states, such as Wisconsin, were requiring more sophisticated land disposal facility designs emphasizing liners and leachate collection systems, and more sophisticated hydrogeologic investigation, monitoring, and financial assurance arrangements. A comprehensive approach was taken in the Agency's 1979 hazardous waste rules (Minn. Rules ch. 7045) and in the 1980 federal hazardous waste regulations (40 CFR parts 260 to 271). This contrasted sharply with the existing solid waste program, especially in light of the growing awareness that many solid waste land disposal facilities were causing ground water problems comparable to those at hazardous waste disposal sites.

One of the Agency's responses to these deficiencies was reflected in its amending of facility permits. Beginning in 1981-1982, the original permits without express expiration dates were upgraded to include increased hydrogeologic investigation, monitoring and design standards. The upgraded permits eventually included provisions for financial assurance and corrective actions. The Agency used its general authorities under the statutes and existing regulations to carry out this upgrading of permits. The Agency also began the long process of revising the solid waste rules.

The Agency staff began reviewing and redrafting the solid waste rules in 1981. Although considerable staff time and effort went into these internal drafts, the staff did not reach agreement on all provisions, and the revisions were postponed without any drafts being circulated outside the Agency. During these early efforts, the Agency informed a large number of interested persons of its intention to revise rules dealing with hazardous waste, solid waste and sewage sludge management. Persons who wished to receive future mailings on the solid waste rules were asked to return a brief form to the Agency. From the responses, the Agency formed an original mailing list for all rule revisions. The mailing list was updated for the solid waste rules in response to another specific form for solid waste rules, mailings, State Register notices, and requests from numerous additional interested persons.

Considerable internal review of the key issues took place again in late 1982. The staff developed a series of position papers. Each paper examined a specific issue related to solid waste rules. These papers provided the basis for the rules proposed for adoption here. See Exhibit II.

In June 1983, a unit was formed within the Agency's Division of Solid and Hazardous Waste to revise the solid waste rules. Before formulating policies or drafting new rules language, the Agency began an extensive process of reviewing existing solid waste programs and policy issues and soliciting outside opinion on these subjects.

A Solid Waste Management Program Development History containing the date, action, and Agency responses discussed in the remainder of this section has been prepared. See Appendix II.

Agency staff prepared an informational item for Agency Board members and interested parties, including the associations representing land disposal facility owners and operators and county officials. This September 16, 1983 item, titled "Solid Waste Management: Introduction to Issues and Staff Actions," presented the staff's review of the solid waste program and described the main issues the staff had identified thus far in the rulemaking effort. See Appendix III.

From August through November 1983, Agency staff held meetings to solicit suggestions on program and rule revisions from knowledgeable persons and interest groups, including county planning and zoning administrators, county solid waste officers, refuse haulers and facility operators, recyclers, community and environmental groups, and other State and regional agencies. Two key groups were the associations then representing owners of private-sector land disposal facilities, the Minnesota Waste Association (MWA), and the Minnesota Association of County Planning and Zoning Administrators (MACPZA). Staff met with nine MWA representatives in Roseville on September 2, 1983 and with MACPZA at their September 9, 1983 Board of Directors meeting in St. Cloud.

To help define and focus the issues, the Agency staff prepared a questionnaire that served as a basis for discussion during meetings. The questionnaire covered issues regarding solid waste planning, disposal abatement, enforcement, county responsibilities, industrial solid wastes, closure, postclosure care, contingency action, financial assurance and possible supplemental funding aid, and liability. The Agency mailed the questionnaire to all solid waste officers, county board chairpersons, and county zoning administrators during August and September 1983 and prepared a Responsiveness Summary to provide a simple overview of the input. See Exhibit III. Comments received reflected the diversity of the interests of meeting participants. Widespread agreement existed that a greater emphasis on environmental protection provisions was needed in the solid waste rules.

The staff also surveyed other states by telephone, using a separate questionnaire. A summary of the results of this survey is available. See Exhibit IV.

Based on the responses received, the staff prepared an action plan outlining main issues concerning solid waste management and the Agency solid waste program. The action plan also described actions the Agency should take in each of these areas. This document, titled "Changes in Minnesota's Solid Waste Management Program," was distributed on December 16, 1983 to all participants in the discussions and all other recipients of the questionnaire. See Appendix IV. It was also distributed to the approximately 350 participants in the "Evaluating Solid Waste Management Options" conference held in Brooklyn Park on February 23-24, 1984. This action plan established the main outline of the Agency's solid waste program changes, including revision of the rules, support for a new State fund to help pay for corrective action costs, and extensive efforts in solid waste management planning. Written comments were submitted on the action plan. See Exhibit V.

Subsequent mailings and staff appearances sought further input from a broad range of interested persons on the substantial impending changes in solid waste regulation. The Agency Board, during its January 24, 1984 regular meeting, approved a suggested staff resolution supporting legislation to: strengthen solid waste management planning; require certificates of need for disposal capacity; add to the Agency's authorities to require financial assurance; and create a State fund for closure, postclosure care, and corrective actions when the operator is unable or unwilling to act. See Appendix V. In testimony supporting this legislation, Agency staff described the Agency's position on major solid waste issues in testimony at several well-attended legislative committee hearings in early 1984. See Exhibit VI.

After enactment of the 1984 amendments to the Waste Management Act, the Agency notified persons on the mailing list of the new statutory requirements. This May 7, 1984 mailing again solicited comments on the range of subject areas to be covered in the rules, and requested persons interested in receiving future mailings on the rules revisions to return a brief enclosed form. See Exhibit VII. This letter was sent to additional potentially interested persons on December 27, 1984. See Exhibit VII. The Agency also published a Notice of Intent to Solicit Outside Opinion in the State Register on May 14, 1984. 8

S.R. 2420. See Exhibit VIII.

During the early drafting of financial assurance and planning portions of the revised rules, the Agency found that several issues needed outside comment before drafts could be completed. On October 1, 1984, the Agency mailed a letter to persons on the solid waste rules mailing list who had indicated interest in planning and certificate of need and financial assurance. The letter contained a request for their response on issues, optional approaches, and the option then believed to have the most merit. Many parties responded to the financial assurance questions with detailed comments. See Exhibit IX.

The Agency worked from March through September 1984 to develop an approach that would establish ground water quality standards for land disposal facilities. A separate October 1, 1984 mailing to selected outside technical experts described the Agency's proposal to include ground water quality standards in the solid waste rules. Two persons from outside the Agency submitted written comments. See Exhibit X.

In late 1984 and early 1985, the staff prepared a series of internal drafts of the revised rules. These drafts incorporated suggestions made by people outside the Agency, including comments received at additional statewide meetings in late 1984 and early 1985. The drafts were extensively reviewed by Agency technical and management staff.

The contents of the evolving rules drafts were explained and discussed in many meetings and public forums in late 1984 and early 1985. See Appendix II. Included among these was a series of eight meetings with multi-county solid waste planning groups, from December 1984 to March 1985, on the financial assurance provisions of the rules. On February 27, 1985, Agency staff met to discuss financial assurance with a technical review panel composed of bankers, insurance company representatives, and surety representatives.

Agency staff members explained the proposed solid waste rules in presentations on November 9, 1984 to the Minnesota Chapter of the Governmental Refuse Collection and Disposal Association and on February 20-21, 1985 at the Agency-sponsored annual Solid Waste Seminar in Bloomington. These presentations were attended by consulting technical personnel, local government officials, and facility owners and operators. In addition to the discussion and comments on the rules received in all these forums, some of the comments in the many meetings held from January through June 1985 on the proposed Comprehensive Solid Waste Management Planning and Certificate of Need Rules were also pertinent to the current rulemaking.

The Agency published its second Notice of Intent to Solicit Outside Opinion in the State Register on January 28, 1985. 9 S.R. 1697. See Exhibit VIII. On January 29, 1985, the Agency mailed the preliminary draft of the financial assurance rules to interested persons on the rules mailing list. The Agency requested comments and stated its willingness to meet with interested parties upon request. See Exhibit XI. Written comments were received. Agency staff responded with letters to many of the commentors. See Exhibit XI.

The Agency entered into discussions with the Minnesota Department of Health on issues surrounding the Agency proposal to establish ground water quality standards for land disposal facilities. An Interagency Toxics Committee met nine times from April 1985 to January 1986. The Committee researched and discussed a number of technical questions regarding allowable limits for consumption of contaminants and related health risk issues, and focused a portion of its activities directly on the solid waste rules proposals. The Committee's efforts culminated in February 1986 with the Department of Health's publication of a report, titled "Recommended Allowable Limits for Drinking Water." See Appendix VI.

On June 18, 1985, the Agency notified all holders of industrial solid waste disposal facility permits that the rule revisions would affect only mixed municipal solid waste and demolition debris facilities, but that substantive rules revisions affecting other types of waste management facilities would await completion of this first rulemaking. See Exhibit XII.

Preliminary drafts of the remaining portions of the solid waste rules were mailed to interested persons on the rules mailing list during the summer of 1985. The solid waste permit rule amendments were mailed July 1, 1985. The rules covering solid waste management facility standards and industrial solid waste handling (codisposal) were mailed August 1, 1985. See Exhibit XII. This mailing also included two papers that described proposed changes in the financial assurance rules. These changes were drafted in response to issues raised in meetings and written comments. The letter advised recipients of a series of informational meetings and requested comments on the rules at those meetings or in writing.

The primary announcement of these informational meetings was a mailing dated July 23, 1985. Agency staff held eight meetings in seven cities in August and September 1985: Roseville, Owatonna, Marshall, Thief River Falls, Fergus Falls, St. Cloud, Grand Rapids, and again in Roseville. The six meetings outside Roseville were full-day sessions. Agency staff explained each of the rules, then took questions and comments. The first Roseville meeting, directed largely at consultants and others interested in more detailed discussion of the technical provisions, took one and one-half days. The final meeting, in Roseville, was a half-day follow-up question-and-answer session. A total of 217 people attended the eight sessions. The attendees included county commissioners, county solid waste officers, facility operators, consultants, representatives of industry, environmental groups, and persons representing other interests. Attendees commented on all of the rules; the comments were later summarized by Agency staff. See Exhibit XIII.

Agency staff met with the Agency Board's Solid and Hazardous Waste Committee in Grand Rapids on October 3-4, 1985 on the financial assurance portions of the proposed rules. See Exhibit XIV. At the latter meeting, staff explained the rules dealing with financial assurance and design, operational, and ground water performance standards for mixed municipal solid waste land disposal facilities, and received suggestions and extensive questioning from Board committee members.

The Agency continued to meet with numerous individual interested groups and technical experts, sometimes at the request of the interested parties and other times at the Agency's request. All these meetings are listed in Appendix II. Brief comments on a few of the meetings follow. Agency staff met in July 1985 with well drillers, soils engineers, and Minnesota Department of Health regulators on the requirements for water monitoring systems at mixed municipal solid waste land disposal facilities, and with representatives of analytical laboratories and ground water sampling firms on the sampling and analytical requirements. In July and August 1985, the Agency met with the Minnesota Chapter of the National Solid Waste Management Association (NSWMA) on the financial assurance provisions. These provisions were discussed with representatives of trust companies on September 24, 1985. The rules were discussed in meetings with the Association of Minnesota Counties on August 16, 1985; the Minnesota Association of Commerce and Industry on September 18 and October 16, 1985; and the Metropolitan Inter-County Association Environment Committee on May 5, 1986. The Agency met with representatives of the Consulting Engineers Council on April 9 and April 17, 1986.

The Agency continued to present discussions of the rules at larger seminars and conferences. These included speeches to solid waste seminars sponsored by MN/NSWMA on July 19, 1985 in Bloomington and by MN/NSWMA and the Association of Minnesota Counties on December 12, 1985. Another speech, to the Association of Minnesota Counties annual convention on January 27, 1986 presented the Agency's position on financial assurance issues. Return visits to the Agency-sponsored Annual Solid Waste Seminar in Bloomington on February 20-21, 1985, February 19-20, 1986 and February 19, 1987 were devoted to presentations, questions, and comments on the rules.

Additional meetings with the Agency Board's Solid and Hazardous Waste Committee were held in Roseville on January 27 and February 24, 1986. At the first meeting, discussion covered the rules provisions regarding solid waste storage, transfer facilities, refuse-derived fuel processing facilities, and codisposal of industrial solid waste at mixed municipal solid waste land disposal facilities. The second meeting covered the permit rules and continued discussion of codisposal issues. See Exhibit XIV.

In February and March 1986, the Agency held a series of meetings statewide to give county commissioners, county solid waste officers and facility operators another opportunity to question Agency solid waste program managers and rulewriters and comment on the rules specifically and the solid waste program in general. These half-day working sessions were jointly sponsored by the Association of Minnesota Counties, the recently-formed Minnesota Association of County Solid Waste Officers, and the Agency. The working sessions were held in ten cities: Rochester, Eveleth, Walker, Mankato, St. Cloud, Thief River Falls, Fergus Falls, Slayton, Montevideo, and Roseville. The format involved a minimum of staff presentations and an extended opportunity for questioning and discussion. A total of 255 people attended the ten sessions. See Exhibit XV.

Taking into account both the written and oral comments, Agency staff redrafted all portions of the rules. A final draft combined the permit, financial assurance and all other portions of the rules. This draft was mailed to all interested persons on the mailing list on September 5, 1986. The letter requested recipients to provide written comments, and announced another round of public informational meetings. These meetings were held in October 1986 in six cities: Duluth, Brainerd, Marshall, Detroit Lakes, Rochester, and St. Paul. See Exhibit XVI.

The last part of 1986 included other meetings with specific groups. The Agency staff on November 14, 1986 mailed another comment request to everyone on the mailing list. This letter advised readers that the period for receiving comments had been extended and described, in general terms, the Statement of Need and Reasonableness and its role in administrative hearings.

The staff had two meetings in late 1986 with the Agency Board's Solid and Hazardous Waste Committee. The first meeting was held on November 24 and concentrated on the technical rules' ground water standards. The second meeting was held on December 15 and covered revisions made in earlier drafts of the financial assurance rules.

The Agency staff met with various interested people on March 18 and 19, 1987 to discuss final changes in the draft rules. The people attending these meetings represented the commentors who had submitted written comments on the September 1986 draft of the rules.

In summary, Agency staff has put in considerable effort to give full exposure to the concepts and the specific language in the proposed rules. All persons living in Minnesota have been given an opportunity for input into the rulemaking.

IV. NEED FOR THE PROPOSED RULES

Minn. Stat. § 14.14, subd. 2 (1986) requires an agency to make an affirmative presentation of facts establishing the need for and the reasonableness of the proposed rules. In general terms, this means that an agency must set forth the reasons for proposing rules and the reasons must not be arbitrary or capricious. However, to the extent that need and reasonableness are separate, need has come to mean that a problem exists and requires administrative attention and reasonableness means that the solution proposed by the Agency is a proper one. The Agency will first address need.

The need for these rules arises from the following sources:

1. The requirements of Minn. Stat. §§ 115.03, 115.07, 115A.02, 115A.42, 115A.917, 116.07, 116.081, and 116D.02 (1986).

2. The need to manage waste in an effective manner to protect human health and the environment.

3. Federal Resource Conservation and Recovery Act criteria for classifying solid waste disposal facilities and practices (40 CFR part 257).

4. The Hazardous and Solid Waste Amendments of 1984 requiring states to adopt and implement a permit program to ensure that facilities which accept household hazardous waste are in compliance with the criteria of 40 CFR part 257.

A. Requirements of Minn. Stat. §§ 115.03, 115.07, 115A.02, 115A.42, 115A.917, 116.07, 116.081, and 116D.02 (1986).

The Minnesota Legislature has "given and charged" the Agency with the power and duty:

> (e) To adopt, issue, reissue, modify, deny, or revoke, enter into or enforce reasonable orders, permits, variances, standards, rules . . . to prevent, control or abate water pollution, or for the installation or operation of disposal systems . . . ;
>
> (1) Requiring the discontinuance of the discharge of . . . wastes into any waters of the state . . .;
>
> . . . .
>
> (3) Prohibiting the storage of any liquid or solid substance or other pollutant in a manner which does not reasonably assure proper retention against entry into any

> waters of the state . . . ;
> (4) Requiring the construction, installation, maintenance, and operation by any person of any disposal system . . . to prevent, control or abate any discharge or deposit of sewage, industrial wastes or other wastes by any person. . . .

Minn. Stat. § 115.03, subd. 1 (1986).

Minn. Stat. §§ 115.07, subd. 1; 116.07, subd. 42; and 116.081, subd. 1 all require a permit to operate a facility. The procedure for obtaining a permit must be established by rulemaking. The Agency is undertaking this rulemaking process to establish permitting procedures for solid waste management facilities.

More specifically, the Minnesota Legislature has required the Agency to "adopt standards for the control of the collection, transportation, storage, processing, and disposal of solid waste . . . for the prevention and abatement of water, air, and land pollution . . . ." Minn. Stat. § 116.07, subd. 2 (1986). The Legislature has supplemented that basic duty and made it more specific with the following:

> Subd. 4. Rules and standards. . . . Pursuant and subject to the provisions of chapter 14, and the provisions hereof, the pollution control agency may adopt, amend, and rescind rules and standards having the force of law relating to any purpose within the provisions of Laws 1969, chapter 1046, for the collection, transportation, storage, processing, and disposal of solid waste and the prevention, abatement, or control of water, air, and land pollution which may be related thereto, and the deposit in or on land of any other material that may tend to cause pollution. . . . Without limitation, rules or standards may relate to collection, transportation, processing, disposal, equipment, location, procedures, methods, systems or techniques or to any other matter relevant to the prevention, abatement or control of water, air, and land pollution which may be advised through the control of collection, transportation, processing, and disposal of solid waste . . . and the deposit in or on land of any other material that may tend to cause pollution. . . .

Minn. Stat. § 116.07, subd. 4 (1986).

The proposed rules are needed to provide a comprehensive program capable of protecting human health and the environment during the collection, transportation, storage, processing, and disposal of solid waste. The rules for solid waste management facilities will establish a system that minimizes the migration of pollutants into the air, land, and waters of the State, detects impacts on the environment, and ensures the availability of financial resources to operate the facilities.

In the Waste Management Act of 1980, the Minnesota Legislature stated its goals for solid and hazardous waste management. The 1980 Act states that it is the goal of the State to improve waste management in the State to serve the following purposes:

> (a) Reduction in waste generated;
> (b) Separation and recovery of materials and energy from waste;
> (c) Reduction in indiscriminate dependence on disposal of waste;
> (d) Coordination of solid waste management among political subdivisions;
> (e) Orderly and deliberate development and financial security of waste facilities including disposal facilities.

Minn. Stat. § 115A.02 (1986).

The Minnesota Legislature has stated that land disposal of waste is not a desirable management option. The Legislature is also concerned about the financial stability of the owners of waste facilities, particularly as financial conditions relate to environmental protection. The proposed rules are needed to assure the financial security of disposal facility operations, closure, postclosure care, and corrective actions.

The Legislature's concern for waste management in Minnesota is further emphasized through the amendments to the Waste Management Act of 1980. Amendments were made in every year from 1981 through 1986. In particular, the 1984 amendments gave very specific direction to the Agency regarding solid waste disposal facilities. These directives are included in the following provisions of Minn. Stat. § 116.07.

> Subd. 4f. Closure and postclosure responsibility and liability. An operator or owner of a facility is responsible for closure of the facility and postclosure care relating to the facility. If an owner or operator has failed to provide the required closure or postclosure care of the facility the agency may take the actions. The owner or operator is liable for the costs of the required closure and postclosure care taken by the agency.
>
> Subd. 4g. Closure and postclosure rules. The agency shall adopt rules establishing requirements for the closure of solid waste disposal facilities and for the postclosure care of closed facilities. The rules apply to all solid waste disposal facilities in operation at the time the rules are effective. The rules must provide standards and procedures for closing disposal facilities and for the care, maintenance, and

> monitoring of the facilities after closure that will prevent, mitigate, or minimize the threat to public health and the environment posed by closed disposal facilities.
>
> Subd. 4h. Financial responsibility rules. The agency shall adopt rules requiring the operator or owner of a solid waste disposal facility to submit to the agency proof of the operator's or owner's financial capability to provide reasonable and necessary response during the operating life of the facility and for 20 years after closure, and to provide for the closure of the facility and postclosure care required under agency rules. Proof of financial responsibility is required of the operator or owner of a facility receiving an original permit or a permit for expansion after adoption of the rules. Within 180 days of the effective date of the rules . . . , proof of financial responsibility is required of an operator or owner of a facility with a remaining capacity of more than five years or 500,000 cubic yards that is in operation at the time the rules are adopted. Compliance with the rules is a condition of obtaining or retaining a permit to operate the facility.

Minn. Stat. § 116.07, subds. 4f, 4g and 4h (1986).

The proposed rules are needed for the Agency to meet the legislative directives regarding the closure and postclosure care of solid waste disposal facilities. The proposed rules are needed to establish the financial responsibility of an owner or operator as it relates to the closure and postclosure care requirements.

The proposed rules are needed to provide a coordinated process by which disposal facilities may receive a permit after a certificate of need has been issued by the Waste Management Board.

> No new capacity for disposal of mixed municipal solid waste may be permitted in counties outside the metropolitan area without a certificate of need issued by the [Waste management] board indicating the board's determination that the additional disposal capacity is needed in the county. A certificate of need may not be issued until the county has a plan approved under section 115A.46. . . .

Minn. Stat. § 115A.917 (Supp. 1987).

In summary, the proposed rules are needed to prevent, abate and control water and land pollution, as required by Minn. Stat. §§ 115.03 and 116.07, subds. 2 and 4 (1986), for the reasons stated above. The proposed rules are needed to provide financial security of waste facilities as stated in the Waste

Management Act of 1980, Minn. Stat. § 115A.02 (1986), discussed above. The proposed rules are further needed to establish standards for closure, postclosure care and financial responsibility, as required in Minn. Stat. § 116.07, subds. 4f, 4g, and 4h (1986). The proposed rules establish a mechanism by which the certified capacity for land disposal of mixed municipal solid waste is reflected in Agency permits. Minn. Stat. § 115A.917 (Supp. 1987).

B. Comprehensive Waste Management to Protect Human Health and the Environment.

In 1967, the Minnesota State Legislature created the Minnesota Pollution Control Agency and mandated a study concerning the control of solid waste within the State. The study would serve as guidance for solid waste management.

A study was completed by Henningson, Durham and Richardson in 1969. Reference 1. The study enumerated problems at dumps throughout Minnesota.

1. Unsightliness due to blowing paper.
2. Uncontrolled burning.
3. Lack of cover.
4. Scavenging and salvaging permitted.
5. No attendants on-site.
6. No quantity records maintained.
7. No rodent or insect control.
8. No ultimate use plan for the sites.
9. Placement of waste in the water table.
10. Placement of hazardous waste on-site.
11. No record of closed site locations.
12. Poor county planning.

After describing the most common solid waste management problems of 1967 and 1968, the report recommended the following actions:

1. Promote state and local legislation to improve operations at dump sites.
2. Develop and enforce standards.
3. Provide leadership in solid waste management.

In 1969, the Agency adopted an air quality rule (now codified as Minn. Rules pts. 7005.0700 to 7005.0820 (1987)) regulating open burning. The rule was adopted to eliminate air pollution problems resulting from facilities without proper air pollution control devices and nuisance conditions resulting from open burning. This rule eliminated the use of burning as a method of solid waste reduction at dumps. Thus, the need for proper management and operational techiques increased in magnitude because permitted land disposal facilities would take in more solid waste than dumps.

On January 12, 1970, the Agency adopted solid waste rules (now codified as Minn. Rules pts. 7035.0300 to 7035.2400 (1987)) to address the collection, transportation, and disposal of solid waste. These rules were intended to close mismanaged dumps and institute the practice of sanitary landfilling, thereby eliminating nuisance conditions at the dumps. The permits allowed by the rules contained standards regarding the amount and frequency of cover, the compaction of the solid waste, methods for disposal of the waste, reporting requirements, and other operational standards. The permits did not require a ground water monitoring system at each facility. Having a ground water monitoring system remained an optional standard until 1973.

In 1971, research available from academic and federal government programs indicated potential problems resulting from accepting industrial and hazardous wastes at mixed municipal solid waste landfills. The Agency required permit applications to designate areas and special handling techniques for storage or disposal of industrial and hazardous wastes at mixed municipal solid waste land disposal facilities. This process allowed these wastes to be stored or disposed of at a facility while the Agency gathered further information to determine the effects the wastes would have on ground water.

In 1972, the EPA published a guidance manual for the design and operation of sanitary landfills. The manual was titled "Sanitary Landfill Design and Operation" (SW-65ts). The manual recommended a five-foot separation between the fill base and the water table. EPA's research indicated the separation would remove enough readily-decomposed organics and bacteria to make leachate acceptable for mixing with ground water. The manual also recommended that two feet of cover and impermeable liners be used to control the movement of liquids into and out of these facilities. There was no recommendation on the permeability needed to ensure the effectiveness of the cover and liner design.

With the above information, the Agency began a review of the solid waste rules to determine changes that would improve its ability to protect Minnesota's environment. Until the changes could be made, permit and enforcement actions continued to emphasize operational standards. Reviewing the available information on disposal facilities and discovering leachate seeps at permitted sites caused the Agency to recognize that ground water could easily be polluted. The Agency determined that changes were needed to prevent pollution.

Therefore, in 1973, the Agency amended the solid waste rules to strengthen the land disposal facility standards. The rule revisions were primarily based on the 1972 EPA guidance manual. The changed requirements included a minimum five-foot separation distance to ground water, mandatory ground water and gas monitoring, stricter control on the wastes accepted at the facility, and prohibition on disposal of hazardous wastes, liquids, sludges, and special infectious wastes at mixed municipal solid waste land disposal facilities. All permit applications were required to include a hydrogeologic study with at least one soil boring placed to a depth of 50 feet below the proposed excavation and lowest elevation of the site.

The 1973 rule revisions also included a new rule, now codified as Minn. Rules pt. 7035.2500 (1987), containing closure requirements for dumps and sanitary landfills. This rule was intended to ensure sites were adequately covered, sloped to encourage surface drainage, and seeded to prevent erosion. The rules as amended in 1973 were deemed adequate to protect the environment, based on the information then available.

During the 14 years that the current permit and technical standards have been in effect, considerable new information has been obtained through literature review and actual monitoring data. This information shows that the existing rules do not provide adequate environmental protection.

In Minnesota, it is estimated that over 1,600 open dumps were used for solid waste disposal. The majority of these sites were located in undesirable areas such as floodplains, swamps, and gravel pits. The Agency directed solid waste management efforts at closing the open dumps in coordination with the construction of sanitary landfills. The permits issued for these early landfill facilities contained little guidance on standards pertaining to the landfills. Initial permits had no expiration dates. The lack of direction and dates in the permits has created considerable difficulty in enforcement of the existing solid waste rules. A more systematic approach is needed to issue permits and modify them as necessary to accommodate technological changes.

In 1984, the Agency took steps to develop a consistent approach to the permitting process for all facilities governed under air quality, water quality, hazardous waste, and solid waste rules. The existing permit rules were revised and consolidated into one set of rules, Minn. Rules ch. 7001. However, few provisions specific to solid waste management were included in the 1984 permit rule revisions. Therefore, revisions are needed to the rules addressing the permitting of solid waste management facilities.

To better understand the need for revisions to the permit rules, it is necessary to look at the changes in solid waste technology and management procedures that have occurred in the last decade. In the 1970's, it became clear that land disposal facilities were not designed adequately to protect the environment. In 1979, a report to the joint legislative committee on solid and hazardous waste indicated that land disposal was not the best management technique and solid waste management should be directed to alternatives other than land disposal. Reference 2. This report became the basis for the Waste Management Act of 1980. The Waste Management Act established a State policy for solid waste management that included the use of alternatives to land disposal. The Waste Management Act required counties to develop solid waste management programs that do not rely on land disposal. The 1984 amendments to the Waste Management Act required counties to obtain a certificate of need for any additional land disposal capacity needed for mixed municipal solid waste. A certificate of need can only be issued after alternative management techniques are implemented.

As counties undertook comparing alternative solid waste management techniques, they looked to the Agency for permit requirements and technical design and operational standards. The existing rules do not address the permitting of recycling facilities, refuse-derived fuel processing facilities, or co-composting facilities. Therefore, revisions to the permit rules are needed to enable counties to compare management alternatives and to provide permit applicants sufficient information so the Agency can review facilities' potential impacts on human health and the environment.

To obtain a certificate of need counties must establish a solid waste management system that incorporates the use of recycling, composting or other methods to reduce the amount of mixed municipal solid waste that must be land disposed. As discussed in item C below, Minn. Stat. § 115A.917 (Supp. 1987) prohibits the permitting of new capacity for disposal of mixed municipal solid waste in the nonmetropolitan area without completion of the planning process and issuance of a certificate of need. Minn. Stat. § 473.823 sets a similar requirement for disposal of mixed municipal solid waste in the seven-county metropolitan area. Therefore, revisions to the permit rule are needed to reflect these statutory requirements.

In 1974, water monitoring results showed that land disposal facilities impacted ground water quality. Additionally, leachate was observed leaking from side slopes and fill areas at the facilities. These early warnings indicated that something was wrong and land disposal facilities could cause pollution. However, these monitoring results were contrary to the perceived fundamentals of facility performance and no standards existed to measure the nature of the impacts. The Agency, counties and facility operators believed these problems were related to poor operation rather than poor design or location. This belief resulted in increased enforcement efforts to correct poor operational practices. Little was done to change designs.

In 1975 and 1976, the Agency put considerable effort into closing dumps and permitting land disposal facilities. The Agency had permitted approximately 125 land disposal facilities and demolition debris land disposal sites by this time. About 100 facilities had some sort of monitoring system. Ten facilities had documented leachate problems, and two had leachate collection systems. Typical monitoring systems at facilities during this time consisted of one private water supply well located at a nearby residence, which may have been as far as one mile away, or suction lysimeters placed around the fill area to monitor the unsaturated soil zone. At some facilities, owners and operators installed and attempted to determine ground water flow directions. At this time the Agency believed that three monitoring wells, one upgradient and two downgradient, could provide adequate information to determine the impacts of the landfill on the surrounding environment.

In 1976, the federal government enacted the Resource Conservation and Recovery Act (RCRA) in response to the new American ideal of self-sufficiency resulting from the 1973 oil embargo. RCRA promoted resource recovery and resource conservation as well as controlling disposal of solid and hazardous waste. Relative to solid waste, RCRA requires many planning activities and established minimal performance standards for land disposal facilities. These performance standards were used to determine the status of a disposal facility - dump versus landfill. RCRA required all states to complete an open dump inventory. By 1977, the majority of Minnesota dumps were closed and landfills permitted. Unfortunately, many of the dumps had not been covered properly or sloped to promote run-off of precipitation. Operations at some sites were so poor that the landfills looked like dumps and were perceived as such.

In 1977, the Agency attempted to correct deficient operational practices through enforcement actions rather than rule revisions. During this time, for example, legal action was taken against the owners of the Oak Grove Landfill. The facility had violated operational standards. The county of Anoka and the Agency jointly revoked the operating permit for the facility. In an Agency hearing, the permit was revoked; however, in an appeal to the court system, the revocation was overturned. The court found that violations of operational requirements, specifically daily cover and litter control, were not sufficient cause for revocation as they could not be directly linked to pollution abatement. This finding cast doubt on the enforcement ability of the Agency. The proposed rules are needed to better define the pollution abatement actions required at a solid waste management facility.

By 1979, the Agency began to focus on ground water issues in general, and hazardous waste in particular. In 1979, the Agency adopted hazardous waste rules. The EPA followed with rules in 1980. These actions focussed the State's attention on hazardous waste. In 1980, the Agency completed the open dump inventory mandated in RCRA. More than 1,600 sites were inventoried and all but 135 were active or historical mixed municipal solid waste land disposal facilities or dumps. After reviewing file information and conducting site inspections, 86 sites were rated as top priorities for pollution potential. The Agency identified a need to close open dumps and control operations at permitted facilities.

The discovery of hazardous waste disposal at solid waste facilities further reminded the Agency of potential pollution problems. During 1980 to 1982, the Agency discovered ground water contamination at solid waste facilities including Ironwood Landfill in Fillmore County, Waste Disposal Engineering Landfill in Anoka County, Winona Landfill in Winona County, Hibbing Dump in St. Louis County, Oakdale Dump in Washington County, and Windom Dump in Cottonwood County. These discoveries, coupled with the knowledge that household quantities of hazardous waste enter solid waste land disposal facilities, again raised concerns about the adequacy of the existing design, monitoring, and siting rules.

In 1980, the Agency developed a program to review industrial solid waste intended for disposal at mixed municipal solid waste land disposal facilities. The program was developed as a follow-up program to the hazardous waste disclosure program and to address the rule now codified as Minn. Rules pt. 7035.1700, item V (1987). The existing rule reads as follows:

> V. The following shall not be acceptable for deposit in sanitary landfills except in amounts normal in household waste: . . . .
> (4) Other substances that may be deemed unacceptable by the agency.

The industrial solid waste program was voluntary and consisted of an Agency review of data provided by the waste generator, the design and operation of the facility, and ground water monitoring test results. From this information, the Agency determined the suitability of the proposed facility for use as a disposal site for the waste in question. Each waste was required to be analyzed and no blanket approvals were granted. For example, paint filters from one industry were not considered acceptable without proper analyses unless the processes and materials could be shown to be the same as those found in an industry that previously analyzed the waste. Disposal of only 7 percent of the total amount of industrial solid waste generated actually was approved through the codisposal process. The staff time needed to review individual codisposal requests was overwhelming and little actual site hydrogeologic information was available.

Difficulties also arose in delivery of waste to the disposal site. The Agency's approval stated only that the waste described by the accompanying data was acceptable for disposal at a particular site. The facility owner had the final approval and the responsibility to ensure that waste delivered to the facility was indeed the waste approved. Inspection of incoming waste was not stringent in many cases. Many facility owners did not accept either their responsibility or the consequences of inappropriate wastes being delivered to the facility.

This problem became particularly important in the case of the Ironwood Landfill in Fillmore County. Generators shipped hazardous waste to the facility along with wastes that were approved through the codisposal process. The hazardous waste contaminated ground water and required costly remedial actions. This facility had been considered an acceptable disposal site for nonhazardous waste because the little site information available at the time indicated the subsurface soils consisted mainly of clay. As the facility owner conducted ground water monitoring, it became clear how little the owner knew about the hydrogeologic conditions at the site.

The Agency reconsidered the need for upgraded design and operational standards and a means to handle nonhazardous industrial solid waste. The facility operators' association (Minnesota Waste Association) requested that the codisposal process be put into rule so all facilities must comply. The proposed rules need to address the issues of managing industrial solid waste at mixed municipal solid waste land disposal facilities and developing adequate design requirements.

In 1980, ground water monitoring at land disposal facilities expanded to include testing for organic pollutants. From this testing, it became apparent that leachate from mixed municipal solid waste land disposal facilities contained a variety of organic pollutants. The testing program included mainly volatile organic chemicals, many of which are toxic or carcinogenic at very low levels. Volatile organic chemicals are found in ground water at nearly every permitted mixed municipal solid waste land disposal facility tested regardless of size or location. Even more surprising to the Agency was its inability to connect the contamination of ground water to the disposal of a particular industrial solid waste disposed of at the site. This once more pointed to the need for rule revisions to upgrade monitoring requirements.

Administrative problems show a need for stricter rules. The first permitted facilities began operations in 1972. Some of these facilities were reaching capacity in 1980. Others incurred considerable expenditures due to ground water contamination. Operators were deciding to shut down operations, close the gate, and walk away, leaving closure work and ground water cleanup undone. The circumstances at numerous sites (Ironwood, Hansen, St. Augusta, Winona and Waste Disposal Engineering) indicated that funds were not being set aside to properly close facilities. The Agency faced the need to take legal action to get facilities properly closed. The proposed rules are needed to ensure sufficient funds are available to complete closure, postclosure care and corrective actions.

The Agency has recognized the need to update its solid waste program to emphasize the proper design, operation, and construction of land disposal facilities. Since 1976, the state of Wisconsin has required liners, leachate collection systems and sophisticated hydrogeologic studies, as have other states such as New Jersey and California. The Agency responded to the deficiencies in its solid waste program in two ways.

First, a team of staff members was organized to begin a rule revision process and existing permits were amended. The 1981 rulemaking process, although short-lived, provided the necessary basis for development of a long-term solid waste regulatory program. The process demonstrated the enormous complexity of developing a State solid waste management program that adequately addressed the technological advances.

Beginning in 1981, the Agency upgraded the original, nonexpiring permits to include increased hydrogeologic investigation, monitoring, and design standards. The Ironwood Landfill incident was a significant factor in the decision to upgrade all permits. Removal of hazardous waste improperly disposed of at Ironwood disrupted much of the site. The Agency recognized that an in-depth hydrogeologic investigation, monitoring system and design upgrade were needed to properly treat the contaminated ground water. The operator had little incentive to complete these tasks voluntarily. The option required changes through the permit process. The Agency determined what changes were needed (hydrogeologic study, closure requirements, monitoring, engineering plans, etc.) and amended the permit, following opportunity for public participation. Since the Agency could not repermit all land disposal facilities at once, a priority system was developed to handle the sites deemed in most need of permit upgrading. The priority was based on the facility size, monitoring results, and other critical factors about the facility.

The permit upgrade process affected recent trends in solid waste management. The facility upgrade process is expensive and facility operators felt they were mistreated because not all facilities entered the process at the same time. In an attempt to remedy what they saw as unfair practices in a competitive market, these operators requested that the Agency revise the solid waste rules to require all facilities to upgrade their sites at the same time. Facility operators tried other means to avoid costs. For instance, when an amended permit was issued to Ironwood, the operators chose to close and left without completing closure requirements. The operator of the Winona Landfill, when faced with the cost of permit upgrade, told the county he would close. The county purchased the facility. When Sibley County was required to upgrade its site, the county turned over management to a private party. The city of Rochester sold its facility to Olmsted County. The proposed rules are needed to ensure that necessary studies and engineering requirements are applied across the board and to minimize any competitive disadvantages that might occur.

In 1982, the Agency again undertook a program analysis to determine the approach needed regarding solid waste management. The Agency wrote position papers to address the various aspects of the Agency's solid waste program. These papers were used as internal working documents and formed the foundation for the proposed rules. The papers discussed issues and options and recommendations on the approach that should be taken. Issues discussed included enforcement, closure/postclosure care, industrial solid waste management, performance standards compared to design standards, ground water monitoring, and alternative solid waste management facilities.

In response to the increase in detected ground water pollution and the issues discussed in the position papers, the Agency formed a special unit to work on revising the solid waste rules in 1983. The rules included upgraded design and operational standards, financial assurance requirements, ground water standards, and procedures for completing a hydrogeologic study. The existing permit rules were found insufficient to properly address the latest technological advances in solid waste management. The proposed rules need to contain a cohesive regulatory system for managing solid waste.

In 1983, the Agency contracted with the firm of Eugene A. Hickok and Associates to conduct a hydrogeologic assessment of land disposal facilities located in two different environments, sandplain and clay. The purpose of the assessment was to: determine if the facility passed or failed the RCRA ground water criteria; gain information on the appropriateness of location, design and operation of the facility; and build a data base of information to support the development of a ground water protection strategy framework for the State. The hydrogeologic assessment of land disposal facilities reached the following conclusions:

1. A land disposal facility could be sited in either sandplain or clay with careful engineering design and long-term operation of the facility, although the engineering needs would not be necessarily the same.

2. The use of cover material of an impermeable nature that is properly graded to facilitate surface water run-off can significantly reduce leachate generation.

3. A liner and leachate collection system at a clay facility is important to minimize the potential ground water impacts by synthetic organics and other chemicals.

4. The use of a liner and leachate collection system can significantly abate the potential for ground water contamination in a sandplain environment.

The consultant prepared a final report on the hydrogeologic assessments conducted at sites located in clay and sandplain environments. See Exhibits XVII and XVIII.

Since the existing solid waste rules did not address the construction of liners, leachate collection systems, or impermeable covers, revisions to the solid waste rules are needed.

C. Resource Conservation and Recovery Act Requirements.

As discussed in Part II, RCRA requires the EPA to adopt guidelines for comprehensive solid waste management plans. 42 U.S.C. § 6944. These plans were to require the disposal of solid waste in sites having no reasonable probability of impacting health or the environment. Id. Subsequent regulations contained criteria for classifying disposal sites as sanitary landfills or open dumps. The facilities fulfilling the criteria were classified as sanitary landfills and those that did not were classified as open dumps.

Among the factors included in the criteria established under RCRA were floodplain siting, surface water quality impacts, ground water quality impacts, landspreading of sludges and other wastes, open burning and air quality impacts, explosive gases, bird hazards to aircraft, and control of access. 40 CFR part 257. In 1980, the Agency classified disposal sites in Minnesota as either sanitary landfills or open dumps. The list of open dumps was submitted to EPA for inclusion on the national inventory of open dumps. The owner or operator of an open dump was required by the Agency to close or upgrade the site to meet the criteria of 40 CFR part 257 and the State solid waste rules.

Disposal facilities remain that violate the criteria listed in 40 CFR part 257. As stated under 40 CFR section 257.3, any facility that fails to meet the criteria poses a "reasonable probability of adverse effects on health or the environment." Many of these facilities are converted dumps and have not been designed, constructed or operated with industry standards considered necessary to meet the criteria.

The proposed rules are necessary to facilitate the Agency bringing facilities into compliance with the criteria discussed above.

D. Hazardous and Solid Waste Amendments of 1984 - November 1987 Permit Program Revision Deadline.

The Hazardous and Solid Waste Amendments of 1984 (Pub. L. 98-616, 98 Stat. 3268 et seq.) amend section 4005 of RCRA (45 U.S.C. § 6945) to address the control of hazardous waste at solid waste facilities. Specifically, by November 1987 states were to have adopted and implemented a permit program or other system with prior approval to ensure that facilities that accept household hazardous waste are in compliance with EPA's criteria. The amendments require EPA to determine whether each state has developed an adequate permit program. The process has been delayed. Recent correspondence indicates that EPA criteria will be published in mid-1988.

In the past, EPA reviewed state permit programs by reviewing each state's solid waste management plan developed under section 4007 of RCRA (42 U.S.C. § 6947). The review and approval process consisted of a general review of the State plan and focused on whether the regulations or statutes addressed the criteria. The review did not consider how the program would ensure that facilities met the criteria. For example, to satisfy the "no ground water contamination" criterion, EPA looked to see that ground water monitoring requirements were included in the regulation. EPA has stated it intends to be more specific in approving permit programs in the future. Two options are currently being considered. Both will require detailed permit programs and accompanying technical standards. For instance, EPA would require each state's rules to include requirements for a leachate collection system and would determine if the standards for the leachate collection system are adequate.

The proposed rules are needed to ensure that the date that will be substituted for the November 17, 1987, deadline established by the Hazardous and Solid Waste Amendments of 1984 is met and that the Agency's permit program contains the necessary detail to ensure the criteria are met.

In summary, the proposed rules are needed: to ensure land disposal facility operations are properly financed for closure, postclosure care, and contingency action; to establish ground water standards for analyzing the performance of solid waste facilities; and to establish proper design and operational standards. The proposed rules are needed to comply with federal and State laws and to protect the health, safety and welfare of the State's citizens.

V. STATEMENT OF REASONABLENESS

The Agency is required to make an affirmative presentation of facts establishing the reasonableness of the proposed rules. Minn. Stat. § 14.14, subd. 2 (1986). Reasonableness is the opposite of arbitrariness and capricousness and means that there is a rational basis for the Agency's proposed action. The purpose of this section is to demonstrate that each provision is a reasonable approach to its defined function.

The discussion below addresses the reasonableness of the provisions of the rules that the Agency proposes to adopt or amend.

A. Reasonableness of Proposed Amendments to Parts 7001.0010 to 7001.0210 PERMITS.

The existing permit rules were adopted pursuant to Minn. Stat. § 116.07, subds. 4 and 4a. That law allows the Agency to issue permits for solid waste facilities and to adopt rules concerning solid waste facilities. Parts 7001.0010 to 7001.0210 establish a permitting procedure that is logical, fair, and gives the public and the applicant an adequate opportunity to comment on the permit. The rules provide an opportunity to hold a contested case hearing or public informational meeting. They set out reasonable conditions to be included in the permit.

The following discussion addresses the reasonableness of the amendment of individual provisions of the rules.

1. Part 7001.0020 SCOPE.

Item A of this part establishes the scope of the permit rules as to solid waste management facilities. The permit rules apply to an Agency permit for "storage, treatment, utilization, processing, transfer, intermediate disposal, or final disposal of solid waste." Item A is amended to make more specific the scope of the permit rules as they relate to permit applications for transfer facilities, recycling facilities, refuse-derived fuel processing facilities, and composting facilities. Reducing the time period from 180 days to 90 days for submittal of those applications is reasonable because the listed facilities are less complex and less Agency review time will be necessary. Agency review of the permit application to adequately protect the environment is less involved because the submittals and facility designs are simple and straightforward.

2. Part 7001.0040 APPLICATION DEADLINES.

This part establishes the timing for an applicant to file a permit application. Proposed new subpart 4 requires that a preliminary application for a new mixed municipal land disposal facility must be filed at least 90 days before the date planned to start activity needed to complete a detailed site evaluation. It is reasonable to require a preliminary application and that it be submitted in advance of the detailed site evaluation because of the extensive time and expense involved in a detailed site evaluation. The submission of a preliminary application gives the Agency time, for example, to advise the applicant that a particular location may or may not be suitable for permitting and to recommend other locations be investigated before the applicant completes a detailed site evaluation. This preliminary review by the Agency will reduce the time and expense incurred by an applicant by eliminating the need for numerous soil borings and monitoring wells at a location the Agency considers unsuitable for use as a land disposal facility.

3. Part 7001.0050 WRITTEN APPLICATION.

This part sets forth the information required to be submitted by the applicant. Item I has been amended to include a reference to new provisions applicable to applications for permits to construct and operate solid waste management facilities that are unique to those facilities. The amendment will inform solid waste management facility permit applicants of the requirements unique to the applications regarding their facility.

4. Part 7001.0060 SIGNATURES.

This part specifies who must sign permit applications. The purpose of these requirements is to ensure that the signer has authority to bind the applicant. This makes the applicant directly accountable and responsible for the statements made in the permit application.

Items A to C are existing provisions and have not been amended.

Item D is amended to include solid waste management facilities in the the exception to the applicability of the requirement that the operator and owner of the facility sign the application. It is reasonable to include solid waste management facilities in this provision because it provides consistency with other Agency programs.

Item E provides that if the landowner is different than the facility owner, both the landowner and the facility owner must sign the application. The requirement that both the landowner and the facility owner sign the application is reasonable because each of these parties has some degree of control over the facility or activity. Both should be accountable for the information that appears in the permit application.

Item F provides that an engineer registered in the State of Minnesota sign all reports and plans prepared for a solid waste management facility permit application. The requirement that an engineer registered in Minnesota sign all plans and reports prepared for the permit application is reasonable because the design of the facility is critical to the performance of the facility and having an engineer registered in Minnesota approve the design offers at least some assurance of proper design. The preparer of the design should be responsible for the information that appears in the permit application.

5. Part 7001.0140 FINAL DETERMINATION.

Part 7001.0140 sets out the main criteria for and the form of the Agency's decision on a permit application.

Subpart 1 of this part provides that the Agency shall issue, reissue, revoke and reissue, or modify a permit if the Agency determines that the proposed permittee will comply or will undertake a schedule of compliance to achieve compliance with all State and federal pollution control statutes and rules and that all applicable requirements of Minn. Stat. ch. 116D (1986) and the rules promulgated thereunder have been fulfilled. This subpart is amended to require that, for solid waste management facilities, Minn. Stat. ch. 473 must also be complied with. It is reasonable that the rules be amended to refer to chapter 473 because that law provides that solid waste management facilities constructed in the seven-county Twin Cities Metropolitan Area must fulfill the requirements of the Metropolitan Council's Comprehensive Plan before the Agency may issue a permit.

Subpart 2 sets forth findings of the Agency that constitute justification for the Agency to refuse issuance of a new or modified permit, to refuse permit reissuance, or to revoke the permit without reissuance. Subpart 2 is amended to include item F which refers to the requirements of Minn. Stat. ch. 473. It is reasonable to include this provision as justification for the Agency to refuse permit issuance because the Metropolitan Council is responsible for overall planning in the seven-county metropolitan area. Without approval of facilities to be constructed, the Metropolitan Council cannot comply with its statutory responsibilities.

6. Part 7001.0170 JUSTIFICATION TO COMMENCE MODIFICATION OF PERMIT OR REVOCATION AND REISSUANCE OF PERMIT.

This part currently sets out eight conditions that justify the start of proceedings to modify a permit or to revoke and reissue a permit. The conditions that justify modification or revocation and reissuance of a permit are: new facility conditions that have a potential to affect the environment; receipt of new information; changes in pollution control statutes or rules due to federal, State or court action; events beyond the control of the permittee; a finding by the Commissioner that a change is needed in order to remove a danger to human health or the environment, or receipt of a request to transfer the permit. It is reasonable to amend these conditions by adding a reference to a new rule that alerts solid waste management facility permittees to the events that will trigger the modification or revocation and reissuance of an Agency permit. This provides permittees with assurance that unjustified unilateral actions will not result in permit modification or revocation.

7. Part 7001.0190 PROCEDURE FOR MODIFICATION; REVOCATION AND REISSUANCE; AND REVOCATION WITHOUT REISSUANCE OF PERMITS.

This part consists of three subparts that provide the procedures for modification, or revocation and reissuance of permits.

Subpart 3 lists minor modifications that do not need to go through the entire public notice procedure. These minor modifications do not involve an increase in the emission or discharge of pollutants into the environment and do not reduce the Agency's ability to monitor the permittee's compliance with pollution control statutes and rules. This subpart reduces the Agency effort needed to make permit changes that have no adverse environmental impact. Item D has been amended to add a reference to a new rule that addresses changes that will be considered minor modifications of solid waste management facilities. It is reasonable to amend this particular subpart to add a specific reference to minor modifications of solid waste management facilities as it provides permittees with a complete list of items that can be changed without entering the lengthy and costly permitting process.

B. Reasonableness of Proposed New Parts 7001.3000 to 7001.3550 SOLID WASTE MANAGEMENT FACILITY PERMITS.

It is reasonable to adopt new rules that specifically address permits for only solid waste management facilities because the standard permitting procedure rules alone cannot address the requirements specific to these facilities. The following discussion addresses on a part-by-part basis the reasonableness of the proposed rules governing the issuance of solid waste management facility permits.

1. Part 7001.3000 SCOPE.

This part lists the existing and new Agency rules that govern the permit application procedures and issuance procedures applicable to a solid waste management facility permit. Making existing Agency rules applicable to a solid waste management facility permitting process, to the extent possible, provides consistency among the Agency's permitting programs.

2. Part 7001.3025 DEFINITIONS.

This part incorporates by reference definitions contained in parts 7001.0010 and 7035.0300. Making definitions that are applicable to the Agency's overall permitting procedure also apply to the parts directed specifically to solid waste management facilities provides consistent use and interpretation of terms.

3. Part 7001.3050 PERMIT REQUIREMENTS.

This part identifies the activities and facilities to be included (subpart 1) and excluded (subpart 2) from the requirement to obtain a solid waste management facility permit. It also establishes that certain facilities are permitted-by-rule if they meet certain requirements (subpart 3) and that their eligibility for permit-by-rule status may be terminated under certain circumstances (subpart 4). The reasonableness of these sections is discussed below.

Subpart 1. Permit required. This subpart identifies the operations and facilities subject to the requirement to obtain a permit. The Agency has the duty to regulate the management of solid waste, including its treatment, storage, processing or disposal. Minn. Stat. §§ 116.07, subds. 2, 4 and 4a and 116.081, subd. 1 (1986). Requiring facility owners that treat, store, process, or dispose of solid waste to obtain a solid waste management facility permit is the most efficient method by which the Agency may evaluate the ability of solid waste management systems to operate in accordance with environmental and human health protection standards. It is appropriate that activities such as the establishment, construction, operation, closure, or expansion, of facilities are subject to the permit requirements because it is at these critical times that the Agency can affect the facility owner's ability to comply with standards and permit conditions that will best protect human health and the environment. If a person were allowed to establish and construct a facility without obtaining a permit, the Agency could be in the position later of choosing between allowing the existence of a facility that does not meet the location and design standards of the rules or stopping the operation of a fully-constructed facility, thus causing a substantial economic loss. Without a review of the facility design and operation procedures proposed for the facility, the Agency has no assurance that appropriate environmental protection standards and rules will be complied with.

Subpart 2. Exclusions. Certain activities, if performed in compliance with specific standards, present a low potential for adverse effects on human health and the environment. The issuance of a permit for those activities would not alter or reduce this potential. Backyard compost areas (item A) have this low potential for adverse effects. Due to the large number of homeowners that compost, it is reasonable to exempt this activity from permit requirements because of the minimal benefit received from any additional administrative burden. The burden of obtaining a permit would discourage the establishment of backyard compost areas. That result would directly conflict with Minn. Stat. § 116D.02 (1986) of the State Environmental Policy Act. This policy designates the reuse of solid waste as the State's highest management priority. Additionally, some solid waste management facilities are regulated under other Agency rules. Requiring them to obtain a solid waste management facility permit is unnecessary to protect human health and the environment. Therefore, it is reasonable to exempt sewage sludge landspreading facilities (item B) from permit requirements in addition to those already imposed by Minn. Rules ch. 7040.

Subparts 3 and 4. Permits-by-rule and termination of eligibility for permit-by-rule. Subpart 3 establishes six categories of facilities deemed to have obtained a permit without making application if the owner or operator meets certain conditions set out in the rule. Subpart 4 allows the Agency to terminate the eligibility of a facility owner or operator if the owner or operator violates any requirements of parts 7035.0300 to 7035.2875, or conducts activities that would require an individual solid waste management facility permit, or if the Agency finds that an individual permit is necessary under the circumstances to protect human health or the environment. The reasonableness of the provisions of subparts 3 and 4 are discussed below.

Items A and B of subpart 3 relate to facilities that because of their small size present a low potential for environmental harm (transfer facilities, demolition debris land disposal facilities). Item A provides that certain transfer facilities are eligible for permit-by-rule status. Transfer facilities with a capacity of less than 30 cubic yards do not receive enough waste to be of concern provided that minimum design and operational standards are satisfied. Therefore, it is reasonable to permit these facilities by rule and simply require notification of their existence to ensure design and operational standards are complied with. Item B makes small demolition debris land disposal facilities eligible for permit-by-rule status. Demolition debris is a relatively inert material with a low potential for environmental harm. Demolition debris is generated during the destruction of buildings and the removal of roads resulting in the need for numerous short-term, small disposal sites. Because of the administrative burden and the inert material being managed, it is reasonable to permit-by-rule demolition debris land disposal facilities operating less than 12 consecutive months and having a capacity less than 15,000 cubic yards, if they notify the Agency and design and operate the facility in accordance with Agency standards. Transfer facilities and demolition debris land disposal facilities are also governed by local ordinances and monitored by these governmental units.

Items C, D and F of subpart 3 establish recycling centers, compost facilities handling only yard waste, and non-sludge wood waste or water treatment lime sludge storage sites as permit-by-rule facilities. These facilities handle wastes that have a low potential for environmental harm if proper management procedures are followed. These facilities require minimum standards. The detailed review and public input of the permit process would be of little benefit to ensure protection of the environment.

Item E of subpart 3 establishes energy recovery facilities governed by air quality rules as permit-by-rule facilities. It is reasonable to grant energy recovery facilities solid waste management permits by rule because the air quality permit will impose stringent standards for the protection of the environment. Solid waste management concerns are addressed in the air quality permit and there is no need to duplicate this effort by issuing a solid waste management facility permit.

Item G of subpart 3 applies to facilities receiving solid waste from the exploration, mining, milling, smelting and refining of ores and minerals. These facilities are regulated under the Minnesota Department of Natural Resources rules on mining and the Agency's rules for State disposal systems. Further regulation of facilities accepting only solid waste generated from the exploration, mining, milling, smelting and refining of ores and minerals under a solid waste management facility permit would not provide additional protection of human health or the environment. Obtaining an additional solid waste management facility permit would unnecessarily burden the applicant for no additional health or environmental protection.

Subpart 4 establishes the reasons for which the Agency may revoke permit-by-rule status for a facility. Since the facilities included in subpart 3 are not always covered by another permit, provisions for terminating eligibility to be permitted-by-rule are included. The rule allows individuals with a facility in permit-by-rule status the opportunity for a public information meeting or contested case hearing if the Agency acts to terminate this status.

There are three findings any one of which constitutes justification for the Agency to terminate eligibility. It is reasonable to terminate eligibility for a facility in violation of the conditions listed in subpart 3 and the Agency technical rules for design, construction, and operation of solid waste management facilities since compliance with these conditions and requirements serves as the basis for eligibility to be permitted-by-rule. It is also reasonable to terminate permit-by-rule eligibility if a facility is required to obtain a solid waste management facility permit for other solid waste activities. Conducting other solid waste management activities at the facility could affect the management alternative permitted-by-rule, thus making it necessary to address operation of the entire facility in an individual permit. It is reasonable to terminate the eligibility of a facility for permit-by-rule status if circumstances exist which show that a more detailed review of the facility design and operation by the Agency is necessary to ascertain how human health and the environment will be protected. Permit-by-rule status has been deemed appropriate by the Agency for solid waste management activities small in size or limited in waste types accepted. If these situations are altered in the manner discussed above, it is reasonable that the Agency use the permit review process to scrutinize facility activities.

4. Part 7001.3055 CLOSURE/POSTCLOSURE CARE.

This part requires the Agency to issue a closure document at the time a solid waste management facility is closed. Agency rules contain requirements for monitoring, site maintenance, testing, reporting, and operation of on-site features after closure. The closure document will serve as the enforceable instrument to be used by the Agency to insure that these activities are completed. Long-term care is needed at some facilities because leachate will continue to be generated, the potential for erosion exists, vegetation must be cared for, etc. Therefore, it is reasonable to issue a closure document at the time a facility ceases operation to inform the facility owner or operator of the requirements imposed after closure, to allow the facility owner or operator the opportunity to request a public information meeting or contested case hearing regarding the closure document, and to provide for long-term care activities.

5. Part 7001.3060 DESIGNATION OF PERMITTEE.

This part requires the Agency to designate the landowner, facility owner, and facility operator as co-permittees for any solid waste management facility permit. Each of these parties has some control and responsibility for the activities that occur at the site. It is reasonable to require that all owners and operators be permittees to ensure that all who have control over the facility or land on which the facility is located are directly responsible for compliance with the permit and Agency rules. Designating only the facility operator would not be reasonable, because it would allow absentee owners to escape responsibility for use of their land. Similarly, designating only facility owners would not ensure that daily operations are properly completed. Therefore, it is reasonable to designate the landowner, facility owner and facility operator as co-permittees to clearly indicate to each party that they are responsible for the activities conducted at the site.

Some commentors disagreed with the designation of landowners as co-permittees. They felt it was unjust to require landowners leasing out property for use as a solid waste management facility to be responsible for on-site activities. They also suggested that the inclusion of landowners as co-permittees could create situations affecting other business transactions because the association with a solid waste management facility would be viewed as negative. The Agency feels that a landowner is responsible for activities that occur on property owned and leased at solid waste management facilities during their operating life and after closure. This direct alliance with the facility indicates a need for the landowner's continued awareness of facility operations. This awareness is most reasonably assured by the use of a permit. Establishing the landowner as co-permittee allows the direct input of the landowner on facility activities.

6. Part 7001.3075 SOLID WASTE MANAGEMENT FACILITY PERMIT APPLICATION.

This part describes in general terms certain of the application requirements for existing and new solid waste management facilities. The areas covered include the submittals and timing of permit applications.

Subpart 1. Application submittals. Subpart 1 requires a final permit application for all solid waste management facilities. The permit applicant for a mixed municipal solid waste land disposal facility must also submit a preliminary application and a detailed site evaluation report. The preliminary application is a screening mechanism to determine the potential suitability of a site or sites for use as a land disposal facility. The screening mechanism assists the permit applicant by eliminating sites considered unpermittable by the Agency before expensive hydrogeologic work is undertaken. Therefore, it is reasonable to have mixed municipal solid waste land disposal facility permit applicants submit a preliminary application before the final application to eliminate unnecessary expenditures of time and money on sites considered unsuitable for permitting.

The detailed site evaluation work plan required with the preliminary application addresses the complete soil boring and hydrogeologic workup of a potential land disposal facility. The detailed site evaluation is a time-consuming effort, but without it many design and operational decisions could not be made. The detailed site evaluation determines the soil types present on site and the ground water conditions present below the soil surface, and develops data for use in determining design for liners, covers, monitoring, and potential corrective actions. It is reasonable to require a detailed site evaluation to minimize the expenditure of time and money on a site that is unsuitable for permitting. Based on the findings of the detailed site evaluation, plans and specifications for the design, construction, and operation of a facility can be developed. This cost is avoided if the site is unpermittable based on site conditions.

Subpart 2. Timing of application. Item A of subpart 2 requires a person who proposes to construct a new mixed municipal solid waste land disposal facility to submit the preliminary application at least 90 days before work begins on the detailed site evaluation. This is a reasonable requirement to allow time for review of the application, for conferring with the applicant regarding site conditions and the detailed site evaluation work plan included in the application, and for consideration of the time needed to complete the detailed site evaluation and submit a final application. The Agency considers the 90-day period as the minimum time needed to review the application. Obtaining comments and conferring with the applicant concerning the site conditions and detailed site evaluation work plan could take more than 90 days. It is to the applicant's advantage to submit the application as soon as possible to allow for these discussions. Therefore, it is reasonable to require that the permit application be submitted at least 90 days before work begins on the detailed site evaluation.

Item B of subpart 2 indicates the timing for application for reissuance of existing permits is governed by part 7001.0040 unless the Commissioner receives a written request for an extension of time. The extension may not go beyond the permit expiration date. The Agency recognizes that problems can arise in completing applications because of the time needed to obtain certain types of information. If the applicant demonstrates good cause, it is reasonable to allow the time extension for submission of the application for permit reissuance. Part 7001.0160 provides for continued operations under expired permits if the Agency has not taken final action due to no fault of the permittee. It is reasonable to provide a time extension for filing the application for reissuance to allow the permittee to operate the facility under a permit.

7. Part 7001.3125 DENIAL OF CONTINUED OPERATION OF AN EXISTING LAND DISPOSAL FACILITY.

This part provides that the Agency may deny the owner or operator of an existing land disposal facility a solid waste management facility permit to operate if the owner cannot bring the facility into compliance with new or existing financial assurance, locational, operational and design requirements, and ground or surface water, or air quality standards. If the Agency denies a permit to operate, the Agency must issue a closure document and may allow the owner up to five years to comply with the closure requirements. One of the Agency's prime responsibilities is to protect the environment and human health. To allow continued operation of facilities where the owner or operator cannot properly finance closure, postclosure care, and corrective action costs and bring the facility into compliance with design and operational standards would be in direct conflict with this responsibility. Therefore, it is reasonable for the Agency to deny a permit to operate a facility under such circumstances.

Because the facility owner may not be prepared to close when the Agency decides to close the facility, it is reasonable to allow the facility owner time to achieve proper slopes, install the required ground water monitoring system, and complete other steps needed prior to closure. Five years is a reasonable time for the facility owner to complete closure activities because of the need for filling active working areas to an elevation providing adequate grades that prevent erosion, for completing hydrogeologic studies and for installing monitoring wells. More time would prolong conditions deemed unacceptable while shorter times may prevent adequate closure activities.

8. Part 7001.3150 CERTIFICATION OF PERMIT APPLICATIONS AND REPORTS.

This part iterates that any person signing the permit application or any report submitted to the Agency must certify to the truth and accuracy of the information contained in these documents as required in part 7001.0070. The part also requires a certifier to acknowledge awareness of penalties for false submissions. Additionally, all technical reports, plans, specifications, and engineering and studies must be signed by an engineer registered in Minnesota. Requiring an engineer registered in Minnesota to certify all technical documents ensures that the facility is designed and all work is completed in accordance with Minnesota standards.

It has been suggested that it is not registered engineers who should sign off on hydrogeologic studies completed in fulfillment of permit or rule requirements; rather only qualifying hydrogeologists should verify the quality of these studies. However, there currently exists no state or nationally recognized certification procedure for hydrogeologists and none is expected for some time in the future. It would be unreasonable for the Agency to require hydrogeologic studies to be completed by a certified hydrogeologist when no nationally recognized certification program exists. It is reasonable to require an engineer registered in Minnesota to sign all reports used in designing the facility in order that the engineer is aware of and understands the portions of the reports that may impact the facility design. Minn. Stat. § 326.02, subd. 3, requires the signature of a registered engineer on all plans or designs done to meet requirements for public safety. A permit applicant will be investing considerable time and money into the completion of a hydrogeologic study that will provide reasonable assurance that a facility located at such a site will have a low risk for ground water pollution if the facility is designed taking the hydrogeologic setting into consideration. It is, therefore, reasonable that an engineer registered in Minnesota sign for the data and conclusions presented in a hydrogeologic evaluation report.

It is also reasonable to require the signature of a person knowledgeable in hydrogeology. Agency staff held several meetings with the local chapter of the American Institute of Professional Geologists to develop rule language on the need for someone knowledgeable in the field of hydrogeology to certify the truth and accuracy of the information supplied in hydrogeologic studies. Although no national certification program currently exists, professionals in the field of hydrogeology have expressed their concern that reports supplying information on the hydrogeologic characteristics of a site be completed by knowledgeable people. They believe that this is best accomplished by requiring the signature of the responsible party on all reports. The Agency agrees that persons with expertise in the field of hydrogeology complete the work and be held accountable for the interpretation provided in the reports. The language proposed in this part requires that a person knowledgeable in the field of hydrogeology sign all ground water and surface water monitoring reports and hydrogeologic studies. It is reasonable to require this signature because the interpretation of soil borings and ground water data at a site is critical to the performance of the facility and the determination if the site is suitable for use for solid waste management. The ability to interpret hydrogeologic data is developed through education and experience and it is reasonable to require the review of this data by a person knowledgeable in the field.

9. Part 7001.3175 CONTENTS OF PRELIMINARY APPLICATION.

This part specifies the information to be contained in a preliminary application for a mixed municipal solid waste land disposal facility permit. The preliminary application provides the Commissioner with information needed to recommend the site's suitability for use as a land disposal facility. The application provides a work plan and schedule to complete the detailed site evaluation.

This part requires that four copies of the complete preliminary application be submitted to the Commissioner. Four copies of the complete preliminary application are required because two copies will remain at the Agency's central office, one copy will be returned to the permit applicant, and one copy will be sent to the appropriate Agency regional office.

Some commentors on the proposed rules have expressed concern about the requirement for preliminary applications. They raised concerns about the requirements for submittal and the terminology used in describing the process. One commentor suggested that if the title were changed from preliminary application to preliminary notification the public's perception of the application process would improve. It is feared that the term application will create an approval/disapproval process rather than an advisory process. In turn, it is suggested that lawsuits will be generated at this point to block further investigation and siting of the facility. The Agency does not believe that the change in terminology will affect the process. No public notice will be issued regarding the preliminary application and resulting Agency advice. The preliminary application process is a matter between the permit applicant and the Agency. It is reasonable to provide for early Agency input into the siting process to alert permit applicants to the suitability of a site and any special requirements for design and construction based on site conditions, and minimize unnecessary costs for work at an unsuitable site.

The information required in a preliminary application is readily available with minimal site investigation. The preliminary application rule requires the applicant to collect background data and prepare for a more detailed site evaluation. The applicant needs this information in any case so the rule does not require extra effort to be expended by the applicant. In many cases, applicants have sought Agency advice voluntarily because of the importance to them of obtaining Agency input into the siting process. Early Agency involvement provides the applicant with information needed to comply with the solid waste rules in designing the facility. This process will allow for shorter review time by the Agency of the final permit application and allow for the construction of the facility sooner.

Some of the information required under this part was suggested to the Agency by commentors who feel the preliminary application serves a useful process in initiating discussions on critical permitting issues like waste disposal capacity needed, phased site evaluation needs, and leachate treatment. It is reasonable to provide a vehicle for initiating work based on an understanding of what is needed to obtain a permit as it allows for a more efficiently planned approach to completing the necessary activities.

Items A, B, C, F and G refer to the applicable portions of existing Agency permit rules. It is reasonable to refer to parts 7001.0050, 7001.3200, and 7001.3275 and Minn. Stat. §§ 115A.917 and 473.823 so that the permit applicant will be alerted to the information requirements in other parts of the proposed rules and in statutes. The information requirements of part 7001.0050 (incorporated into items A and B) are basic identification information needed for all facility permits. This information refers to facility owners, facility location, and topographic information available about the site. Part 7001.3200 (item C) details the information included in a preliminary site evaluation report. Minn. Stat. §§ 115A.917 and 473.823 (item F) address the requirements that a county or land disposal facility owner must meet to obtain a certificate of need for land disposal capacity before a mixed municipal solid waste land disposal facility permit may be issued. This requirement alerts the permit applicant that there must be a need for the disposal capacity before the Agency can issue a permit. This must be done early in the siting process to eliminate work being completed for a site that cannot be permitted because no land disposal capacity is authorized. Part 7001.3175 (item G) contains the requirements for completion of a detailed site evaluation. By referring to this part, the permit applicant is informed of the information needed to complete the evaluation and to establish a work plan for completing the detailed site evaluation.

It is reasonable to require the information listed in this part because it is needed to complete the final application, is available at minimal cost and effort, and provides early indications whether the site is suitable for use as a land disposal facility.

Item H requires that the preliminary application include a discussion on efforts made to secure treatment facilities for leachate generated at the facility. The applicant must begin to search out leachate treatment options early in the siting process to determine if on-site treatment or pretreatment facilities are needed and to make appropriate size adjustments on the land acquisition. A chosen site may be suitable for disposal, but not for on-site leachate treatment. Requiring preliminary investigations into leachate treatment will eliminate unnecessary redesign or delays due to unavailability of leachate treatment.

10. Part 7001.3200 PRELIMINARY SITE EVALUATION REPORT.

This part lists the information required in the preliminary site evaluation report. The preliminary site evaluation report provides information needed to determine a site's potential for use as a mixed municipal solid waste land disposal facility.

In the preliminary site evaluation report, the permit applicant is required to submit a statement of the land disposal capacity needed. The method of site selection must be included. Minn. Stat. § 115A.917 (1987) requires that counties not in the metropolitan area complete a solid waste management plan. This plan contains the calculated land disposal capacity needed for ten years and a description of a site selection process for locating a land disposal facility. It is reasonable that the Agency require a statement regarding the land disposal capacity as this information is necessary to determine if a proposed site has sufficient capacity and space for setback requirements. If sufficient space is not available, the costs associated with the site could be so burdensome that the Agency would not consider the site permittable. It is reasonable that the Agency address the site selection process in the preliminary site evaluation report to provide an understanding of the basis for choosing or rejecting a particular site for location of a land disposal facility.

For the site or sites recommended for further study, this part requires that the preliminary site evaluation report contain a discussion on the site's ability to meet the technical standards of proposed parts 7035.2525 to

7035.2815.

Item A requires a discussion of the site geology and ground water characteristics as revealed in existing hydrogeologic maps and references, air photography, soil borings and well logs and other information described in proposed rule part 7035.2815, subpart 3, item E. This information in the preliminary site evaluation report helps determine potential impacts a site might have on its surrounding area.

Item B requires the applicant to evaluate the site's ability to protect ground water and surface water from leachate releases from the facility's leachate management system. This information is basic to determining a site's potential for use as a permitted land disposal facility.

Item C requires that the site be evaluated for its ability to be monitored for ground water impacts. This information is necessary to be able to monitor ground water beneath the site to determine the site's compliance with the technical requirements of proposed Minn. Rules pt. 2815, subp. 4.

Item D requires that the feasibility of containing and removing polluted ground water or waste and waste by-products be discussed in the preliminary site evaluation report. Controlling the extent of the pollution is necessary to minimize impact on human health and the environment. Additionally, if it is not feasible to contain and remove polluted ground water or waste and waste by-products, the site would be considered unsuitable for use as a land disposal facility because the technical requirements of proposed Minn. Rules pts. 7035.2525 to 7035.2815 could not be met.

Item E requires that the feasibility of meeting the locational standards of proposed Minn. Rules pts. 7035.2555 and 7035.2815, subp. 2 be discussed in the preliminary site evaluation report. This evaluation of the site's location will dictate its permittability without a variance from the technical requirements.

Item F requires that the site be evaluated for the land available to meet setback distances from the property line and the designation of a compliance boundary. Enough space is needed for the volume of waste expected, on-site operation activities, and the establishment of a compliance boundary to determine compliance with the ground water and surface water standards of proposed Minn. Rules pt. 7035.2815, subp. 4.

Item G requires investigation of the availability of suitable material for liners and covers. The availability of material suitable for use as a liner and cover is integral to satisfactory performance of the land disposal facility. Availability of materials may suggest preferring one site over another.

Item H requires the applicant to evaluate the potential for soil erosion or surface drainage to lead to increased leachate generation, failure of leachate containment features, poor-quality run-off, or other undesirable consequences.

Addressing these concerns in the preliminary site evaluation report is needed to properly design the facility to meet the technical requirements of proposed Minn. Rules pts. 7035.2525 to 7035.2815.

Item I requires a report on initial efforts to secure leachate treatment. These results will address the existing treatment facilities contacted and their response to treating leachate. The Agency will use this information in determining the applicant's options for treating leachate, advising the applicant on follow-up procedures, and providing assistance to the applicant in securing leachate treatment.

11. Part 7001.3275 DETAILED SITE EVALUATION REPORT.

This part requires the applicant to conduct a detailed site evaluation and specifies the information that must be contained in a report on the evaluation.

Subpart 1. Scope. Proposed part 7035.2815 sets out the specific technical requirements for mixed municipal solid waste land disposal facilities. This subpart requires that a detailed site evaluation report be submitted for all mixed municipal solid waste land disposal facilities. In the report, the applicant must discuss whether the proposed site meets the requirements of proposed part 7035.2815. Four copies of the report must be submitted to the Agency. A detailed site evaluation report for mixed municipal solid waste land disposal facilities serves as a basis for the Agency's evaluation of the environmental impact of the facility.

Subpart 2. Hydrogeologic evaluation. This subpart requires the applicant to submit hydrogeologic investigation data as part of the detailed site evaluation report. The investigation must define the soil, bedrock, and ground water conditions at a site. The details for the investigation are contained in the standards of proposed part 7035.2815, subpart 3. Requiring an extensive investigation of the subsurface soil conditions enables the Agency to establish monitoring requirements and determine impacts on the environment. Additionally, this information will be used in evaluating the suitability of the site for a facility, in designing the facility, and for implementing corrective actions when a facility affects the environment.

Subpart 3. Soils for cover and liner construction. This subpart establishes the requirements for analyzing soils to be used in cover and liner construction. The facility owner or operator must disclose the amount of soil available as well as the ability of the soils to meet construction specifications outlined in proposed part 7035.2815. The cover and liner systems are key elements in minimizing the impact a facility has on the environment. If sufficient quantities of soil are not present at the site or very near the site they must be transported to the site at great expense. In that case, the facility owner or operator will need to review the decision to use the site or consider using synthetic materials. This information is needed before the final site design and operation manual are developed. Therefore, it is reasonable to address this information in advance of the final application.

Subpart 4. Conceptual facility design. This subpart establishes the elements to be addressed in a conceptual design of the site layout and construction sequence. The conceptual facility design requires the facility owner or operator to review how the facility will be constructed to meet the design requirements of proposed parts 7035.0300 to 7035.2815 and to consider unique conditions of the site. It is reasonable to require a facility owner or operator to submit conceptual drawings for the facility design because the Agency is responsible for permitting of the facility and if the facility cannot be designed to comply with Agency standards an early determination will eliminate unnecessary expenditures of time and money. Early submittal of the conceptual design will allow the Agency to work with the facility owner or operator to arrive at a final design that will minimize environmental impact and maximize operational efficiency.

Item A requires a description of waste to be received, the amount and type of cover needed, and the site capacity. This information is needed to design the facility to provide environmental protection.

Item B requires a site layout depicting surface drainage, existing and proposed screening, on-site and off-site surface waters, rock outcroppings, on-site buildings and wells, and the property boundaries. This information is needed before detailed site plans are drawn to evaluate the unique site features that must be addressed in the final plans.

Item C requires a site development plan addressing fill areas, borrow areas, on-site roads, and surface drainage control structures. This information is needed during the conceptual stage to assure orderly site development to manage surface water drainage during the construction and operations of the facility to minimize disruptions to the progressive filling at the site.

Item D requires a plan sheet for all special waste management areas at the site. These areas include general storage areas, waste tire storage areas, recycling areas and industrial solid waste fill areas. Addressing these areas during the conceptual design of the facility will facilitate determination of space needs, traffic control designs and other design specifics integral to the overall design and operation of the facility.

Item E requires that the fill area be described by number and size of each phase, the direction of filling, depth of fill, final contours, and the location and description of leachate and gas collection, storage and treatment systems.

These items are integral to the overall site operation. Their relationship to other facility features is needed to develop a final design for the facility.

Item F requires a description of the leachate collection, storage, and treatment system. This information is needed to evaluate material needs, determine construction schedules, and develop the operations manual for the site before the final permit application is submitted.

Item G requires the applicant to describe the liner system proposed for the facility. This includes the type of liner, method of placement and protection, and other unique features. This information is needed to enable the Agency to review material specifications and the construction methods to be addressed in the permit. Additionally, the liner is the most critical factor in minimizing leachate migration from the fill area to ground water and is vital to the protection of human health and the environment. This information must be considered prior to submitting a final permit application to allow the Agency to assist the permit applicant in developing a final design that meets the technical requirements of proposed Minn. Rules pts. 7035.2525 to 7035.2815.

Explosive gases are generated in land disposal systems. Item H requires a description of the gas monitoring, venting, and collection system. This information is needed to finalize design plans for the cover system, monitoring protocol and operations manual. The conceptual plans for the gas management system are needed prior to finalizing the facility design in order to make the permit applicant aware of available options and the preferred option.

Item I requires that an estimate of construction cost be included with the conceptual facility design. An estimate of construction costs will enable the permit applicant to evaluate alternative design options that will meet Agency standards. Estimated construction costs will also provide the permit applicant with an understanding of how scheduling of facility construction could impact project costs and may indicate the preference of one option over another.

Subpart 5. Proposed compliance boundary. This subpart requires that the facility owner or operator propose a compliance boundary for monitoring the facility's performance. This boundary is the point at which the Agency will enforce ground water quality standards. It is reasonable to require the facility owner to propose the compliance boundary at this time to assure that one can be established that satisfies the requirements of proposed part 7035.2815, subpart 4. Without a compliance boundary, the Agency will be unable to determine the impacts a facility is having on the environment. The compliance boundary in conjunction with technical standards of proposed Minn. Rules pt. 7035.2815, subp. 4, are needed to evaluate potential corrective actions. Because Agency rules contain ground water standards, which if exceeded initiate enforcement action, it is reasonable to have the facility owner or operator recommend the location of the compliance boundary.

Subpart 6. Feasibility of contingency action. This subpart is intended to require the permit applicant to use the hydrogeology and soils information to evaluate the feasibility of corrective actions.

Item A requires the applicant to determine if corrective actions are technically feasible and estimate the cost of these actions. It is reasonable to require this evaluation during the detailed site evaluation as the technical feasibility and estimated costs for corrective actions are needed to determine the probability of success if actions becomes necessary.

Item B requires that the permit applicant identify and describe the potential facility failures that would initiate corrective actions. It is reasonable to require an assessment of the feasibility of instituting corrective actions at the facility because corrective actions are very costly. The applicant may select an alternative site or redesign the facility to minimize the potential failures and the need for corrective action. Early planning for possible actions allows the applicant to consider additional design and construction techniques, and initiates review of the financial aspects of operating a facility.

Item C requires that, for every potential type of failure identified under item B, the applicant describe the procedures needed to identify the extent of the problem, modify monitoring procedures, identify corrective actions to repair problems, estimate costs for repairing the problems, and determine the level of success expected. This evaluation is needed to assess the suitability of a site for use as a land disposal facility and to address the funding for corrective actions.

Commentors on the proposed rules expressed their concern whether any applicant would be able to comply. The commentors suggested that potential was too vague as a standard of conduct. They felt that the applicant should only be required to address specific failures. The Agency feels potential is an appropriate description of the failures to be addressed in the application, particularly when this subpart provides a list of possible failures that might occur at a facility. If the Agency required all possible failures to be addressed, some contingency action plans would address incidents that would never occur. For instance, it is unreasonable to require the inclusion of providing private water supply if there are no nearby residents. This would result in an unnecessarily high contingency action cost estimate for the facility. If the Agency did not require any evaluation of failures that might occur at a facility, the applicant would be ill-prepared to deal with failure situations and financial assurance funds would be insufficient.

The requirement that potential failures be addressed allows the applicant to address specific site conditions. By allowing this flexibility, the Agency provides for the development of plans and corrective action to reflect facility designs and encourages the use of design and construction techniques that minimize risks associated with the facility. It is reasonable to allow for specific facility design and operation plans to be developed in a manner that minimizes the type of failures that could occur at the site.

Item D requires the applicant to evaluate the feasibility of implementing corrective actions at the site based on the information developed under items B and C. It is reasonable to require this evaluation because if corrective actions cannot be implemented at a particular site it may make the site unsuitable for use as a solid waste management facility because it would put human health and the environment at risk.

Subpart 7. Final use. This subpart requires that the detailed site evaluation report include a proposal for the use of the site after closure. It is reasonable to include this information in the detailed site evaluation report as it is needed to determine the location of monitoring systems, final facility design, and the feasibility of using a proposed site as a land disposal facility. Knowing the proposed final use of a facility can impact facility design. No use will be permitted that would cause the facility to violate the technical standards of proposed parts 7035.2525 to 7035.2815.

Subpart 8. Additional information. This subpart requires that the detailed site evaluation report contain the information needed to complete an Environmental Assessment Worksheet or Environmental Impact Statement, if necessary. It is reasonable to include this information in the detailed site evaluation report as an Environmental Assessment Worksheet must be completed before a permit may be issued. The Worksheet may show that an Environmental Impact Statement is necessary. This information provides the basis for determining environmental impacts from a facility and thus allows for incorporation of unique design features into the final plans to address these impacts.

12. Part 7001.3300 GENERAL INFORMATION REQUIREMENTS FOR FINAL APPLICATION.

This part establishes the general information that must be submitted with all final permit applications for solid waste management facilities. The final permit application provides the Agency information to determine whether to issue a solid waste management facility permit. This determination will affect whether a facility is allowed to operate or, if operating, be required to close. Therefore, it is reasonable to require extensive and detailed information regarding the facility's location, design, construction, operation, and proposed closure. This information will allow the Agency to evaluate the facility's environmental impact and serve as a basis for the conditions in the permit. Therefore, it is reasonable to require extensive and detailed information. Since compliance with the standards of parts 7035.0300 to 7035.2875 is a condition for issuance of a permit, it is reasonable to require sufficient information to allow the Agency to determine whether the facility can comply with those standards.

The first paragraph requires the applicant to submit four copies of the permit application and supporting materials to the Commissioner. Four copies of these materials are needed for review purposes and for distribution after approval. The information submitted in the permit application is reviewed by Agency staff knowledgeable in the specific area, e.g., hydrogeologists review the site evaluation and water monitoring submittals. The most efficient method for completing these reviews in a timely manner requires concurrent review of the materials. In the seven-county metropolitan area, the permit application must also be reviewed by the Metropolitan Council staff before the Agency's decision on the application's acceptability is made. Again, to reduce the time involved in the total review time, it is most efficient to have the Metropolitan Council staff look at the permit application materials concurrently with Agency staff. Concurrent review decreases not only the time involved in the review process but also the number of times the permit applicant is subjected to answering the same questions for two different agencies as all questions are incorporated into one response letter. When the permit application is approved, copies are distributed to the permit applicant, Agency Regional Office, and the Metropolitan Council, as appropriate. The approved permit application is then used during facility construction, operation and inspections to ensure compliance. It is reasonable that the proper number of copies be submitted with the original permit request to ensure timely review and all modifications are incorporated into all permit applications making four complete documents. This will ensure completeness and consistency during compliance determinations.

The first paragraph also requires that the horizontal scale on all drawings and plans be one inch equals 200 feet. A horizontal scale is needed on plans and drawings in order that an understanding of actual site conditions can be obtained from reviewing drawings and plans. Without the use of horizontal scales on the design plans, actual construction and operations will be difficult to complete as no point of reference will be available to determine location or size. "One inch equals 200 feet" is a reasonable scale to use because it allows most site plans to represent facility activities on normally-used engineering blue-line paper reducing costs for the design phase of the project. This scale also provides a reasonable level of detail to understand site-specific conditions. By including the specific scale size in the rule, the Agency ensures consistency between design plans eliminating the potential costs incurred by some permit applicants for obtaining a higher level of detail.

Under this paragraph, the permit applicant is also required to date all plans and reports with the initial data prepared and all subsequent revisions. All revisions are to include a notation as to the specific revisions made. It is necessary to date all plans and reports in order that the most recent version is used in the construction and operation of the facility and during inspections by the Agency staff. Revisions to plans, in particular, can be very subtle and without highlighting the changes they could be overlooked by parties using the plans. It is reasonable to require the permit applicant to date all plans and reports because it does not increase the burden on the applicant yet ensures all parties are using the most up-to-date version of the plans and reports.

Item A requires a general description of the facility, e.g., the type of solid waste facility and whether the facility is new or existing. This information will enable the Agency to gather information on the regulatory history of the facility.

Item B requires an industrial solid waste management plan including a description of the waste types and proposed management techniques. It is the applicant's responsibility to properly manage all waste the facility accepts. This information will allow the Agency to evaluate the applicant's ability to manage industrial solid waste at the facility, to evaluate the environmental impact, and to provide a basis for conditions in the permit.

Item C requires a description of the security procedures and equipment required at the facility by proposed part 7035.2535, subpart 3. This information will assist the Agency to determine facility compliance with the access control requirements of proposed part 7035.2535, subpart 3. The Agency will base the security requirements included in the permit on this information.

Item D requires a copy of the inspection schedules required under proposed part 7035.2535, subpart 4 and parts 7035.2815 to 7035.2875. Based on these schedules, the Agency will conduct inspections to provide assurance that spills and other conditions that could cause sudden pollution problems do not go undetected for long periods of time. Since these schedules establish the frequency and extent of inspections and affect the adequacy of the inspections, they should be submitted for Agency review and inclusion in the permit.

Item E requires a copy of the contingency action plan required by proposed part 7035.2615. The contingency action plan establishes methods for handling emergencies and unplanned releases of pollutants at the facility. Since this plan details response to such situations, it is reasonable to require the plan be submitted to the Agency for review and inclusion in the permit. If the plan is inadequate or contains improper management procedures, Agency staff will be able to work with the applicant to amend the plan. This plan is needed to develop cost estimates used to establish a proper level of financial assurance in accordance with parts 7035.2685 to 7035.2805.

Item F requires a description of procedures, structures and equipment used at the facility to prevent adverse effects on human health and the environment. This information is needed to help the Agency determine the effectiveness of the design of the facility to prevent impacts on human health and the environment. Solid waste management facilities have the potential for adversely affecting human health and the environment. Facility impacts can be avoided or mitigated if appropriate procedures, structures and equipment are used at the facility. The submission of this information will allow the Agency to address in the permit the use of preventive measures at the facility.

Item G requires a description of precautions to prevent accidental ignition or reaction of ignitable or explosive wastes or waste by-products. Since fires and explosions can cause unplanned releases of solid waste or pollutants, it is reasonable to request information on the precautions the facility owner or operator will take. This information will be reviewed for adequacy and included in the permit to assure proper handling.

Item H requires a description of traffic control at the facility. Traffic management at the facility can affect the facility's potential for accidents and unplanned releases of solid waste or pollutants. Information on road conditions and capacities will assist in determining whether the roads are adequate for the types of vehicles expected to use the facility.

Item I requires a description of how the storage requirements of part 7035.2855 will be met. Requiring this information is reasonable because the improper storage of wastes could produce polluted run-off water and a health and safety hazard to facility personnel. This information allows the Agency to incorporate any needed provision into the permit.

Item J requires a closure plan and a postclosure care plan, where applicable, in the permit application. The provisions of proposed parts 7035.2635 to 7035.2655 contain closure and postclosure care requirements. This includes establishing cost estimates. Requiring these plans allows the Agency to determine the adequacy of the plans and incorporate these provisions into the permit. Since proper closure and postclosure care actions are necessary to prevent adverse effects on human health and the environment, it is reasonable to require facilities to provide assurance that the facility can and will be closed and, if necessary, properly maintained and monitored after closure. Since the closure and postclosure care plans provide the basis for cost estimates in establishing financial assurance instruments, it is vital that the plans be accurate and detailed and that the Agency review and approve them as a part of the permit.

Items K to M require up-to-date closure, postclosure care and contingency action cost estimates and evidence of the establishment of financial instruments. The cost estimates are based on the closure, postclosure care and contingency action plans. These activities may be expensive but are essential to prevent adverse effects on human health and the environment. The value of the financial mechanism is dependent on the cost estimates. Therefore, it is reasonable to require facilities to submit cost estimates and copies of the financial instruments with the permit application.

Item N requires a topographic map, floodplain map, development plan and other locational information. The scale of one inch equals 200 feet is needed to ensure that the map is proportioned to show details accurately. It is reasonable to require these maps and plans, since this information is needed to determine the facility's potential for adverse effects on the surrounding area. Contours are needed to determine surface water flow at and adjacent to the facility. This information will enable the Agency to determine the direction of surface water run-on and run-off and more accurately evaluate areas that might be impacted by the facility. Requiring information such as map date, scale, and direction arrows, subitems (1), (2), (6), is also reasonable so that maps can be accurately interpreted.

It is reasonable to require information on floodplains, wetlands, shorelands, wells, zoning and boundaries of parks and wildlife refuges, subitems (3), (4), (5), so that compliance with location standards and the potential for adverse effects on water supplies, aquatic life, wildlife and the surrounding area can be determined. These areas are environmentally sensitive and could be adversely impacted by the operation of a solid waste management facility. Other existing laws and rules establish management standards for these sensitive areas and a solid waste management facility may violate these standards.

Subitems (7) to (11) and (14) require the display of information on legal boundaries, land ownership, township, range, section numbers, and easements and rights-of-way. This information is needed to determine the exact location of the facility. Based on the locational information, the Agency can also determine what units of government have jurisdiction over the facility so that a public notice can be sent to them.

Subitem (12) requires showing the location and elevation of a permanent benchmark. This base measurement for all future readings is needed to provide accurate readings of site contours, ground water elevations, and design feature locations when actual site inspections are conducted to evaluate compliance with design plans. It is reasonable to require this information to allow for consistency between the Agency's and facility owner's site measurements.

Subitem (13) requires a location grid system on every plan. Requiring a grid system is reasonable because it allows accurate siting of specific design features including well locations by establishing a base from which measurements are made.

Subitem (15) requires all nearby airports be shown. This information is needed to allow the Agency to determine compliance with federal regulations regarding the location of solid waste management facilities near airports. It is reasonable to require this information as it provides the Agency with information to determine permit conditions and compliance with other regulations.

Subitem (16) requires that the location of fences, gates and other access control be shown. It is reasonable to require this information as it allows the Agency to determine if adequate access control is provided at the facility and to incorporate these conditions in the permit.

Subitem (17) requires showing all off-site and on-site water supply and monitoring wells. It is reasonable to require this information because it will assist in determining potential impact areas if a release occurs at a facility and allow the Agency to incorporate the points as monitoring sites in the permit.

Subitem (18) requires showing various elements of the facility design, the location of existing and proposed structures, storage areas, disposal areas, run-on and run-off control structures, access and internal roads, loading and unloading areas, and fire control systems. During the permitting process, these features will be evaluated to ensure that the facility can be operated in compliance with the technical standards.

Item O requires that the application show any geologic and location information necessary to demonstrate compliance with the technical rules. It is reasonable to require this information for the Agency to properly evaluate the potential impacts from a facility and whether the facility can be operated in compliance with the technical standards. This information will be used in establishing permit conditions.

Item P requires an operations and maintenance manual describing how the facility will be managed to prevent malfunctions, deteriorations, and unplanned releases of solid waste and pollutants. Since the proper operation of a facility is necessary to assure the protection of human health and the environment, it is reasonable to require the submission of this information for Agency review and inclusion in the permit.

Item P lists nine specific areas of concern to be addressed in all operation and maintenance manuals. The reasonableness of including each of the concerns is discussed in detail below. Subitem (1) requires that all operation and maintenance manuals include a description of the facility and all design parameters. The operation and maintenance manual is used by the facility owner and the facility personnel for operating the facility to meet Agency standards and rules and all other governing statutes and rules. In order to ensure consistency in facility operations, it is necessary that details concerning its design, construction and operation specifications be provided. This is accomplished through the operation and maintenance manual during the permitting process. In order to construct a facility, the owner must have an understanding of the facility's function and the design parameters governing its operation. This subitem merely establishes a point of reference for this information.

Subitem (2) states that the operation and maintenance manual must contain emergency shutdown procedures. The operation and maintenance manual serves as a training tool for facility personnel. It should provide guidance on normal day-to-day operations and procedures during emergency situations. Prompt and correct responses to unexpected events can save lives, prevent needless damage to the facility, and minimize impacts on the environment. Common sense dictates that facility personnel be aware of the steps to be followed for shutting down site equipment in times of emergency. This subitem establishes the reference to be used for maintaining the information. By requiring the information to be available at all facilities, the Agency ensures that a consistent approach to developing the procedures is followed.

Subitems (3) and (4) are closely related. Subitem (3) requires that all operation variables and procedures be contained in this manual. It is logical that facility personnel have one resource for obtaining the necessary information to ensure efficient and proper operation of the facility. Subitem (4) requires that the manual also contain trouble-shooting procedures. Trouble-shooting is a systematic process by which a person evaluates the causes to malfunctioning systems at a facility. By understanding the operation variables and procedures to be included in the manual, the trouble-shooting procedures will be used to identify the most likely causes of a problem. This information must be readily available to facility personnel for facilities to be operated in the most efficient manner with a minimum of delays. These subitems do not require additional work by a facility owner or operator preparing a reasonable system to manage risks associated with a particular facility. For instances when these steps are not being conducted by a facility owner or operator, these items provide a reasonable method to ensure that proper evaluations on facility operation are conducted.

Subitems (5) and (6) address the need to include preventive maintenance requirements and safety requirements and procedures, respectively. Again, sound risk management operations dictate a program of prevention rather than reaction. Not all problem situations can be anticipated or prevented; thus, the need for contingency action plans. However, careful planning and training can minimize these unexpected situations. The operation and maintenance manual is the controlling document for a facility. It is the guideline for facility personnel actions. Therefore, it is reasonable that preventive maintenance or daily operations and upkeep of facility equipment be included in the manual.

Subitems (7) and (8) address maintaining correct and up-to-date records. Subitem (7) requires the facility owner or operator to explain how equipment maintenance records are to be completed and maintained at the facility. These records will supply the Agency, the facility owner, and facility personnel insight on the effectiveness of the preventive measures employed at the facility and record of compliance with appropriate requirements. Subitem (8) requires the manual to include a section on maintaining site inspection records. Site inspections provide routine evaluation on facility performance and should be sufficiently detailed in order that they might indicate problem areas. Facility owners and operators for purposes of equipment warranties and compliance verification need to record the data obtained during a facility inspection. This subitem merely establishes the reference in which the facility owner or operator supplies the details on maintaining the records.

Subitem (9) requires the inspection schedule to be included in the operation and maintenance manual. Since this manual is the reference document for all interested parties, it is important that it contain all information needed to properly operate the facility. As indicated earlier, routine inspections provide the data used to operate or maintain a facility in compliance with appropriate rules, standards and statutes. It is a reasonable requirement that the details for conducting these critical facility evaluations be contained in the document used by all facility personnel and regulations. This ensures the consistency of inspection procedures including timing and level of detail and eliminates the oversight of facility personnel on any one component of the management system. This type and level of detail is important in operating an efficient and effective risk management program.

Item Q requires that a construction inspection, quality control, and quality assurance plan be submitted with the final permit application. Facility construction is critical to the facility's performance and compliance with the technical standards. It is reasonable to require this information to allow Agency review of construction verification procedures prior to issuing a permit for construction and operation of the facility. Compliance will become a condition of the permit.

Item R requires the submission of any additional information the

Commissioner needs to determine whether the facility will meet all applicable federal and State statutes and rules. The final permit application must provide sufficient information for the Agency to make a determination to issue or deny a solid waste management facility permit. Part 7001.0140 establishes the findings that must be made to issue a permit. It is reasonable to require additional information that is relevant to the facility and the final determination of compliance with applicable law.

13. Part 7001.3375 FINAL APPLICATION INFORMATION REQUIREMENTS FOR COMPOST FACILITIES.

This part establishes the additional information that must be contained in the final permit application for solid waste management facilities that produce compost. The information requirements of this part are based on the final facility standards in proposed part 7035.2835. Since compliance with these standards is one of the conditions for permit issuance, it is reasonable to require sufficient information to allow the Agency to determine whether the facility will meet the standards and receive a permit.

Items A and B require a description of the design of the composting process and the physical features of the facility. This information will be used to evaluate the potential impacts to human health and the environment and to establish permit conditions.

Item C requires a description of the material to be composted. Information on the types of material allows the Agency to assess the facility's potential to comply with the technical standards.

Items D and E require a description of the residue generated from the compost process and the method for disposal of the residue. It is reasonable to require information on the residue and how it will be managed to ensure that a disposal method capable of minimizing impacts to human health and the environment will be used.

Item F requires information on the design of an odor control system. The composting process is a biological method of decomposing solid waste and may produce odors. It is reasonable that the Agency have information regarding the design of the odor control system in order to assess the ability of the system to comply with the technical standards.

Items G and H require a description of the design and performance specifications for the compost facility including retention times, temperatures, number of turns, and the air flow design. Requiring the detailed design information is reasonable because the compost process used is critical to the quality of compost produced. The Agency needs this information to adequately assess the ability of the facility to generate a compost capable of meeting the technical standards. This information will be used in developing permit conditions for the facility.

Item I requires an operating plan. This information is needed as operation of the facility is critical in ensuring the facility meets standards. Additionally, since following the operating plan is a condition of the permit, it is reasonable that the Agency receive the plan for review before issuing a permit. The operating plan must contain a waste analysis plan. It is reasonable to require this information as the results of the analysis will be used as the basis for end use distribution of the compost product and the assessment of the facility's compliance with technical standards. The Agency needs this information to adequately assess the results of analyses submitted in accordance with permit conditions.

The operations plan must also contain a description of the proposed end uses for the compost. This information is needed because of the close relation of the facility design to the proposed compost end use. Therefore, it is reasonable that the Agency receive the information prior to permit issuance.

14. Part 7001.3400 FINAL APPLICATION INFORMATION REQUIREMENTS FOR TRANSFER FACILITIES.

This part establishes the additional information to be contained in the final application for solid waste transfer facilities. The information requirements of this part are based on the facility standards of proposed part 7035.2865. Those standards are specific for facilities used as points for transfer of solid waste between collection and ultimate management.

Item A requires detailed plans and supporting documents. The detailed plans are needed to allow the Agency to assess the effectiveness of the chosen design in minimizing impacts to human health and the environment. Because the specific design specifications are the basis for any permit issued, it is reasonable that the Agency receive this information for review and inclusion in the permit.

Subitem (1) requires that the facility design and layout be addressed in the detailed plans. This information is needed to determine the processing capabilities of the facility and potential impacts on the surrounding area. It is reasonable to require this information as it will be used in establishing the conditions of the permit.

Subitem (2) requires a discussion of the security measures to be employed at the facility. Requiring this information is reasonable because the disruption of facility operations due to vandalism and unintentional intrusions can affect the capability of the facility to meet technical standards. The Agency needs to review the security measures before issuing a permit to assess their adequacy in preventing adverse impacts to human health and the environment.

Subitems (3) and (11) require a discussion on the size and type of vehicles to be used at the facility and the on-site road design. Because the type and size of vehicles impacts the facility design and on-site road requirements, it is reasonable to require this information during the permit application to allow the Agency to determine if the facility design is adequate.

Subitem (4) requires a discussion of the types of waste to be handled at the facility. Since the type of waste to be handled at the facility is integral to the facility design and operations, it is reasonable to require this information with the permit application. The Agency needs this information to assess the adequacy of the facility design to meet technical standards based on the waste accepted for management at the facility.

Subitem (5) requires the intended operating hours for the facility and subitem (13) requires the operating procedures for the facility. This information is needed to determine if the facility is capable of processing the incoming waste in a manner that will not result in adverse impacts to human health and the environment. It is reasonable to require this information during the permitting process because compliance with the operating procedures will be made a condition of the permit and the Agency needs to determine their adequacy.

Subitem (6) requires the amount of storage capacity at the facility and the maximum amount of waste expected. The improper storage of waste or waste by-products may result in damage to the facility and impacts to human health and the environment. Information on the storage capacity will allow the Agency to review the storage needs at the site and indicate any special conditions needed in the permit.

Subitem (7) requires a detailed discussion on the equipment to be used at the facility. It is reasonable to require this information as it is needed to assess the adequacy of the facility to process the waste for transport to the next solid waste management facility. The equipment needs will become a condition of the permit.

Subitem (8) requires a discussion of the control of dust, vectors, litter, noise and odors at the facility. The considerable traffic volumes may produce noise and dust problems. If the facility design is not adequate to process incoming waste, then litter, vectors and odors may cause nuisance conditions and adverse impacts on human health and the environment. It is reasonable that this information be provided during the permitting process to allow the Agency to evaluate the facility design in regard to these concerns and address any special conditions needed in the permit.

Subitems (9) and (10) require a discussion of the frequency of waste removal, the method of removal, and the final deposition of the waste. It is reasonable to require this information as it is needed for the Agency to assess whether proper management methods will be used to minimize impacts to human health and the environment.

Subitem (12) requires a site closure plan. This plan establishes procedures for removing all waste from the facility and any part of the facility that may require special handling methods due to its potential for affect on human health and the environment. Compliance with this plan will be made a condition of the permit. If the plan is inadequate or contains improper closure management techniques, Agency staff will be able to work with the permit applicant to amend the plan.

Subitem (14) requires the applicant to address any composting or recycling activities that may be conducted at a transfer facility. These activities must be planned for in advance of facility construction to minimize disruptions to the main function of the facility. It is reasonable to require this information with the permit application to allow the Agency to assess the impacts of these operations on the transfer facility and ensure that they will meet the technical standards established for those operations. The permit conditions will reflect the special need of these operations.

Subitem (15) requires that the design plans and engineering report discuss the safety and emergency procedures to be used at the facility. This information is needed to assess the ability of site personnel to adequately respond to emergency situations without endangering themselves. Because these procedures will become conditions of the permit, it is reasonable to require this information during the permitting process for Agency review.

Item B requires the submittal of any additional information needed to show that the facility will meet the technical standards of proposed part 7035.2865. It is reasonable to provide for the submittal of additional information because there are many designs that could be used for a transfer facility and the rules cannot address each issue for all designs.

15. Part 7001.3425 FINAL APPLICATION INFORMATION REQUIREMENTS FOR DEMOLITION DEBRIS LAND DISPOSAL FACILITIES.

This part establishes the additional information to be contained in the final application for permits for demolition debris land disposal facilities. The information requirements of this part are based on the technical standards of proposed part 7035.2825. Since compliance with these standards is one of the conditions for issuance of a permit, it is reasonable to require sufficient information for the Agency to determine if the facility will comply with the standards and whether a permit should be issued.

Item A requires the facility owner or operator to include the calculations of site capacity and operating life for the facility. This information is used to evaluate potential problems, e.g., is on-site equipment equal to handling incoming waste, associated with a facility because of size and duration of operations. It may be necessary to address the concerns raised by this information in the facility permit. Therefore, it is reasonable that it be included in the final permit application.

Item B requires information regarding the facility's run-on and run-off diversion system. Since run-on can affect the facility operations and run-off can affect the environment, proposed part 7035.2825 requires that run-on be diverted and run-off from the disposal area be collected. It is reasonable to require this information so the Agency can determine compliance with this standard.

Item C requires a description of the procedures to be used in controlling the wind dispersion of particulates and fugitive dust. It is reasonable to require this information because of the nature of demolition debris; particulates and fugitive dust can be a problem to the extent that human health and the environment may be impacted. The Agency needs this information to assess the facility design and its ability to meet the technical standards regarding particulates and fugitive dust.

Items D and E require detailed plans showing the filling sequence and cross-sectional views indicating existing grades and final elevations. The plans must show the lowest fill elevation as it relates to the water table and bedrock conditions. This information is used to assess the ability of the facility to comply with proposed standards. Based on this information, specific permit conditions will be established to ensure compliance with the technical standards of parts 7035.0300 to 7035.2655 and 7035.2825.

Items F, G and J require that the permit application contain soils and hydrogeologic information needed to evaluate the site conditions and its suitability for use as a disposal site. This information is not required at the same level of detail for all facilities. The need for a detailed hydrogeologic evaluation and ground water monitoring system is dependent on the size, location and wastes to be handled at the facility. It is reasonable to require that this information be submitted with the permit application as it is needed for the Agency to assess potential impacts from the facility and adjust permit conditions accordingly.

Item H requires that the permit application address the control of noise and access at the facility. Vehicles used to transport demolition debris waste are large and may generate noise in excess of standards. If access at a demolition debris land disposal facility is not controlled, intruders could disrupt the site operations by disposing of improper wastes and by destruction of design features. Thus, it is reasonable to require this information to allow the Agency to review the design for adequacy to ensure that the technical standards will be met.

Item I requires a description of the equipment to be used at the site. This information is needed to determine if the site will have the equipment to be properly operated to meet the technical standards. It is reasonable to require this information in the permit application because the equipment capabilities are integral to the ability of the facility to be properly operated.

Item K requires a listing of other permits required before the facility may be constructed. It is reasonable to require this information in the permit application because it may be necessary to coordinate the facility design with all permit conditions pertaining to the site. The Agency needs this information to assess issues of facility design that may impact the issuance of permits by other bodies.

Item L requires that an inspection procedure for incoming wastes be developed for the facility. Permits for these facilities limit the type of waste acceptable for disposal based on design and operational needs. If unapproved wastes are disposed of at the site, the potential for adverse impacts on human health and the environment will increase. It is reasonable to require this information to allow the Agency to assess the adequacy of the inspection procedure used to detect unapproved wastes.

Item M requires any additional information needed to show that the technical standards can be met. It is reasonable to require this information because each facility is unique in its location and design and it is not possible to specifically address each possibility by rule. The Agency will use this information in establishing permit conditions unique to the specific facility.

16. Part 7001.3450 FINAL APPLICATION INFORMATION REQUIREMENTS FOR REFUSE-DERIVED FUEL PROCESSING FACILITIES.

This part establishes the additional information an applicant must include in a final application for a refuse-derived fuel processing facility. The information requirements of this part are based on the facility technical standards of part 7035.2875. Since compliance with these standards is a condition for permit issuance, it is reasonable to require sufficient information to allow the Agency to determine whether the facility will be able to comply.

Item A requires that a description of the area used for separating the incoming waste into its various components, such as ferrous metals, screenings, fuel and residuals. This information is needed to determine space requirements and other design specifics to ensure the facility can be operated in compliance with the technical standards. It is reasonable that the Agency receive this information during the permit process for review and use in establishing permit conditions.

Item B requires the specific facility design including storage areas for the waste components and residuals, loading and unloading areas, and the processing methods used. Because the processes used in developing refuse-derived fuel may vary depending on the facility accepting the fuel, it is reasonable to require detailed information on the specific processing method to enable the Agency to determine whether the facility will be able to comply with Agency standards.

Items C and H require a description of the end products generated at the facility and their use. It is reasonable to require this information to allow the Agency to assess the proper management techniques available to handle the end products in a manner that minimizes the impact to human health and the environment. This information will be used in reviewing the facility design and in establishing permit conditions.

Item D requires a material flow and balance calculation. This information is used in sizing the facility and in determining the needs for managing the end products. It is reasonable to require this information to allow the Agency to assess the adequacy of the facility design.

Items E and F require the specific details for the design of the facility including the odor control system. It is reasonable to require this information because the design is integral to the facility's ability to comply with technical standards and compliance with the design specifications will become a condition of the permit. The Agency needs this information to assess the adequacy of the facility to process incoming waste and to comply with technical design and operation standards.

Item G requires the operations manual to specifically include the processing equipment and protective measures to prevent explosions. Inadequate equipment or explosions could result in harm to human health or the environment because of unexpected releases of pollutants. It is reasonable to require detailed information regarding the process equipment to allow the Agency to determine whether the facility will comply with standards.

Item I requires any additional information needed to show that the facility will be able to meet standards. It is reasonable to allow the Agency to review the unique design of each facility to determine appropriate permit conditions. Additionally this provision allows flexibility in the submission of permit applications as the information relates to a specific facility.

17. Part 7001.3475 FINAL APPLICATION INFORMATION REQUIREMENTS FOR MIXED MUNICIPAL SOLID WASTE LAND DISPOSAL FACILITIES.

This part establishes the additional information to be contained in the final permit application for mixed municipal solid waste land disposal facilities. The information requirements of this part are based on the specific standards contained in proposed part 7035.2815. It is reasonable to require this information to enable the Agency to determine if the facility will be able to meet standards so that a permit may be issued.

Item A requires the submission of the needed disposal capacity as determined under Minn. Stat. §§ 115A.917 and 473.823, subd. 6. The Agency may issue permits for mixed municipal solid waste land disposal facilities only after needed capacity is certified. It is reasonable to require that information to determine if the facility will be in compliance.

Item B requires a description of the waste types to be handled at the facility including those requiring special handling procedures and disposal areas. Potential harm to human health and the environment will result from the mismanagement of incoming wastes. Examples include food wastes and industrial solid waste streams. It is reasonable to require the submittal of this information to enable the Agency to review the information and include the management procedures in the permit.

Item C requires information regarding the status of the Environmental Assessment Worksheet or Environmental Impact Statement. The completion of an Environmental Assessment Worksheet or Environmental Impact Statement or both are necessary before an Agency permit may be issued for the construction and operation of a land disposal facility. A declaration of negative impact or the inclusion of specific design, construction or operational features to protect the environment are necessary to issue a permit. Therefore, it is reasonable to require the final application to include the status of the worksheet or impact statement to allow the Agency to review the documents and include any necessary provisions in the permit.

Item D requires detailed plans and an engineering report regarding the design, construction and operation of the mixed municipal solid waste land disposal facility. The plans and report must show how compliance with the technical standards of parts 7035.0300 to 7035.2815 will be maintained. The specific areas to be addressed include the liner system (subitem (1)), the leachate collection and treatment system (subitem (5)), drainage control (subitems (2) and (3)), and the plans depicting the construction and fill sequence (subitem (6)). Subitem (4) requires the control of particulate matter to be addressed. This information will serve as a basis for conditions in the permit. Since compliance with the standards of parts 7035.0300 to 7035.2815 is a condition of permit issuance, it is reasonable to require sufficient information to allow the Agency to determine whether these standards will be met.

Item E requires the final application to address the geologic and hydrogeologic information on the site. This information will have been collected during the detailed site evaluation conducted under part 7001.3275. It is reasonable to include the information in the final application for completeness. No additional work is required of the facility owner or operator under this item.

Item F requires the submittal of an operation and maintenance manual with the final application. The Agency's review of the information contained in the final application supplies the basis for approval or denial of a facility permit application. The operation and maintenance manual contains the procedures to be followed by facility personnel to ensure compliance with rules and standards. Therefore, it is reasonable that this information be supplied to the Agency for the application review and final permit determinations.

Item G requires a description of how the facility will be inspected. Routine inspections ensure the facility is operating as designed. It is reasonable that the Agency and facility owner or operator agree on the level of detail needed in the inspection program. This process is most efficiently conducted during the permitting period to ensure consistency from start-up to closure.

Item H requires detailed plans and engineering reports on the final cover and monitoring protocol during the postclosure care period. This information is to be supplied in closure and postclosure care plans for the facility. It is reasonable to address these issues at the time of permit application as the Agency is required under Minn. Stat. § 116.07, subd. 4g, to establish standards for these actions that will prevent, mitigate, or minimize the threat to public health and the environment. The permitting process is the proper time to address the suitability of planned activities. Additionally, Minn. Stat. § 116.07, subd. 4h, states that compliance with financial responsibility rules is a condition for obtaining or retaining a permit. These plans are the basis for establishing financial responsibility because the cost estimates are provided in the plans. Therefore, it is necessary and reasonable that the plans be submitted at the time of permitting.

Item I requires the specific design for the proposed gas monitoring, collection and treatment system. This information is required to allow the Agency to assess the adequacy of the facility design to prevent the migration of gas off-site in a manner that would have adverse impacts to human health and the environment. Requiring this information in the permit application is reasonable because the gas is of concern from a safety issue and an environmental issue. If designs do not properly address the control of gas, serious impact may result. The Agency will review the design, determine its adequacy, and include the appropriate conditions in the permit.

18. Part 7001.3500 TERMS AND CONDITIONS OF SOLID WASTE MANAGEMENT FACILITY PERMITS.

This part provides for the term of a solid waste management facility permit and for general conditions which, in addition to the general conditions required in all Agency permits by part 7001.0150, are to be included in all solid waste management facility permits.

Subpart 1 provides that the term of a solid waste management facility permit is five years. Due to the high potential of harm to the environment from the improper management of solid waste at a solid waste management facility and the rapid advancement of technology, it is reasonable that these permits be reviewed and reissued on a five-year basis. It has been suggested that permits be issued for the entire life of the facility. The Agency considers this to be unreasonable because technology changes during the life of the facility would not be accounted for. A five-year term permits reasonable updates of facility designs in order to prevent impacts that go undiscovered for some period of time resulting in costly corrective actions. The term is also consistent with all other permits issued by the Agency.

Subpart 2 provides that the certified capacity determined in compliance with Minn. Stat. §§ 115A.917 and 473.823, subd. 3, be contained in the facility permit. By statute, the certified capacity for a mixed municipal solid waste land disposal facility is a condition of permit issuance. Therefore, it is reasonable that the permit expressly state the facility's certified capacity.

Subpart 3 provides that the general conditions established in the Agency's general permit rules, part 7001.0150, subpart 3, apply to solid waste management facility permits. This is reasonable because those conditions establish important legal limitations on the duties and rights conveyed with the issuing of the permit.

Item A requires the facility owner or operator to maintain records of all ground water monitoring data and ground water surface elevations for the active life of the facility and, for disposal facilities, for the postclosure care period. The facility owner or operator is required to maintain an operating record until closure of the facility. It is reasonable to require the creation of an ongoing record of the ground water quality in the vicinity of the facility so that impacts on the ground water quality during the life of the facility and postclosure care period can be detected. The operating record provides a summary of the volumes and types of waste accepted at the facility and is reasonable for use in Agency determination of compliance with facility operational standards.

Item B establishes the conditions that must be met before operations at a facility may begin. These conditions include verification procedures needed regarding the construction of the facility. It is reasonable to require this information because the improper construction or modification to the facility design could result in releases of pollutants and impacts on human health and the environment.

Subitem (1) requires the submittal of as-built plans signed by the facility owner or operator and an engineer registered in Minnesota. The engineer must certify that the facility was constructed or modified in accordance with the permit. This information is needed to allow the Agency to assess the suitability of construction and to determine if all modifications are in compliance with the permit and technical standards. It is reasonable to require this information before operation of the facility because modifications to the facility could impact operational procedures, which may need to be altered due to the modification.

Subitem (2) requires inspection of the facility by the Commissioner before operations may begin. The facility owner or operator must have received a letter from the Commissioner indicating that the certification submitted under subitem (1) is complete and approved. It is reasonable to require that operations not begin until after the Commissioner's letter is received because the letter will indicate that the construction of the facility is in compliance with the permit and that operations may proceed as planned or the construction is inadequate and changes are necessary before operations begin. This inspection is the Agency's last review of the facility prior to operation to ensure its suitability for use as a solid waste management facility.

Subitem (3) requires that no operations be initiated until the Commissioner has approved the financial assurance amount and instrument to be used. Requiring the finalization of this information before operation of the facility is reasonable because, if operations begin and a problem arises, funds must be available to resolve the problem. It is also mandated by Minn. Stat. § 116.07, subd. 4h, that financial responsibility rules be complied with as a condition of facility operation.

19. Part 7001.3550 MODIFICATION OF SOLID WASTE MANAGEMENT FACILITY PERMITS; REVOCATION AND REISSUANCE OF PERMITS.

Existing parts 7001.0170 to 7001.0190 set forth general provisions for the modification and revocation and reissuance of Agency permits. However, due to considerations that are only applicable to solid waste management facility permits, provisions are needed in addition to those provided in the general conditions. To accommodate these considerations, proposed part 7001.3550 establishes additional reasons that constitute justification for the Commissioner to commence proceedings to modify, or revoke and reissue, a solid waste management facility permit. These reasons are based on the requirements of parts 7035.0300 to 7035.2875, which are only applicable to solid waste management facilities.

Based on the approach used in parts 7001.0170 to 7001.0190 for permits in general, this part distinguishes between major modifications and minor modifications. Generally, permits are modified in accordance with the procedures set forth in parts 7001.0110 to 7001.0150. However, for changes considered minor in nature, the Commissioner may modify a permit without following these procedures. In determining what changes are minor modifications, the Agency considered the potential effect the permit change could have on human health and the environment, and the requirement of parts 7035.0300 to 7035.2875.

Subpart 1. Scope. This subpart is reasonable because it specifically states that this part supplements the existing requirements found in the Agency's general permit rules.

Subpart 2. Additional justification for modification of permits or revocation and reissuance of permits. This subpart provides ten justifications for permit modification or revocation and reissuance as they relate to solid waste management facilities, in addition to those set out in part 7001.0170.

Item A is a determination by the Commissioner that modification of a closure plan or a postclosure care plan is required by part 7035.2625 or part 7035.2645. Part 7035.2625 requires the owner or operator of a solid waste management facility to have an Agency-approved closure plan and part 7035.2645 requires an Agency-approved postclosure care plan. These plans are incorporated as conditions of the facility permit. However, these parts contain provisions for amending the plans whenever changes or events occur that affect the plans. Accordingly, this part contains the additional administrative provisions necessary to amend the plans. Considering that changes might be necessary and that the permit must be specific and up-to-date to be an effective tool to regulate the facility, it is reasonable to have provisions for modifying the permit.

Item B involves the filing by the facility owner or operator of a request for an extension of the time periods contained in parts 7035.2625 to 7035.2655. These parts contain provisions regarding closure and postclosure care activities including time limits allowed for closure and reasons for approving time extensions. Provided the facility owner or operator makes the demonstrations required in parts 7035.2625 to 7035.2655, the Agency may approve a time extension. However, the closure plan, which is part of the facility permit, specifies when the facility will be finally closed and contains a schedule for final closure. If a time extension is to be approved, the permit must be modified to reflect this change. Accordingly, this part contains the additional administrative procedures necessary to amend the closure plan. Since closure activities for some facilities could require more time to complete than the rule allows or originally planned for, it is reasonable to modify the permit to allow time extensions.

Item C involves the notification of the Commissioner by the permittee that the facility will close in advance of the date contained in the permit. Because the closure plan indicates when the facility will be closed and how the facility will be closed, it is reasonable to modify the permit due to early closure of the facility.

Item D involves a finding by the Commissioner that modification of the postclosure care period is necessary as provided in part 7035.2655. Part 7035.2655 requires that postclosure care must continue for at least 20 years after the closure is completed. That part also contains provisions allowing the Agency to adjust the postclosure care period by reducing or extending it and specifying the basis for the adjustment. Accordingly, this part contains the administrative procedures necessary to amend the permit to reflect an adjustment in the postclosure care period. An example of when this provision might be applicable is a disposal facility showing no release of pollutants to the air or ground water at the tenth year after closure. Since the potential for environmental harm is decreased, it is reasonable to re-evaluate the time needed for postclosure care.

Item E involves a finding by the Commissioner that the permittee has made the demonstration required by parts 7035.2645 and 7035.2655 that a disturbance of the integrity of the containment system is necessary. Part 7035.2655, subpart 2, prohibits the facility owner or operator from disturbing the integrity of the final cover, liner, or other containment system component or the monitoring system without Agency authorization. If a disturbance is authorized by the Agency, a permit modification is needed so the postclosure care plan can be changed to include information regarding the disturbance.

Accordingly, this part contains the additional administrative procedures necessary to amend the plan contained in the facility permit.

Items F and G involve adjustments to the levels of financial responsibility required of the facility owner or operator. Parts 7035.2665 to 7035.2805 establish financial assurance requirements for facility owners and operators of mixed municipal solid waste land disposal facilities. Due to the variety of facilities and their associated risks, it is reasonable to allow the level of financial assurance to be adjusted according to the conditions and risks. Since the permit specifies the level of financial assurance, any changes in that level must be reflected in the permit. Therefore, an adjustment of the level of financial assurance is a reasonable justification for modifying the facility permit. Accordingly, this part contains the additional administrative procedures needed to modify the permit to reflect adjustments in the level of financial assurance.

Item H involves the Commissioner's finding that corrective actions cannot bring a facility into compliance with ground water standards within the specified period of time. Corrective actions are intended to minimize the hazard to human health or the environment by controlling the release of pollutants or treating polluted waters. Since the timetable for the completion of the corrective actions is included in the permit, it is reasonable to allow a modification of the permit to allow the completion of the corrective actions. Accordingly, this part contains the administrative procedures needed to modify the permit to reflect adjustments to the time needed to complete the corrective actions.

Item I involves the Commissioner's findings that conditions applicable to facilities were not included in the facility's permit. Since the facility's permit is intended to contain all requirements that must be complied with, it is reasonable to provide the administrative procedures needed to modify the permit to reflect adjustments to the permit.

Item J involves the requirement for a certificate of need for the permitting of a facility for new or additional land disposal capacity. Since a certificate of need is required for permit issuance and the certified capacity becomes a condition of the permit, it is reasonable to allow modifications to the permit to reflect changes in certified capacity.

Subpart 3. Minor modifications of permits. This subpart specifies seven types of corrections or allowances that can be made to a solid waste management facility permit without the need to follow the administrative procedures of parts 7001.0100 to 7001.0210. These are considered minor modifications due to their low potential for adversely affecting human health or the environment. The corrections and allowances are based on requirements set forth in parts

7035.0300 to 7035.2875, which are applicable to solid waste management facilities. Upon consent by the facility owner or operator, the Commissioner may modify the permit without public notice. Requiring formal modification procedures for these changes would be an administrative burden.

Item A provides for the modification of a permit when the expected year of closure changes. The year of closure is estimated during the development of a closure plan for the facility. Since circumstances such as an increase or decrease in volume of waste received may cause the expected year of closure to change, it is reasonable to allow for permit modification with limited administrative processing.

Item B involves changing the schedule to complete final closure. The schedule to complete final closure is included in the permit issued by the Agency. Should circumstances such as the need for cover placement and seeding during winter months cause the delay of closure activities, it is reasonable to allow permit modifications. Since the delay in such cases would not increase the facility's potential for harmful effects on human health or the environment, it is reasonable to consider them minor modifications and allow the changes to be made without formal administrative procedures.

Items C and D involve changing the list of equipment and facility emergency coordinators in the permit's contingency action plan. The contingency action plan is required by part 7035.2615. The contingency action plan must specify persons qualified to act as emergency coordinators and list the emergency equipment at the facility. During the term of a permit, it is likely that emergency coordinators and equipment will need to be changed and updated due to personnel changes and equipment purchases and replacement. Since these are only changes in name and equipment pieces, not in requirements or compliance standards, there should be no increase in potential effects on human health and the environment. Accordingly, it is reasonable to allow these changes to occur through a minor modification of the permit.

Item E involves changing the construction schedule approved in the facility owner's or operator's development plans. The plans for development are only estimated at the time of permit application. A change in the construction schedule may be appropriate because of the volume of waste received or the time of season needed for construction. Changing a construction schedule should not increase the potential effects on human health or the environment. The facility cannot be operated if the additional construction is needed before handling waste. It is reasonable to allow this change through a minor modification of the permit.

Item F allows for the changing of monitoring frequency without formal modification procedures. Monitoring assesses facility performance. Frequency is based on the best estimate of obtaining reliable information. Once a monitoring data base is established, it is possible to change the frequency of monitoring without impacting human health and the environment. Therefore, it is reasonable to make these modifications without formal administrative procedures.

Item G is a general provision that permits may be modified without formal procedures if the modifications will not result in an increase in the emission or discharge of a pollutant to the environment, or that will not reduce the Agency's ability to monitor the facility. The technical standards and specific permits issued for solid waste management facilities contain numerous dates and manuals that must be kept and it is not possible to include each potential modification in this subpart. Allowing a general clause for the modification of plans contained in permits in this manner is reasonable because it ensures that plans can be kept up-to-date through consensual modification without a burdensome modification procedure.

Subpart 3 also requires that, for facilities in the metropolitan area, items A, B and F must be reviewed and approved by the Metropolitan Council prior to Agency approval of the modification. Minn. Stat. § 473.823, subd. 3 requires the Metropolitan Council to determine if a permit application or modification is consistent with its policy plan. Items A, B and F address changes in the expected year of closure, schedules for final closure and monitoring frequencies. Modifications to these aspects of a facility's design and operation could have implications regarding the Metropolitan Council's policy for solid waste management in the metropolitan area. Therefore, it is necessary that the Metropolitan Council be involved in the review of modifications to dates and schedules orginally found to be consistent with the policy plan.

C. Reasonableness of Proposed Amendments to Part 7035.0300 SOLID WASTE MANAGEMENT FACILITY RULE DEFINITIONS.

The following discussion addresses the reasonableness of the proposed new and amended definitions of key words and phrases used in the solid waste management facility permit and technical rules. Definitions not changed will not be addressed. It is reasonable to include definitions in the proposed rules to provide a consistent interpretation of terms by all parties. As the general meaning of terms can be understood differently by persons depending on their background, it is important that one meaning be established. By defining potentially confusing terms, the Agency provides the regulated community an understanding of what is expected of them in order to comply with the proposed rules.

Subpart 1. Scope. This subpart, which specifies where the definitions are applicable, is reasonable because it informs all readers of the rules what definitions apply. This establishes a consistent meaning to be used among all affected parties.

Subpart 2. Acceptable daily intake. A definition of acceptable daily intake is included to clarify what the Agency means when it describes the basis for developing ground water standards. It is reasonable to include this definition because the ground water standards are integral in determining facility compliance and all affected parties should understand how the standards are derived.

Subpart 4. Aquifer. The rule incorporates a definition found elsewhere in Minnesota Rules. This definition is included because protecting aquifers is a main purpose of the rules. We must all understand what is being protected. It is reasonable to provide a consistent approach for regulating the protection of these areas.

Subpart 5. Ash. The term ash can be used to mean anything remaining from a process generating heat. The Agency feels this definition would be too broad for use in regulating waste materials, as it could be implied that compost is an ash. Residual waste is separated from ash in determining proper management options.

Subpart 6. Assets. The definition is included to provide a standard operating definition for use in discussions relating to financial assurance. This definition presents the common meaning of the term as used in the business community.

Subpart 7. Backyard compost site. The definition clarifies what material types are considered to be suitable for composting. This definition states the meaning of backyard to include commercial sites composting yard waste at business offices. Backyard compost sites are permitted by rule. Those eligible for such status should know what the Agency means by this term.

Subpart 8. Bulking agent. This term is used in describing the composition of a compost system. It is necessary to provide consistent interpretation of the materials used in a compost system.

Subpart 9. Bulky item. The definition is included to assist the regulated community in identifying a category of solid waste that may require special handling.

Subpart 11. Certified capacity. Certified capacity is the basis for permitted capacity and is essential in the determination of financial assurance. The regulated community must understand that certified capacity is determined under certain statutes and rules.

Subpart 12. Closure. Closure is key in determining financial assurance and protecting human health and the environment by minimizing the potential for pollutants to leave a facility after operation has ceased. It is reasonable to define this term in such a manner that all facility owners and operators will understand how closure relates to their specific facility.

Subpart 13. Closure document. This definition is a shorthand term for referring to the variety of administrative tools available to the Agency for establishing requirements that extend for a period after the facility has closed.

Subpart 14. Closure plan. A closure plan is used, among other things, to develop cost estimates for financial assurance. Compliance with it becomes a condition of a solid waste management facility permit.

Subpart 15. Co-composting. The term is more broadly defined than used elsewhere; therefore, it is reasonable to define it. The definition provides the facility owner more flexibility in the design and operation of the facility.

Subpart 16. Commissioner. This definition is included to reflect recent legislative changes in terminology. The 1987 Legislature revised statutes to change the title of the Executive Director of the Agency to Commissioner effective August 1, 1987.

Subpart 17. Community water supply. This definition includes by reference an existing definition found in Minn. Rules pt. 4720.0100. The use of an existing definition provides consistency between regulatory bodies in their efforts to protect human health and the environment.

Subpart 18. Compliance boundary. This chapter establishes water quality standards for mixed municipal solid waste land disposal facilities. The regulated community must know where the standards will be enforced. The property boundary is not the appropriate place for enforcing the water quality standards, so the term compliance boundary was conceived. It is not a term currently used in the solid waste industry and the facility owner needs to understand the Agency's interpretation of the term.

Subpart 19. Compost facility. Standards for the design and operation of compost facilities are included in the rules. Many materials may be composted but would not be regulated under this chapter as they are not defined as solid waste. It is reasonable to define compost facilities to be those composting solid waste. This notifies the facility owner what standards will be applied to the facility depending on what type of waste is composted.

Subpart 20. Composting. The existing definition of this term is modified to reflect a more concise definition from rules promulgated by the state of Washington titled, "Regulations Relating to Minimum Functional Standards for Solid Waste Handling." This definition is consistent with other information found in literature on composting. The term "humus-like" was obtained from other states' definitions so the compost could be used as a soil conditioner.

Subpart 21. Contingency action plan. A contingency action plan is used in developing cost estimates for financial assurance and in responding to problems at a facility. It is reasonable to include a definition of this term in order that all parties have a similar understanding.

Subpart 22. Corrective action. Provisions in the proposed rules require the repair of problems at the facility that may cause the facility to be out of compliance with the standards. It is necessary to define this term to provide the facility owner or operator guidance on how the Agency will interpret corrective action as it relates to steps used to bring a facility back into compliance with the standards established to minimize threats to human health and the environment. It is reasonable to include this definition as it provides a consistent interpretation to the term as it applies to solid waste management facilities since the term is used in regulating other waste facilities including hazardous waste and surface impoundment facilities.

Subpart 23. Cover material. This existing definition is modified to reflect the general approach followed in this chapter in designing, constructing, and operating facilities based on actual site specific conditions. In the past, specific materials were defined as acceptable for use as cover materials at land disposal facilities. The proposed definition deletes references to the specific materials, makes the the use of a cover material contingent on the Agency's approval and specifies important characteristics of good cover material. This modification maintains sufficient flexibility in this chapter to respond to technological advances capable of protecting human health and the environment. It is reasonable to include in this modified definition the opportunity to evaluate numerous cover options on the basis of economical feasibility as well as technical feasibility to comply with Agency standards.

Subpart 24. Current assets. This definition is generally used by the business community and will provide consistency in developing information regarding assets and evaluating financial assurance documents.

Subpart 25. Current closure cost estimate. This definition refers the facility owner or operator to part 7035.2625, which identifies a specific estimate developed in compliance with a specific part of the rules that deals with facility closure. The definition implicitly provides that only the most recent cost estimate will be considered in developing financial assurance estimates. This definition is reasonable because the closure cost estimate used in establishing suitable financial assurance funds must be the most recent estimate to minimize the chances of the fund being unnecessarily large or insufficient.

Subpart 26. Current contingency action cost estimate. This definition refers the facility owner or operator to part 7035.2615, which identifies what must be included in developing a cost estimate for corrective actions at the facility. This definition implicitly requires that only the most recent cost estimate will be accepted by the Agency. This definition is reasonable because this cost estimate will be used to develop the level of funding required to implement these actions.

Subpart 27. Current liabilities. The definition is needed to ensure the same information is used by the facility owner or operator and the Agency in evaluating the financial status of the owner or operator. The definition is commonly used in the business community.

Subpart 28. Current postclosure care cost estimate. This definition refers the facility owner or operator to part 7035.2645, which identifies the items to be addressed in the postclosure care plan cost estimating. This definition provides for a consistent approach to cost estimating procedures and that only the most recent cost estimate will be used to establish funding for postclosure care.

Subpart 30. Demolition debris. This definition specifies the type of materials constituting demolition debris for the purposes of management under this chapter. In the past, unusable construction materials were included in the definition of demolition debris. Construction materials are waste supplies resulting from the construction, remodeling, and repair of buildings and roads. This material will consist of waste paints, building putty, packaging, sealants, oils, etc. This definition is needed to clarify that construction waste is not considered to be demolition debris and must be handled differently. It is reasonable to clarify the Agency's interpretation for use in regulating demolition debris.

Subpart 31. Demolition debris land disposal facility. This definition is needed to explain what the Agency intends to regulate under standards proposed for a particular facility. This definition is a reasonable way to alert facility owners how the Agency classifies specific facilities for regulatory purposes.

Subpart 32. Design capacity. This definition is included in this part to allow the Agency to distinguish between design capacity and certified capacity. As discussed in subpart 11, certified capacity addresses only the in-place volume for mixed municipal solid waste that has been disposed of on or in land. Design capacity is used for all solid waste management facilities, not just the disposal of mixed municipal solid waste at land disposal sites. For instance, a land disposal facility may be used to manage industrial solid waste as well as mixed municipal solid waste and would thus have a greater design capacity than certified capacity. This definition is needed to specify what the Agency will include in the design capacity of a facility. It is reasonable to indicate how design capacity is determined for a facility.

Subpart 33. Disposal. This definition is a reference to and incorporation of the statutory definition of the term. It is reasonable to refer the facility owner to the existing statutory definition for consistency in interpretation.

Subpart 34. Disposal facility. This definition is a reference to the statutory definition of the term. This chapter establishes standards for disposal facilities. Facility owners and operators must be alerted to their responsibilities. It is reasonable to include this definition for consistent interpretation of the term.

Subpart 35. Energy recovery facility. The definition of this term is needed because it has not been used previously in rules and facility owners need to be advised what constitutes an energy recovery facility for regulatory purposes. It provides for a consistent interpretation of the term.

Subpart 36. Existing facility. It is necessary to define the term, existing facility, for use in distinguishing facilities constructed under existing rules from those to be constructed under the proposed rules. In some cases, the proposed standards would not be imposed at the same time for existing facilities as new facilities. Therefore, the definition of this term informs the facility owner or operator how the term will be used by the Agency in determining implementation schedules for the proposed rules.

Subpart 37. Facility. The definition specifies the features added to, modified, or utilized at a site that constitute the actual facility. These features include the land, structures, monitoring devices, and other improvements on the land used to monitor, treat, process, or dispose of solid waste, leachate, or residuals. It is reasonable to include these items in the definition to clarify that building structures in the commonly used meaning are not the sole items considered in regulating a facility. Additionally, it deletes adjoining property owned by the same person from being included in regulatory actions if not used for the purposes described in this term. Since the term facility is used in the proposed rules to include many design features, it is reasonable to define the term in this part to alert site owners and operators of the Agency's understanding as to what constitutes a facility.

Subpart 38. Floodplain. The existing definition is proposed to be modified to clarify the Agency's understanding of what constitutes a floodplain. This term is used to describe a wide variety of conditions relating to rivers and streams when the water level is found to be above normal conditions. It is necessary to more narrowly define this term because the proposed rules specifically prohibit the locating of a solid waste management facility in the floodplain. It is reasonable to define this term to clarify to facility owners and operators the Agency's intent on controlling activities in a specific area of the floodplain. A one percent or greater chance of flooding in a given year is the common definition used for planning purposes by municipalities in establishing zoning restrictions and the federal government in defining flood zones for issuance purposes. The Agency believes it is reasonable to be consistent with the common use of the term.

Subpart 39. Free liquid. Because free liquids are expressly prohibited from land disposal facilities under the proposed rules, it is necessary to define exactly what is meant by the term. It is reasonable to include a definition for this term that addresses how free liquids will be determined to ensure a consistent interpretation is used. It is reasonable to use the definition in defining free liquids for regulatory purposes and in maintaining consistency between agency and federal definitions to avoid regulatory conflicts.

Subpart 41. Gross revenue. This definition is needed to provide a common understanding for determining the financial stability of a company. It is necessary that the reporting firm and the Agency interpret the meaning of this term in the same manner when discussing the financial status of the company. This definition presents the common meaning used in the business community.

Subpart 42. Ground water; groundwater. This definition is a reference to an existing statutory definition. The definition is needed since the proposed rules are drafted with the intent to protect ground water and all parties need to understand what the Agency understands this term to mean. It is reasonable to refer to the existing definition to obtain consistent interpretation by all regulatory bodies.

Subpart 43. Hazardous substance. This definition incorporates an existing statutory definition. This definition is needed because hazardous substances are specifically prohibited from solid waste management facilities. The definition is accepted by the regulatory and regulated communities.

Subpart 44. Independently audited. The determination of the financial status of a facility owner or operator is critical in establishing financial assurance mechanisms. This definition is needed to specify who is eligible to complete the review of a facility owner's or operator's financial status. The definition provides an understanding of the term as commonly used.

Subpart 45. Industrial solid waste. A definition for this term is needed because industrial solid waste is a unique waste category separate from mixed municipal solid waste or demolition debris. The Agency proposes under these rules to regulate industrial solid waste separately from mixed municipal solid waste and demolition debris; different than other waste types; therefore, it is necessary to clarify what is intended for regulation as an industrial solid waste. No previous definition existed and there has been confusion over what is considered to be industrial solid waste by the Agency. It is reasonable to include all solid waste generated from an industrial or manufacturing process and nonmanufacturing activities such as service or commercial establishments because the solid waste generated from these activities may contain free liquids or pollutants at levels deemed unacceptable for management at particular solid waste management facilities. For instance, food processing facilities may generate highly putrescible waste products during the canning process. These wastes would not be considered acceptable for management at a transfer facility without the capabilities of shipment within a 24-hour period. This waste is different than the waste commonly experienced from households or commercial businesses due to the amount of putrescible material and must be distinguished as such to ensure proper management. It is reasonable to exclude the office materials, restaurant and food preparation wastes, discarded machinery, demolition debris, or household refuse because they are either excluded from the definition of solid waste, handled as a specific waste type in the proposed rule, or fall within the statutory definition of mixed municipal solid waste. This definition will provide for a consistent interpretation and alert facility owners about the special regulations for this waste type.

Subpart 46. Industrial solid waste land disposal facility. The proposed rules in this chapter establish specific standards for this type of facility. Therefore, it is necessary to alert site owners what the Agency considers to constitute this type of facility. Specific standards for these facilities are first proposed in this chapter.

Subpart 47. Inert material. Inert material is generated during the composting of solid waste material. A definition is needed for this term because it is not commonly used in solid waste management. Because the common dictionary definition of inert would encompass more than the Agency intends to address with the term, it is reasonable to provide a narrower definition in the rule. The term excludes soil particles and other naturally occurring materials because of the confusion that might occur regarding the amount of inert material permitted in compost. Soil particles have little potential to negatively impact the environment; thus, eliminating the need to control the amount in a final compost product. It is reasonable to include the definition to provide a interpretation of the term for use in the proposed rules and eliminate any confusion that might occur.

Subpart 48. Infectious waste. Because this type of waste is unique in its characteristics and presents special risks in handling the waste, special consideration for its management is required under the proposed rules. A definition for this term is needed to clarify the waste types in this category in order to understand the requirements for managing the waste and the potential risks associated with the improper handling of the waste. The definition is reasonable because it specifies the waste types considered infectious by the Minnesota Department of Health (MDH) in regulating hospitals, clinics, nursing homes, laboratories, etc. Defining the term in this manner allows affected parties to approach the management of waste generated at their site in a consistent manner that ensures compliance with the Agency's and the MDH's regulatory process. It appropriately includes waste materials that pose special handling techniques to protect persons managing the waste while excluding wastes generated at these sites that do not pose the same concerns like food wastes, office wastes, etc. It is reasonable to provide a definition that all parties can use in determining whether materials are in this waste type.

Subpart 49. Intermittent cover. The proposed rules are intended to develop facility-specific requirements. With this concept in mind, the Agency proposes to eliminate the term daily cover and use the term intermittent cover. The Agency believes it is reasonable to use intermittent cover because there will be situations when daily cover is not appropriate. Therefore, it is more proper to use a term that reflects the Agency's view on the proper use of cover. A definition is needed for this term because it is new and facility owners need to understand the Agency's meaning.

Subpart 50. Intervention limit. A definition for this term is needed because the concept of an intervention limit is not widely used in solid waste management and is new to Minnesota. It is necessary that this term be explained in sufficient detail to provide the facility owner with a clear understanding of when the Agency proposes to intervene to protect ground water from pollution, i.e., at what concentration of certain undesirable substances the Agency will exert its enforcement authority. It is reasonable to include this definition because the intervention limits established in the proposed rules will be used to trigger particular actions protecting ground water. The facility owner or operator and the Agency need to have the same understanding for regulatory terms in order to approach facility design, construction and operation from a common basis.

Subpart 51. Karst. The term karst is used to define a specific geologic formation or condition. The definition of this term is included in the rules to clarify the Agency's interpretation of this term for use in regulating the location of solid waste land disposal facilities. Because a land disposal facility may not be located in an area characterized by karst conditions, inclusion of a definition is reasonable.

Subpart 52. Land disposal facility. The existing definition of land disposal <u>site</u> is proposed to apply now to land disposal <u>facility</u>. This change is needed to provide a term that is consistent with existing Minnesota Statutes and eliminate any confusion that might arise. It is reasonable to include this definition in this part to alert all parties to the change in terminology.

Subpart 53. Land pollution. This existing definition is modified slightly to reflect the changes in commonly-accepted terminology developed since the original definition was adopted. The definition is needed to show that pollution can occur from the mismanagement of not only waste but also waste by-products. The definition has also been modified to include provisions that address land pollution from the contamination of soils at a facility as well as the contamination that results from land-based activities. It is reasonable to include this definition in this chapter to alert facility owners and operators to the Agency's understanding of this term since a standard is proposed in the rules for land protection.

Subpart 54. Landspreading. A definition for this term is needed to distinguish this activity, which takes place on the surface, from land disposal which involves below-surface soils. Because the standards for landspreading are different than those for land disposal, it is reasonable to supply a definition for the term to provide the facility owner or operator with the Agency's intended meaning.

Subpart 55. Landspreading site. A definition for this term is included to distinguish a site used for the landspreading of waste or waste by-products from a site used for the disposal or processing of waste or waste by-products. It is reasonable to provide this definition to give the facility owner or operator an understanding of the Agency's intent before the facility owner enters into the review of the technical standards for such a site or waste taken to such a site.

Subpart 57. Leachate management system. This term has not previously been included in rules regarding solid waste management facilities. Standards for a leachate management system are contained in the proposed rules. A definition is needed to provide a clear assessment as to what the Agency includes in the term of a leachate management system for regulatory purposes.

Subpart 58. Liabilities. In reviewing the financial status of facility owners or operators, the Agency will compare available moneys against obligations. A definition for these obligations is needed to alert reporting firms to the Agency's meaning so they can supply the proper information. The definition is reasonable because it is the meaning commonly used in the business community.

Subpart 59. Limit of detection. The proposed rules establish numerical standards for ground water quality. The establishment of these standards requires that the analyses used to identify substances found in the ground water also be established. The defined term is a common laboratory term not previously used in Agency rules. This definition provides the facility owner or operator an understanding of the level of analysis the Agency will require when monitoring ground water quality.

Subpart 60. Limit of quantitation. This term is not commonly used in solid waste management. However, it has considerable use in the chemical analysis field for expressing qualitative accuracy in analyzing compounds and solutions. A definition of this term is needed because the term is used in the proposed ground water standards of this chapter.

Subpart 61. Liner. The proposed rules establish standards for the design and construction of liners at solid waste management facilities. A definition is needed to clarify what part of a facility is governed by these standards. Because the proposed rules establish design and construction standards for the first time, it is reasonable to include a definition for this term to establish what activities are governed by the standards.

Subpart 62. Lower compliance boundary. The proposed rules establish water quality standards for solid waste management facilities to protect human health and the environment. The definition in this subpart is needed to indicate to the regulated community at what depth below land surface standards will be enforced by the Agency. This definition provides a general explanation of the meaning of this term as it is used in the technical provisions of the chapter.

Subpart 63. Mixed municipal solid waste. This definition incorporates a statutory definition. Because the major portion of the proposed rules relates to mixed municipal solid waste, a definition of the term is needed.

Subpart 64. Mixed municipal solid waste land disposal facility. The largest portion of the proposed rules governs this type of facility. The definition provides the facility owner and operator an understanding of the term for use in determining the requirements applicable to the particular facility in question. This definition eliminates any confusion that might exist with other land disposal facilities and the standards that apply to those facilities.

Subpart 65. Monitoring point. Because this term is unique to the solid waste rules as they relate to the protection of water quality and the enforcement of water quality standards, a definition of this term is necessary. This term must be distinguished from similar terms such as monitoring wells and piezometers. This definition provides a consistent interpretation of the term when determining the proper actions needed to comply with the proposed rules.

Subpart 66. Monitoring well. The definition incorporates an existing statutory definition. A definition of this term is needed because of the similarity between this term and other terms in the proposed rules. A difference in terminology could be confusing; therefore, it is reasonable the definition be included in this part.

Subparts 68, 69 and 70. Net income, Net working capital, and Net worth. These terms are used in assessing the financial stability of a facility owner or operator. These factors are critical in establishing a facility owner's or operator's ability to meet financial assurance requirements. Definitions are necessary to ensure all interested parties have the same understanding of the meaning for these terms. The definitions are currently accepted by hazardous waste facility owners and operators in Minnesota and throughout the country.

Subpart 73. Operator. Chapter 7001 makes operators co-permittees of a facility. A definition for this term is needed to provide a general understanding for the usage of this term. This term is the basis for establishing regulatory control.

Subpart 74. Owner or facility owner. This definition is necessary to alert people managing solid waste as to who the Agency will consider an owner and responsible for obtaining a permit as required by statute.

Subpart 75. Parent corporation. In establishing financial assurance, facility owners and operators are allowed under the proposed rules to show sufficient financial stability to self-insure activities at the facility. In some cases, the local facility owner or operator may be associated with a larger firm and may wish to use this firm as the financial backer for activities at the facility. A definition is needed to clarify who may act as financial guarantor to a local firm. The definition is commonly used in the business community.

Subpart 76. Permeability. The term, permeability, may have different variations of the same basic meanings dependent on the professional background of personnel developing the data. Because the design of a facility and the enforcement of certain standards rely specifically on permeability, it is necessary to provide a single definition to be used by all parties. Hydraulic conductivity or coefficient of permeability was chosen instead of intrinsic permeability to account for the fluid's influence on the medium it is travelling through. Intrinsic permeability reflects only the soil properties in calculating the flow through the soil. It is reasonable to use hydraulic conductivity in defining permeability since it is the leachate and ground water movement through subsurface soils and their interactions with the soil particles that will dictate the facility's compliance with standards. This definition eliminates potential confusion associated with using a term with different implications.

Subpart 77. Permitted waste boundary. The proposed rules contain standards directly related to the permitted waste boundary. A definition for this term is necessary to alert the facility owner and operator where certain standards will be applied during operation of the facility. Because this term is unique to solid waste management facilities, it is reasonable to provide a concise definition and consistent interpretation of the term.

Subpart 79. Personnel; facility personnel. Because the proposed rules establish training standards for facility personnel, it is necessary to define who the Agency considers to be facility personnel. The definition clarifies who will be governed by facility personnel training standards.

Subpart 80. Piezometer. The definition for piezometer is needed to clarify the particular function of a piezometer as compared to a monitoring well. Since the design and construction standards for piezometers are different from monitoring wells, a definition to clarify the differences between these installations is needed.

Subpart 81. Pollutant. This definition incorporates an existing statutory definition. It is reasonable to refer to the statutory definition to avoid confusion in using this term as it relates to many programs.

Subpart 82. Postclosure; postclosure care. The proposed rules establish for the first time standards for maintaining a facility after facility operations have ceased. It is necessary to define the terms applied to this period of maintenance. This definition is reasonable because it alerts the facility owner to the actions that make up the postclosure care.

Subpart 83. Postclosure care plan. The proposed rules require a facility owner to prepare a postclosure care plan. This definition consists of a reference to part 7035.2645, which defines what is included in a postclosure care plan. A definition is needed because a postclosure care plan has not been required in previous rules.

Subpart 84. Process to further reduce pathogens. The proposed rules establish specific performance standards to be met in the production of compost from solid waste. This definition includes the four known processes that meet the standards and allows other processes that also meet the technical standards.

Subpart 85. Property boundary. Because specific controls and standards are applied at the property boundary under the proposed rules, a definition of the term is needed in the rules. This definition is reasonable because it alerts the facility owner and operator to the area within which controls and standards will be applied.

Subpart 86. Public water supply. This definition consists of a reference to part 4720.0100, which explains the meaning of this term. Because more than one Agency is involved with the protection of public water supplies, a definition is needed to alert the facility owner or operator as to which meaning the Agency will use. The proposed term is generally understood and will provide a consistent interpretation among all regulatory bodies.

Subpart 87. Radioactive waste. The proposed rule incorporates a statutory definition. It is reasonable to define the term by means of a reference because this provides a consistent interpretation to the meaning of the term for regulatory purposes.

Subpart 88. Recycling facility. The proposed rules establish specific standards for recycling facilities for the first time. A definition is needed to alert facility owners and operators as to what constitutes a recycling facility. It is reasonable to include this definition because it provides guidance to the facility owner and operator as to what provisions of the proposed rules are applicable to operations at the site.

Subpart 91. Refuse-derived fuel. The proposed rules establish standards for facilities generating refuse-derived fuel. This term is unique to the management of solid waste. A definition is needed to alert facility owners and operators to what type of product constitutes this type of fuel. This is the first time the term has been used in solid waste regulations and the definition provides a common interpretation.

Subpart 92. Regional flood. This existing definition is slightly revised only as to form. This modification simply provides consistency in the proposed rules.

Subpart 93. Release. This definition incorporates an existing statutory definition. Because the term is used in the proposed rules with implications for specific actions to be taken, it is necessary to define this term to alert facility owners and operators to the potential impacts it may have on their operations. It is reasonable to rely upon the statutory definition because this term is used in other regulatory programs for the same purposes; this provides for consistent interpretation of the term.

Subpart 95. Run-off. This definition is a minor modification of an existing provision. The modifications are needed to clarify the Agency's intent that any liquid flowing from a facility is considered run-off rather than just precipitation.

Subpart 96. Run-on. This definition alerts the facility owner and operator that liquid draining onto a facility is of as much concern as liquid draining off the facility. This definition is needed to show that not only precipitation is of concern. Any liquid that moves onto the facility is a concern as well.

Subparts 97, 98 and 99. Septage, Sewage sludge and Sludge. The definitions of these terms incorporate statutory definitions. Because these terms are used in regulating facility operations, it is necessary to define them to alert facility owners and operators to the provisions that might apply to their operations. Because these terms are used in other regulatory programs in the same manner, it is reasonable that they be defined in the same way to provide for consistent interpretation.

Subpart 100. Solid waste. The existing definition of this term is modified to conform with the statutory definition. Since this chapter establishes standards for the management of solid waste, a definition is needed. It is reasonable to include this definition to alert facility owners and operators as to the types of materials generally considered to be solid waste.

Subpart 102. Solid waste land disposal facility. Because this phrase is the basis for describing specific types of solid waste land disposal facilities, a definition for it is needed. The definition provides for a consistent interpretation of this term.

Subpart 103. Solid waste management facility. The existing definition is modified to alert owners and operators whose operations had not been previously regulated that their operations constitute a facility. This definition reflects the changes made to the rules in bringing additional solid waste management facilities within the purview of the rules.

Subpart 104. Solid waste storage. This existing definition is modified to alert facility owners and operators that storage under the proposed rules has a specific meaning and is regulated with this meaning in mind. The focus in the definition is changed from where solid waste is held to how long solid waste of a minimum quantity is held. The holding time of 48 hours was selected because it minimized the potential risks associated with holding solid waste for a lengthy period of time without operational safeguards yet allows facility owners and operators to manage wastes in an efficient manner. Solid waste stored for greater than 48 hours will be subjected to climatic conditions such as wind and rain that will produce dust or leachate and may begin the first steps of decomposition generating leachate, gas, and odors. It is reasonable that waste stored for time periods under these conditions be required to meet protective design and operational standards. The quantity of 10 cubic yards was selected because this is a common-size design for packer trucks carrying mixed municipal solid waste and other delivery trucks for industrial solid waste. The Agency believes that waste stored in quantities larger than 10 cubic yards presents operational concerns and the facility should be designed to address these concerns.

Subpart 106. Stabilization test. The proposed rules utilize the stabilization test in determining the proper ground water sample to obtain from a monitoring well. Because this term is new to the monitoring program for solid waste management facilities, a definition is needed to explain what a stabilization test consists of. The definition alerts the facility owner and operator to the actions comprising a stabilization test to ensure consistency throughout the industry.

Subpart 108. Sum of the current cost estimates. This phrase has a particular meaning for purposes of this chapter. A definition is needed to clarify that the phrase means the total cost estimates for closure, postclosure care, and contingency. No other cost estimates are included in this sum. The sum is used in determining financial assurance fund levels and payments.

Subpart 109. Surface water compliance boundary. Because this term is unique to the regulation of solid waste management facilities, a definition is needed. This definition alerts the facility owner to where enforcement actions and standards will be applied. This definition provides a common interpretation of the term for use in establishing standards.

Subpart 110. Tangible net worth. To demonstrate financial assurance, a facility owner or operator has the option to show financial strength sufficient to pay for closure, postclosure care, and contingency action in a timely manner. The Agency must review a facility owner's or operator's financial report to evaluate the financial strength of the firm. The defined term is a factor in the test used to determine financial strength. A definition is needed to provide the reporting firm with the Agency's understanding of this term. The definition provided in this subpart represents the common meaning used in the business community.

Subpart 111. Transfer facility. The existing term and definition are modified solely to bring the terminology into conformance with language used in the proposed rules. These modifications do not affect the interpretation of this term.

Subpart 112. Waste. This definition incorporates a statutory definition of the term. Because the proposed rules are aimed at regulating waste, a definition for the term is needed. The term forms the basis from which particular waste types are more precisely defined in this part.

Subpart 113. Waste boundary. This term is unique to the solid waste management facility program. Because the term is new and unique to the solid waste program, a definition is needed. The definition defines the area used to deposit solid waste to be surrounded by a specific border. Particular standards proposed in the technical rules are applicable at this boundary. Consistent interpretation is needed for equitable application of the standard.

Subpart 114. Waste by-products. The proposed rules regulate not only waste but also waste by-products as they relate to the protection of human health and the environment. Because only waste is physically managed in most instances, a definition is needed for the by-products also regulated. By defining this term, the Agency alerts facility owners and operators to standards for the design, construction, and operation of facilities as related to the by-products of waste disposal, processing, or treatment.

Subpart 115. Waste collection service. This definition is needed to clarify the operations that constitute this service. The definition is generally used by the entire industry.

Subpart 116. Waste containment system. The proposed rules provide standards for the design, construction and operation of the total system used to manage solid waste. The system generates and must contain solid waste, gas and leachate. A definition is needed to clarify the Agency's interpretation of what features at a site constitute the waste containment system.

Subpart 117. Water monitoring system. Minor modifications are proposed in this existing definition. The modifications bring the language into conformance with the remaining parts of this chapter. More general terms replace the specific limiting terms of the past.

Subpart 118. Water table. A minor modification is proposed to this existing definition. Reference to other Agency rules that have been modified to be no longer applicable is eliminated.

Subpart 119. Wetland. The existing definition of the term was written in 1970. More recent work has altered the use of the term. The new definition of the term consists of a nationally accepted definition published by a federal agency. It is reasonable to incorporate that meaning for this term because of the standards applicable to these areas. The consistent use of the term will provide for easy compliance with national standards.

Subpart 120. Working face. This existing definition is modified solely to reflect a change of terms from site to facility. It does not impact a facility owner's or operator's operation.

Subpart 121. Yard waste. Yard waste is a term unique to the proposed solid waste management rules. Because the term is unique and specific standards are proposed for the management of this waste, a definition is needed. The definition alerts facility owners and operators to what is covered in standards applicable to yard waste.

The definitions in items E, G, H, J, L, M, Z, AA, GG and II of existing part 7035.0300 are repealed. Item E contains the definition of daily cover. The proposed rules do not use this term. Item G contains the definition of director. Since the 1987 legislative session changed the title of the head of the Agency from Director to Commissioner, this definition is no longer needed. Item H contains the definition of final solid waste disposal. This term is not used in the proposed rules. Item J contains the definition of free moisture. This term has been replaced with the term free liquid which is defined in the proposed rules. Item L contains the definition of incineration. The proposed rules do not regulate solid waste incineration. Incineration is regulated under the Agency's Air Quality program. Item M contains the definition of intermediate solid waste disposal. This term is not used in the proposed rules. Item Z contains the definition of sanitary landfill. The proposed rules define specific land disposal facilities, so this term is no longer used. Item AA, scavenging, is an obsolete term no longer used in the proposed rules. Item GG contains a definition for special infectious waste. This term was changed to infectious waste with the definition slightly altered in the proposed rules. Item II defines the term underground water. This term is no longer used in the proposed rules. Since these provisions are no longer needed, it is reasonable to repeal them.

D. Reasonableness of Amendments to Part 7035.0400 GENERAL REQUIREMENTS.

This existing part is proposed to be modified to correct cross-references to include the new technical rules and alter language to make it consistent with other parts. The modifications proposed in this part do not alter the meaning and provide clarification of the proposed rules to facility owners and operators.

E. Reasonableness of Parts 7035.0600 VARIANCES and 7035.0605 AVAILABILITY OF REFERENCES.

Part 7035.0600 is an existing rule relating to variances to the rules. It sets out the standards and procedures for the Agency to grant variances. This part is proposed to be modified in its entirety to remove the substance of the part and replace it with a reference to the variance provision in the Agency's Procedural Rules, chapter 7000, and Minn. Stat. § 116.07, subd. 5. Those provisions provide the specific standards to be used in evaluating the need for a variance and the procedures to be followed to provide public input into this process. The modified rule alerts affected persons of their rights and obligations under chapter 7000 and Minn. Stat. ch. 116. The modification provides a consistent approach to granting variances from Agency rules.

Part 7035.0605 is a new provision. This part is needed to inform affected persons where they can locate certain materials referred to in the rules. Because the proposed rules refer to the specific materials for use in complying with the technical standards, it is necessary to provide a list of places where these references can be obtained for use without having to purchase them.

F. Reasonableness of Amendments to Parts 7035.0700, STORAGE OF SOLID WASTE AT INDIVIDUAL PROPERTIES, and 7035.0800, COLLECTION AND TRANSPORTATION OF SOLID WASTE.

These parts are existing provisions. They are proposed to be modified simply to make the language consistent throughout this chapter. These modifications do not alter the meaning or implementation of these parts.

G. Reasonableness of Amendments to Parts 7035.1590 to 7035.2500 INDUSTRIAL SOLID WASTE LAND DISPOSAL FACILITY REQUIREMENTS.

Existing parts 7035.1600 to 7035.2500 are the rules currently applicable to all land disposal facilities. They were adopted pursuant to Minn. Stat. § 116.07, subds. 2 and 4, which allow the Agency to establish standards for the management of solid waste. This series is being amended to apply only to industrial solid waste land disposal facilities.

In 1983 when the Agency decided to revise the existing solid waste rules, a survey was taken to determine the concerns of facility owners and local governments about solid waste management. Additionally, the 1984 Legislature in amendments to the Waste Management Act required the Agency to develop rules regarding financial assurance, closure standards, postclosure care requirements, and contingency action. The survey results and the legislative amendments corresponded in expressing a major concern over the proper disposal of mixed municipal solid waste. Monitoring of land disposal facilities for mixed municipal solid waste shows ground water pollution exists at these sites. No guidelines existed for the design, construction and operation of these facilities to prevent ground water pollution. Interested parties asked that specific ground water standards be established along with the closure, postclosure care, and financial assurance requirements.

In reviewing the task before it, the Agency decided that it would not be feasible to undertake rule revisions for mixed municipal solid waste management at the same time as industrial solid waste management. Industrial solid waste represents many waste categories that have a variety of chemical, physical, and biological characteristics. A rulemaking process to establish new standards for industrial solid waste management would be difficult because the requirements would need to be flexible enough to address those characteristics yet be consistent in approach to all facilities. Mixed municipal solid waste is, in general, a homogenous waste that contains a specific range of characteristics. However, the technology of mixed municipal solid waste management has changed rapidly over the past few years. The rule revisions required that the technological changes be addressed. Thus, the Agency determined that a more feasible approach would be to undertake rule revisions for these waste types at different times. Because of the expressed concern for mixed municipal solid waste management and the Waste Management Act Amendments of 1984, the Agency decided to proceed with rule revisions for mixed municipal solid waste management. After this rulemaking is complete, a new rulemaking process will begin for industrial solid waste.

Part 7035.1590 and amended parts 7035.1600 to 7035.1700 establish the design and operation standards for industrial solid waste land disposal facilities. These standards provide a fair and logical approach to the design and operation of these facilities based on site-specific and waste-specific characteristics. Parts 7035.1800 and 7035.1900 establish the requirements for submitting permit applications and construction certifications. These procedures give the public and the applicant adequate information about the Agency's approval process that they might comment on the Agency's decision on the permit application. Part 7035.2500 establishes closure standards for industrial solid waste land disposal facilities.

The following discussion addresses the reasonableness of amending individual provisions of the rules.

1. Part 7035.1590 INDUSTRIAL SOLID WASTE LAND DISPOSAL FACILITY DESIGN.

This new part explains what sections of the chapter apply to owners and operators of industrial solid waste land disposal facilities. Affected persons are also alerted under this provision to how specific requirements may be used in establishing design and operation controls for the management of a specific waste type. This part is needed because industrial solid waste land disposal facilities have been singled out for exemption from the general system proposed in these rules. These facilities will be regulated under the past system until the system can be modified to specifically address industrial solid waste.

This part also provides for owners and operators to submit to the Agency documentation that the requirements of parts 7035.1590 to 7035.2500 do not apply to their particular facility. The Agency's approval or disapproval will be based on the hydrogeologic setting, waste characteristics, fill size, soil conditions, operating practices, and the potential for harm to human health and the environment. The facility owner or operator will submit this information at the time of permit application in order to substantiate the design and operation plans included in the application. Parts 7035.1600 to 7035.2500 were originally promulgated with only the management of mixed municipal solid waste in mind. They are being retained for industrial solid waste land disposal facilities until rulemaking can be completed regarding this specialized category of solid waste.

Part 7035.1590 is needed to alert affected persons what specific standards will be applicable to their industrial solid waste land disposal facilities. The implementation of this part is not difficult and will not change the industrial solid waste management system.

2. Part 7035.1600 PROHIBITED AREAS FOR INDUSTRIAL SOLID WASTE LAND DISPOSAL FACILITIES.

This part is an existing provision of this chapter, retained specifically to apply to industrial solid waste management facilities. This part is needed to identify the areas where industrial solid waste land disposal facilities are prohibited. This part clarifies language to be consistent with the language used in the remaining parts of the chapter. These modifications clarify what is governed by this part and do not change the standards already applicable to these facilities.

3. Part 7035.1700 REQUIRED PRACTICES FOR MAINTENANCE AND OPERATION OF INDUSTRIAL SOLID WASTE LAND DISPOSAL FACILITIES.

This existing part is retained and amended for application to industrial solid waste land disposal facilities only. The language is modified to be consistent with the remaining parts of this chapter. The provision regarding the acceptance of dead animals, previously applicable to mixed municipal solid waste land disposal facilities, is repealed. These facilities are normally designed and operated to manage a specific waste type and are not sufficiently flexible to address the proper disposal of dead animals. The proposed modifications will not alter the requirements regulating industrial solid waste land disposal facilities.

4. Part 7035.1800 PERMIT APPLICATION AND REQUIRED PLANS FOR INDUSTRIAL SOLID WASTE LAND DISPOSAL FACILITIES.

This existing part is modified to refer to industrial solid waste land disposal facilities instead of landfills and to bring other language into conformance with the other parts of this chapter.

The Agency permit rules adopted in 1984 established criteria for all permits issued by the Agency. Only minimal permit standards were established for solid waste management facilities. The Agency decided that it would not be practical to include specific permit requirements for industrial solid waste land disposal facilities until the revised technical rules are promulgated for them.

This part is retained to provide specific permit guidance for industrial solid waste management facilities. The Agency has determined that specific permit requirements for these facilities should not be included in chapter 7001 until the technical standards for industrial solid waste management facilities are revised. The Agency does not believe appropriate permit requirements can be included in chapter 7001 until the technical revisions for these facilities are complete. The modifications to this part do not affect the regulation of industrial solid waste management facilities.

Item C, subitem (3) has been modified to replace the term bedrock with the phrase underlying geology. This modification is made simply to conform with general practices now used in evaluating subsurface conditions. It reflects the practice to understand other confining layers that might be present and do not specifically fall within the narrow term of bedrock.

5. Part 7035.1900 BASIC PERMIT, CERTIFICATION AND COMPLIANCE REQUIREMENTS FOR INDUSTRIAL SOLID WASTE LAND DISPOSAL FACILITIES.

This existing part is modified to address industrial solid waste land disposal facilities only. The modifications also update the language of this part to be consistent with the other parts of this chapter. A provision no longer applicable because of procedural changes has been deleted. That provision related to the effective date of this part.

6. Part 7035.2500 INDUSTRIAL SOLID WASTE LAND DISPOSAL FACILITY ABANDONMENT.

This existing part has been modified to bring it into conformance with the other parts of this chapter. Provisions that are not applicable to industrial solid waste land disposal facilities are proposed to be deleted. The deleted provisions address the designation of another facility for a disposal facility and burning control.

Industrial solid waste land disposal facilities are normally owned and operated by the industry generating the waste. They are not generally open to the public. Because the public does not use the site and the owner/operator generates the waste, it is not necessary to provide notice for an alternative site.

The provision requiring the facility owner or operator to stop burning upon closure is no longer necessary. This provision was originally adopted based on the need to close open burning dumps and to develop proper procedures for closing these dumps. General burning of waste is not permitted and facility designs incorporate burning control measures.

Part 7035.2500 is necessary to provide the owner or operator of these facilities the minimum criteria to be satisfied before the Agency will certify the facility properly closed. The proposed modifications do not impact the existing system.

H. Reasonableness of Parts 7035.2525 to 7035.2655 SOLID WASTE MANAGEMENT FACILITY GENERAL TECHNICAL REQUIREMENTS.

The following discussion addresses the reasonableness of the proposed new rules regarding the general technical requirements for solid waste management facilities on a part-by-part basis. The Agency believes there are fundamental design, construction, and operational criteria applicable to all solid waste management facilities. Rather than repeat these criteria for each facility, the Agency has chosen a more reasonable and efficient method of consolidation of the criteria into one section of this chapter.

1. Part 7035.2525 SOLID WASTE MANAGEMENT FACILITIES GOVERNED.

This part establishes the solid waste management activities governed by parts 7035.2525 to 7035.2875. The solid waste management activities not governed by these parts are also defined.

Subpart 1. General requirements. Subpart 1 requires all owners and operators of facilities that treat, transfer, store, process or dispose of solid waste to comply with the requirements of parts 7035.2525 to 7035.2875. This subpart informs affected parties of the provisions of this chapter that establish standards for their particular activities in order to protect human health and the environment. The subpart is needed to provide these persons adequate notice as to what rules apply to them.

Subpart 2. Exceptions. Subpart 2 identifies the solid waste management activities that will not be regulated under parts 7035.2525 to 7035.2875. Exemptions are needed for activities already regulated under other Agency rules or activities with such a low potential to harm human health and the environment that regulation is not warranted. It is reasonable to match the potential for environmental harm with the amount of regulation.

Item A excludes backyard compost sites from regulation under the proposed rules. Small compost sites established by homeowners, owners of apartment complexes, or single business establishments present little potential for environmental harm because of their size and the type of waste handled. Backyard compost sites are established for vegetative waste in small quantities eliminating potential run-off and health issues associated with larger facilities. It is reasonable to exclude these sites as regulation under the proposed rules for compost facilities is unwarranted. Backyard compost sites are governed by the general nuisance laws of the State and local governmental conditions.

Item B excludes from regulation under most provisions of the chapter recycling sites that handle one waste type only or are used for the collection and transportation of recyclables to a processor in volumes less than 30 cubic yards. The facility owner is required to notify the Agency of the existence of the recycling facility and what materials will be managed at the facility. The facility owner is also required to store the recyclables in a manner that prevents nuisance conditions and run-off. Strict regulation of these facilities under a detailed administrative process would not be consistent with the potential for environmental harm represented by the activities at the site. Strict administrative regulation of these sites would, in effect, prohibit local clubs, churches, and government units from establishing convenient drop-off locations for the collection of recyclables. It is more cost-effective to manage recyclables as a separate waste stream in terms of work effort needed and marketability of the collected items. It is reasonable to minimize the regulation needed for recycling sites based on the potential for environmental harm and because the Agency will be informed as to the location of the sites should there be a need for action.

Item C excludes industrial solid waste land disposal facilities from regulation under parts 7035.2525 to 7035.2875. These facilities are excluded from regulation under these parts because the existing rules are being retained for these facilities. When the Agency began to revise the solid waste rules originally promulgated in 1970, two main waste classifications needed to be addressed: mixed municipal solid waste and industrial solid waste. Each classification presents a complicated set of issues regarding the management of disposal, transfer or other solid waste management activities. The Agency concluded that an extensive rulemaking process could not be undertaken for these waste classifications at the same time. The Agency decided that the issues surrounding mixed municipal solid waste management would be addressed first because a capacity problem existed and specific legislative mandates were given to the Agency. At the same time, the Agency decided that the solid waste rules promulgated in 1970 would be retained for industrial solid waste land disposal facilities until a rulemaking process could be initiated for this waste classification. Readers of the various drafts of the proposed solid waste rules have suggested that a more comprehensive set of industrial solid waste rules should be proposed at this time. It is the Agency's belief that a comprehensive set of regulations more sensitive to the issues of industrial solid waste management could be developed if delayed until after the mixed municipal solid waste rule revisions are adopted. It is reasonable to exclude industrial solid waste land disposal facilities from regulation under parts 7035.2525 to 7035.2875 because these parts are written for the management of mixed municipal solid waste and are not entirely appropriate for the management of industrial solid waste. Because the Agency intends to revise rules governing industrial solid waste management, it is reasonable to maintain the current system for these facilities until revised rules are adopted.

Item D excludes facilities for the management of solid waste generated from mining activities from regulation under parts 7035.2525 to 7035.2875. These activities are regulated under the Agency's Division of Water Quality permit rules (part 7001.0020, item E) and the Minnesota Department of Natural Resources' rules regarding mining activities (chapter 6130). These programs adequately address all solid waste issues and the regulation by another program is not justified.

2. Part 7035.2535 GENERAL SOLID WASTE MANAGEMENT FACILITY REQUIREMENTS.

This part establishes standards applicable to all solid waste management facilities. The Agency believes these requirements are the foundation for the proper operation of any solid waste management facility and are needed to protect human health and the environment. It is reasonable to include these provisions in one part to advise facility owners and operators of their responsibilities.

Subpart 1. Unacceptable wastes. Subpart 1 addresses the types of wastes considered unacceptable for management at solid waste facilities. In many cases, the solid waste management facility is not designed to properly handle a specific waste. This subpart acknowledges that household quantities of undesirable wastes may be delivered to the solid waste management facility. The rules do not require the owner or operator to sift incoming household waste to ascertain whether unacceptable wastes are included. Household quantities are permitted at solid waste management facilities. Household quantities cannot be precisely defined. If a particular amount were specified, such as eight ounces of a material, disposers may divide larger quantities of wastes into smaller containers to circumvent this exemption.

Item A lists hazardous waste as an unacceptable waste. A similar provision appears in the existing solid waste rules. Facility owners and operators need to know their responsibility regarding the management of hazardous waste at a solid waste management facility. A solid waste management facility is not designed or operated for managing hazardous waste. Therefore, adequate precautions are not in place to prevent the mixing, spillage, or other mismanagement of hazardous waste. The potential for mistakes resulting in harm to human health and the environment is high. Because of the potential dangers associated with hazardous waste and the lack of proper controls at a solid waste management facility, it is reasonable to prohibit accepting hazardous waste at these facilities.

Item B prohibits sewage sludge, septic tank pumpings, sewage sludge compost or sewage unless it has been or will be treated by a process to further reduce pathogens. Pathogens are disease-carrying organisms. The listed waste types are high in pathogen content due to the sources of this waste. Unless a facility is specifically designed to treat the waste to kill pathogens, serious human health problems may result. Facility personnel must be properly trained to handle the listed wastes in a manner that does not subject them to human health problems. Thus, if a facility is not designed to receive untreated sewage sludge or facility personnel are not properly trained, unintended mismanagement of the waste will result. Because of the human health hazards associated with the wastes, it is reasonable to prohibit the listed wastes at solid waste management facilities unless the wastes have been treated or will be treated at the facility.

Item C prohibits accepting untreated infectious wastes at solid waste management facilities. The mismanagement of infectious wastes may cause the rapid dissemination of disease-carrying organisms in the environment resulting in human health problems. Infectious waste consists of hospital, nursing home and veterinary wastes that have been exposed to a contagious or infectious disease. It is reasonable to prohibit the acceptance of infectious wastes at solid waste management facilities because specific treatment methods unavailable at solid waste management facilities are needed to sterilize these wastes to kill the disease-carrying organisms.

Item D prohibits the acceptance of waste oil at solid waste management facilities unless permitted through the industrial waste management plan developed for a specific facility. Waste oil when properly managed can be accepted at a solid waste recycling or transfer facility for delivery to another facility that can reuse the waste oil or dispose of it in an environmentally sound manner. Because solid waste management facilities can be designed and operated to properly manage waste oil, it is reasonable to allow the delivery of waste oil to a solid waste management facility that has been designed to handle this waste, and prohibit that delivery if the facility is not properly designed.

Item E prohibits the acceptance of radioactive waste at a solid waste management facility. Radioactive waste when not properly managed may harm human health and the environment. Specific management techniques are needed to safely handle radioactive waste. Solid waste management facilities are not designed or operated to minimize the risks associated with the management of radioactive waste. Because of these risks, it is reasonable to prohibit the acceptance of these wastes at solid waste management facilities.

Item F prohibits the acceptance of wastes containing free liquids at solid waste management facilities. Free liquids can create numerous problems at a solid waste management facility. These problems include run-off from a facility not designed to contain the liquid, excess moisture disrupting the composting process resulting in ineffective treatment of the waste, and operational problems at land disposal facilities when the waste is moved in the working area for compaction and covering. Surface run-off, ineffective compost production, and improper land disposal management can result in surface water and ground water pollution as well as increased land disposal of materials that would have been reused or used in a more cost-effective manner. The listed concerns make it is reasonable to prohibit these waste from solid waste management facilities.

Item G prohibits the acceptance of free liquids at solid waste management facilities. As with wastes that contain free liquids, the delivery of free liquids to a solid waste management facility can severely disrupt the operation and design of the facility. With the disruption of normal operating procedures or design features, the risk for environmental damage increases. The integrity of the operation and design features of a solid waste management facility is the key to the ability of the facility to meet Agency performance standards. For instance, if free liquids are delivered in large quantities to a land disposal facility the integrity of the liner and leachate collection system could be disrupted by erosion from the rapid discharge of liquid into the fill area and by the inability of the collection system to remove the liquid from the fill area. The erosion of a liner causes a need to repair the liner or the rapid movement of leachate into the environment. The increased volume to be handled by the leachate collection system may cause a need to discharge increased volumes of leachate to a treatment facility, which may be unable to properly handle the additional flow. Because of the problems associated with the delivery of free liquids to a solid waste management facility, it is reasonable to prohibit free liquids from these facilities.

Subpart 2. Required notices. Subpart 2 establishes notifications a facility owner or operator must give the Agency. The facility owner and operator must notify the Agency before transferring ownership or operation of the facility. The facility owner or operator must also notify the new owner or operator of the existing permit conditions. This provision is needed to inform the facility owner about what is expected when a solid waste management facility is sold. Because a permit modification is needed to change the listing of co-permittees on the permit, the facility owner or operator must apprise the new owner of the responsibilities associated with operating the facility. This provision is easy to implement and reasonable.

Subpart 3. Security. Subpart 3 establishes the requirements for securing a solid waste management facility from unauthorized entry. The facility owner or operator is required to use a fence or similar device to prevent unauthorized entry onto a solid waste management facility unless the owner or operator can demonstrate that disturbance of the facility will not cause violations of part 7035.2525 to 7035.2875 or injury to the intruder. Facility integrity is critical to prevention of environmental harm or human health problems. Facilities are designed and operated to meet a specific set of standards. The entry of unauthorized persons could disturb this integrity and create not only environmental problems but a danger to humans entering the facility unaware of the type of disturbance that may have occurred. For instance, the vandalism of wells by removing protective staking or breaking off covers could result in total destruction of the well by site equipment and create a conduit for pollutants to enter the ground water. Because of the need to protect the facility's integrity and the liability associated with personal injuries and environmental damage, it is reasonable to require security at the facility.

Subpart 4. General inspection requirements. Subpart 4 addresses the inspection requirements, considered to be a minimum, applicable to all solid waste management facility owners and operators. This subpart is needed to advise facility owners and operators of the Agency's requirements for the minimum actions needed to preserve the integrity of the facility design and operation. A regular inspection program is essential in maintaining a facility capable of consistently meeting performance standards. Because of the importance of maintaining facility operations in peak condition, it is reasonable to require that a minimum inspection program be conducted at all solid waste management facilities.

Item A establishes the goals of an inspection program to be carried out by the facility owner or operator. An inspection program must be capable of detecting malfunctions, deterioration or discharges from the facility. Should these conditions exist, the potential for the release of pollutants to environment and for creating a threat to human health is great. This provision is needed to provide the facility owner or operator general guidance for developing an inspection program. This item requires a consistent approach to inspection programs.

Item B requires the facility owner or operator to develop a written schedule for inspecting all aspects of a facility, from monitoring devices to safety equipment. The schedule must be kept at the facility to be used by facility personnel in establishing work schedules. The inspection schedules must highlight specific items to be reviewed including well casings, pump motors, bank erosions and survey markers. This information is needed to ensure that facility personnel understand what must be looked for at the facility to ensure the facility is operating properly. The information to be included in the inspection has not been specified in order that this information will be developed based on the specific facility design and operation. Although this item establishes the requirement for a written inspection schedule and requires that the schedule identify the types of problems to be watched for during an inspection, the specific program must address the conditions at the facility. This item provides sufficient flexibility to allow the facility owner or operator to tailor the inspection program to the facility yet provides sufficient guidelines for use as minimum standards to assure a base level inspection program for all facilities.

Item C requires that the inspection schedule be submitted with the permit application for a facility. The Commissioner will evaluate the schedule to ensure it will minimize threats to human health and the environment. The facility owner or operator is required under this item to revise the schedule whenever conditions at the site warrant a revised schedule or the facility design is modified. This provision is needed to inform the facility owner or operator when the inspection schedule must be submitted and its relationship to the facility permit issued by the Agency. This provision is easy to implement and does not require special submittals.

Item D requires that the facility owner or operator remedy any deterioration or malfunction within two weeks after an inspection. Maintaining facility equipment in proper working order is integral to the overall performance of the facility. If the facility is not in proper working order, the potential for releases of pollutants to the environment or safety hazards will be higher than normal. Because the intent of the proposed rules and the design of the facility is to protect human health and the environment, it is reasonable to require the repair of equipment malfunctions and deteriorations within two weeks of detection.

Item E requires that the facility owner or operator maintain an inspection log currently and for at least five years after the date of the inspection. This time period is extended indefinitely during time periods when enforcement actions remain unresolved. The inspection log must include the time and date of the inspection, the inspector's name, observations, and the dates and nature of repairs completed. This information is needed to ensure that the facility is being inspected on a routine and regular basis. The information provided in the inspection log will be reviewed at the time a permit is reissued for a facility and when enforcement action has been initiated due to violations. The information will help determine whether the permit must be revised to reflect operational or design changes made due to the results of inspections and any resulting corrections needed. During an enforcement action the inspection logs will be reviewed to determine if the inadequacy of an inspection schedule caused the violations. Additionally, the repair information will shed light on whether the violations were the result of recent problems not yet corrected or a past malfunction that is now reaching a detectable level but should not increase further with time. Because the information maintained on the inspection log is critical to the evaluation of the facility conditions and is not difficult to obtain, it is reasonable to require that the facility owner or operator maintain an inspection log and keep the records for an established period of time.

Subpart 5. Industrial solid waste management. This subpart requires that all industrial solid waste delivered to a solid waste management facility be managed to protect human health and the environment. Every owner or operator of a solid waste management facility must develop an industrial solid waste management plan. This plan must identify the types of industrial solid waste to be accepted at the facility and how it will be managed as well as the types of industrial solid waste that will not be accepted at the facility. A key component of the industrial solid waste management plan will be the portion of the plan devoted to the establishment of criteria used by the facility owner or operator to determine if an industrial solid waste is acceptable for management at the facility.

The existing solid waste rules contain a provision that states any waste considered unacceptable by the Agency may not be disposed of at a mixed municipal solid waste land disposal facility. The Agency used this provision in establishing its codisposal program currently in effect for determining the acceptability of industrial solid waste at mixed municipal solid waste land disposal facilities. The codisposal program consists of an Agency review of information submitted by an industrial solid waste generator. The information submitted by the waste generator consists of the results of analysis obtained from running an Extraction Procedure Toxicity Test and an ASTM water leach test. These tests are used to simulate the leaching characteristics of the waste under acidic and neutral conditions, respectively. The results of these analyses are used to determine if the waste is hazardous based on the Extraction Procedure Toxicity Test and if not, whether it may be disposed of in the acid environment of a mixed municipal solid waste land disposal facility.

The Agency established maximum leaching concentrations for the waste to be considered acceptable for management. The codisposal standards were based on drinking water standards and the hazardous waste limit. The codisposal standard was ten times the drinking water standard and one-tenth the hazardous waste standard. If these numbers differed, the more conservative number was used. <u>See</u> Appendix VII. If the waste was found to be nonhazardous but failed the codisposal standard, the ASTM water leach test results were used to determine if the waste could be disposed of in a separate area. Along with the results of these tests, the Agency reviewed the facility inspection reports for any violations, the facility design for ability to accept the waste, and facility equipment for ability to properly handle the waste. If the Agency found the waste acceptable, an approval letter was issued with any special conditions for managing the waste attached. This approval was considered a minor modification to the facility permit. The facility owner or operator had the final decision whether to accept or reject the waste and for inspection of incoming shipments to ensure that the waste is as identified on the codisposal application. The Agency also encouraged the reuse or land application of the waste when possible.

The Agency's approval serves only to confirm that the waste is acceptable based on data submitted by the waste generator. However, to many facility owners and operators this approval represents a guarantee. Therefore, a false reliance has developed among waste generators, facility owners, and facility operators. The approval does not guarantee delivery of the proper wastes as approved. It is important for the facility owner or operator to maintain a system of inspecting and verifying waste deliveries under the codisposal program.

The codisposal program is currently being operated on a voluntary basis. However, where distinct waste streams are known, the Agency requires approval prior to disposal. The program does not reach the majority of industrial solid waste generators. Obtaining Agency approval before disposal is not consistently required by facility owners throughout the State. In 1984 and 1985, the Agency reviewed codisposal requests amounting to 120,200 cubic yards and 152,800 cubic yards, respectively. It is estimated that 2,000,000 cubic yards of industrial solid waste is generated annually. Although these figures are estimates, they indicate that the current codisposal program handles about 7 percent of the industrial solid waste generated in Minnesota.

In the initial rulemaking efforts started by the Agency in 1983, facility owners were asked about the appropriateness of the codisposal program. Facility owners requested that the Agency adopt the codisposal program in rules to eliminate the voluntary nature of the program. Most people, particularly county solid waste officers, felt the program was worthwhile, but that improvements were needed on timeliness of review and level of technical assistance provided to county inspectors, facility owners, and facility operators on identifying the waste types. The Agency agreed that a review process was necessary for industrial solid waste. Not all waste generators were aware that their waste was hazardous, nor did facility owners or operators recognize the need for special handling.

The initial draft rules regarding the management of industrial solid waste attempted to improve the codisposal program by formalizing the application and review process, establishing standards for waste management, and ensuring compliance by a system of signed approvals and inspections. As proposed, the draft rules provided a very complete regulatory system for industrial solid waste. This system was determined to be very time consuming and burdensome for facility owners and operators, waste generators, and the Agency. A similar system is in effect in Illinois and conversations with staff of the Illinois Environmental Protection Agency indicate they are unable to review and process all the requests for disposal.

After reviewing the initial draft rules for industrial solid waste management, the Agency discussed its ability to meet the anticipated demand and the expected benefits from the program. A second draft set of rules regarding industrial solid waste was written in a format similar to the first, but exempting some forms of industrial solid waste from review. This system would have approved wastes by rule in an effort to decrease the number of requests to be reviewed. The facility owner or operator would have been responsible for the review of these wastes to determine their acceptability for the specific facility.

The Agency forwarded the second draft to facility owners and operators, and county solid waste staff for review. The comments received on this draft indicated that it did not meet the concerns it was intended to address. Although it reduced some administrative burden, full compliance by industrial solid waste generators would constitute a burden still exceeding the Agency's ability to respond in a timely manner. This system also seemed to perpetuate the reliance of facility owners and operators on the Agency and obscure the ultimate responsibility of the facility owner or operator for accepting the waste. Implementing this program would have required extensive staff commitment. The system would not ensure that facility owners and operators would better understand their responsibilities.

To this point, the draft rules were aimed at the disposal of industrial solid waste at mixed municipal solid waste land disposal facilities. As Agency staff discussed an appropriate approach to a third draft of the rules, it became apparent that management of industrial solid waste could impact other facilities as well. Agency staff met with a committee of the Agency's Board to discuss the objectives of an industrial solid waste management rules. As a result of these meetings, the Agency Board approved a third approach for establishing an industrial solid waste management program. This program would place the responsibility for reviewing and approving all industrial solid waste for management on the facility owner or operator. This is the approach in the proposed rules.

The facility owner or operator is required by the proposed rules to develop an industrial solid waste management plan. The Agency will review and approve this plan with the permit application. The plan will determine the mechanism by which a facility owner or operator will evaluate industrial solid waste to ensure proper management techniques are used. The mismanagement of industrial solid wastes can result in disruption of facility operations, in violations of facility performance standards, and possibly in harm to human health and the environment. The development of a management plan will also provide the facility owner or operator an understanding of industrial solid waste management.

Some commentors suggest that facility owners or operators will be unable to develop an industrial solid waste management plan because they do not understand what constitutes an industrial solid waste. These commentors feel an industrial solid waste should not be defined by the process generating the waste but by a set of criteria established by the Agency. The commentors suggested the criteria be based on leachate characteristics of the waste because they felt these characteristics represented potential risks associated with the waste. The suggestion included a provision that the Agency match industrial solid wastes to proper management techniques for each type of solid waste management facility.

The Agency believes that to define industrial solid waste by a set of criteria based on leachate analyses would avoid other concerns associated with industrial solid wastes. Although leaching characteristics represent potential risks associated with the migration of pollutants into ground water, they do not address such issues as spontaneous combustion, compostability, compaction capabilities, or storage needs. The Agency believes it is more appropriate to define industrial solid wastes based on the generation process than a set of criteria that could not reflect accurately the various types of risk associated with different wastes and facilities. For example, refuse-derived fuel processing facilities may not accept foundry waste because it could damage equipment due to its abrasive nature while a recycling or transfer facility may willingly act as an intermediary between the generator and a user. Compost facilities may look favorably at food processing waste while a land disposal facility may not wish to accept it due to moisture content.

The Agency feels facility owners or operators will be able to adequately address the management of industrial solid waste. Facility owners and operators operate sophisticated facilities in composting solid waste, producing fuel from solid waste, and controlling leachate migration using liners and leachate collection systems. Industrial solid waste represents only one component of a facility's operation. With technical assistance and training from the Agency, the facility owner or operator will be able to make increasingly more sophisticated choices in the management of industrial solid waste. It is reasonable to allow the facility owner or operator to match the risk associated with a particular waste with a particular management technique rather than establishing by rule standards for all facilities.

The proposed rules provide a general framework for the development of a management plan by identifying the factors that must be considered in establishing a system to evaluate and inspect incoming wastes. Specific wastes to be identified in a management plan are included in the proposed rule. The establishment of an industrial solid waste management plan for all solid waste management facilities is reasonable because industrial solid waste is accepted at all facilities. The proposed process will eliminate the duplication of effort for some land disposal facility owners and operators. Land disposal facility owners and operators have, in some cases, developed an evaluation program for industrial solid waste as a response to the Agency's codisposal program. By eliminating the duplication of waste evaluation, the Agency and the facility owner or operator may spend more time on the determination of proper management techniques for specific wastes.

The specific provisions of this subpart are discussed in greater detail below. These provisions inform the facility owner or operator of the areas of concern to be addressed in the management plan.

Item A requires that the facility owner or operator provide a discussion on how industrial solid waste will be managed at the facility. This discussion may consist of a statement that prohibits the delivery of industrial solid waste to the facility followed by an explanation of how incoming wastes would be inspected to guarantee that this standard is met. The Agency expects that this would be the situation at very few facilities. In general, industrial solid waste can be properly managed at any facility provided the owner or operator has properly designed the facility and its operations. In cases where a recycling facility has been established to handle a single waste type or transfer station has less than 30 cubic yards total capacity, it is likely that industrial solid waste would not be accepted. How detailed a facility owner or operator must discuss the management techniques will depend on the type of facility the plan is written for and the waste types expected. It is reasonable to allow the management plan to reflect site specific conditions because facility designs are different and facility owners and operators have different comfort levels on the acceptable risk. All situations cannot be addressed in a rule; thus flexibility is needed. The Agency will use guidance manuals and training programs to assist the facility owner in managing industrial solid waste.

Subitem (1) requires the facility owner or operator to specify the procedures that will be used to notify industrial solid waste generators of the requirements to be imposed upon them and what steps to be used to inform waste haulers and generators of the procedures. Under this subitem, the facility owner or operator is required to establish a system for waste generators to use in requesting acceptance of the waste for management at the facility. If no waste is to be accepted at the facility, this provision requires the facility owner or operator to discuss how this message will be communicated to waste haulers and generators.

Under this subitem, the Agency expects the facility owner or operator to discuss how news media, personal contact or letters will be used to reach waste haulers and generators. It is important that the owner or operator establish a system to alert potential users of the facility about the requirements. In the existing program, this type of system has consisted of personal contacts with waste generators and written procedures for how the waste generator requests the facility owner to accept the waste. Generally, these procedures include verification that the waste is not hazardous, is not infectious, and does not present any safety risk to the facility owner or operator. This verification is demonstrated by the signature of the waste generator.

The level of detail contained in the management plan must be sufficient to provide facility personnel with the information needed to properly carry out the program. The Agency will review this information to determine if the notification and education programs are sufficient, will reach the potential facility users, and will provide sufficient information to the waste haulers and generators so that they may comply with the facility owner's or operator's requirements. The notification process should include a news item in the local newspaper as a minimum and letters to known industrial solid waste generators. The education program should establish a routine for informational meetings to discuss the facility owner's requirements and one-on-one meetings. The facility owner can use the education program to disseminate information and to gather information from generators and haulers for improving the overall management program.

A system for the notification and education of waste haulers and generators is needed to inform these parties what will be expected of them. In some cases, the facility owner or operator may require delivery of all industrial solid waste over a certain quantity or with a certain characteristic in a separate shipment to the facility owner. The facility owner or operator may require signatures by both the waste hauler and waste generator. A form should accompany each shipment of industrial solid waste. Because these types of requirements may affect operating procedures, it is reasonable that the facility owner or operator provide notice to the waste haulers and generators.

Waste haulers are included in the requirements of this subitem because they are a key component in the proper management of industrial solid waste. The waste hauler must understand the impacts on human health and the environment that might result from the improper packaging or delivery of particular waste types to a specific facility. If the facility is designed to handle a waste only under particular conditions, the waste hauler could severely curtail the facility's management if the necessary conditions are not met. Notification to customers of conditions placed upon their use of a facility is standard business operations.

Subitem (2) requires the facility owner or operator to specify in the industrial solid waste management plan the procedures that will be used to evaluate waste characteristics. This subitem does not require the facility owner or operator to complete an analysis of the waste but rather set up a process by which adequate information will be supplied to the facility owner or operator by the waste generator or hauler to ensure proper management techniques can be used in handling the waste for disposal, incineration, transfer, storage or recycling. The information obtained must be reflective of the waste being evaluated and the management technique to be employed. If the waste is to be accepted at a solid waste incinerator, this information might include the metal content, the combustion potential, and other key factors that may affect the ability of the facility to comply with permits controlling its operations.

The facility owner or operator may feel the only information needed to evaluate the waste is that the waste was generated from a particular process that consistently generates a waste of little concern for management at the facility. For instance, the owner or operator of a land disposal facility constructed with liner/leachate collection may only be concerned that the waste not be a liquid or a hazardous waste. In reviewing an evaluation plan, the Agency may look at the treatment facility for the leachate and decide that information regarding the leaching characteristics of the waste is key to determining its affect on leachate quality and the eventual treatment of the leachate.

In discussing the provisions of subitem (2) with affected parties, suggestions were made by some that the Agency finalize a specific set of analyses to be completed by the waste generator and the criteria used to evaluate the results obtained from these analyses. Others felt that because the acceptance of industrial solid waste is for the most part subjective, assuming it is nonhazardous, the Agency should have little say in how a facility owner or operator decides to accept a particular waste. Concern was also raised about the potential for unfair competitive advantages of a facility owner or operator requiring minimal data versus the facility owner or operator carefully evaluating the risks associated with a particular waste.

The Agency feels that the language of subpart 5, and subitem (2) in particular, strikes a balance between the concerns raised by facility owners and operators, and local government officials. Under this subitem, the facility owner or operator determines the level of risk analysis to be completed on potential waste to be managed at the facility. The Agency reviews the system established by the facility owner or operator to ensure that it will provide a review of each waste adequate for protection of human health and the environment. This provides the facility owner or operator the ability to establish a complete risk management program for the site. If one facility owner or operator does not establish the same level of analysis as another, the risk for environmental damage may rise causing either an increase in the amount of funds set aside for contingency action or in the actual moneys expended to clean up problems that occur at the site as the result of wastes mismanaged due to the lack of understanding about its properties. Subitem (2) provides the facility owner and operator flexibility in designing and operating an industrial solid waste management facility compatible with specific facility conditions.

Subitem (3) requires the facility owner or operator to establish a procedure for managing incoming industrial solid waste including identifying any special requirements. Included in the procedure must be a method and rationale for accepting or rejecting a waste. These procedures are needed to ensure that facility personnel are aware of the risks associated with a waste at the facility. The evaluation conducted under subitem (2) is of little value unless a determination is made that the approved waste is the waste received. The facility owner or operator must establish the criteria for managing a particular waste prior to acceptance because if the waste cannot be managed at the site due to the unique design and operation of the facility, the facility owner or operator may wish to designate this waste as unacceptable. If procedures are not established for managing the waste, the potential exists for mismanagement of the waste resulting in harm to human health and the environment.

The Agency will review the procedures for accepting or rejecting the waste and for the management techniques to be used. The Agency's review of the procedures will focus on the capability of the procedures to protect human health and the environment and their consistency with the facility design and operation approved by the Agency. For instance, if the owner or operator of a compost facility determined that foundry sands were acceptable for use in the compost operation, the Agency would determine whether or not the addition of the sand would disrupt the composting operation or the final product end use distribution. If the waste would disrupt the final product, the Agency may decline to approve the industrial solid waste management plan because it will not adequately protect human health and the environment. The same type of occurrence might arise at a transfer facility that was not designed to accept bulky items, tires, or other waste types that require special storage procedures. If the facility is not designed or constructed to address the management of these wastes, the Agency is compelled to disapprove their acceptance unless modifications are made to the facility.

Commentors on the proposed rules suggested that the Agency establish the management practices and acceptance criteria by rule. These people felt a consistent and standardized system for managing industrial solid waste was best established by rule and not through the Agency's review of individual management plans. Local governmental officials were concerned about their ability to evaluate individual management plans without specific rule requirements. These officials believed their solid waste ordinances might not be comprehensive enough without specific criteria for approving the plan.

The Agency agrees that a specific set of standards established by rule may ease the local officials' functions in approving industrial solid waste management plans, but would not necessarily result in adequate plans for all facilities. In writing standards in a rule, the facility being regulated must be considered. In the case of industrial solid waste management plans, the entire set of solid waste management facility types must be considered in establishing the standards. A specific standard acceptable for use at a mixed municipal solid waste land disposal facility may have little bearing for a recycling facility and vice versa. Therefore, it is more appropriate to establish a standard that provides the facility owner or operator sufficient flexibility to establish a set of criteria and management procedures consistent with the specific design and operations of the facility used to manage the waste.

The owner or operator of a solid waste management facility must understand the risks associated with accepting particular waste types. The establishment of specific acceptance criteria and management practices can create a false security for the facility owner or operator due to a lack of understanding how the criteria were developed. The Agency acknowledges that understanding risk management and designing a complete facility program to minimize potential risks is acquired over time. The Agency intends to provide the facility owner or operator with assistance in developing an industrial solid waste management plan and in understanding the potential risks associated with particular wastes. The Agency's existing training programs will be expanded to address the evaluation and management techniques for industrial solid wastes. The Agency does not intend to impose the same restrictions on all solid waste management facilities or even on the same facility types. It is the Agency's position that the same criteria be used in determining the suitability of a management plan to protect human health and the environment. These criteria would address at least the following areas of concern:

1. Will the acceptance criteria distinguish hazardous from nonhazardous waste?

2. Are the acceptance criteria based on analyses, volume, size and other waste-specific characteristics?

3. Can facility operations physically handle incoming waste?

4. Are the proposed management techniques adequate for the specific facility?

5. What special handling techniques are needed to minimize potential risks associated with the waste?

The provisions of subitem (3) provide the facility owner and operator with adequate flexibility to establish a waste management program responsive to actual site conditions. The facility owner and operator are in the best position to determine the amount of risk associated with a particular industrial solid waste considered acceptable, thus, it is reasonable to establish a standard requiring the facility owner to establish a management program approved by the Agency.

Subitem (4) requires the facility owner or operator to establish an inspection program for incoming wastes. The program must include procedures that will provide reasonable assurances the waste delivered is the waste approved. Along with the inspection requirements the subitem requires the facility owner or operator to establish criteria by which further information and review of an incoming waste may be required. This requirement pertains to incidents such as when nonapproved waste is delivered to the facility, when the quantity delivered exceeds the approved quantity, or when the physical characteristics of the waste are different than described in the evaluation process. It is critical to the success of the proposed management program that the facility owner or operator be assured that incoming waste be approved wastes only. Should unapproved wastes be delivered to the facility and accepted by facility owner or operator, the results could be disastrous to the facility. For instance, loads of hot wood ash could ignite other waste resulting in a fire and damage to the facility or barrels contain liquid wastes could severely damage the integrity of a lined land disposal facility.

The provisions for inspecting incoming waste and determining its acceptability based on the inspection or further evaluation are needed to ensure that the potential risk associated with the mismanagement of particular wastes is minimized. The Agency will review the proposed criteria to determine if the inspection schedule and acceptance criteria are adequate for the facility designated to receive the waste. For example, receiving two extra barrels at a transfer facility may not justify rejection of the load; however, a compost facility may not be designed to incorporate the extra waste into its operation or store the waste until it can be used. The Agency's review will determine if the facility owner has proposed a program sufficient for determining when further evaluation is needed. The facility owner or operator will decide the percentage of barrels to be inspected, the depth to which loose waste is reviewed, and what constitutes a violation of the agreement made between the facility owner or operator and waste generator. The Agency will provide the facility owner or operator with guidance on a reasonable approach and work with the facility owner or operator to address specific problems such as white powdery material compared to white granular matter or power plant ash compared to waste-to-energy incinerator ash.

The program established by the facility owner or operator should include what types of forms are to accompany the waste delivery, whose signatures are required, and how the waste is to be delivered. The acceptance of the waste may then be contingent on whether the hauler and generator signed the appropriate forms, the waste was delivered in a segregated load, or the quantity received was previously approved. By establishing these details in advance of accepting industrial solid waste, the facility owner or operator will be able to properly train facility personnel in accepting the waste. These procedures are considered to be normal operating procedures for businesses wishing to minimize risks associated with their process and some facility owners or operators have already established such programs.

Item B contains a list of specific industrial solid waste categories that must be addressed in the industrial solid waste management plan. The list was derived from the codisposal request forms received by the Agency since the inception of the codisposal approval program for mixed municipal solid waste land disposal facilities. The list has been reviewed by affected parties and no other specific waste categories could be identified for inclusion in this item. The Agency anticipates that, as the industrial solid waste program involves additional waste, additional categories may be specifically identified under this item for review by facility owners and operators. The criteria used to place a waste category on this list included knowledge of the waste being generated on a regular basis, variability in waste characteristics, amount of waste generated and potential hazards associated with the waste. The Agency also considered the ability for the waste to be handled at a solid waste management facility rather than a special industrial solid waste facility or hazardous waste facility.

A specific list of waste categories to be addressed in all industrial solid waste management plans is necessary to present a baseline from which all facility owners and operators will develop their program. The Agency developed the list of waste categories based on the risk associated with the wastes, the management options available for the wastes, and the probability that the wastes will be encountered by solid waste management facility owners and operators. By including the list of waste categories in the rule, the Agency has provided facility owners and operators a minimum standard by which the industrial solid waste management plan must be developed. From this list, the facility owners or operators may evaluate the suitability of their facilities to manage a particular waste, the amount of risk a specific waste category represents, and the changes that may be necessary to allow for management of the waste category.

Commentors on the proposed rules have suggested that the regulated community and the public would be better served if the rules contained specific criteria regarding each waste category. Suggestions have been made that the rules address the risk associated with each waste category and the specific management technique to be used at the various facilities. The management technique would be directed specifically to the facility type, for example, a transfer facility accepting asbestos waste would be required to have sealed, locking containers for storage of the asbestos waste until delivery to a permitted disposal facility. It has been said that by establishing these criteria the Agency would eliminate the inadequate management practices that some commentors felt were being used at solid waste management facilities.

The Agency believes that the inclusion of specific criteria and management techniques in a rule would create a false impression of security among facility owners. Part of the cost of doing business is the risk associated with that business. The prudent business manager attempts to minimize risks by understanding the system under which it operates. If the Agency supplies a specific set of criteria to be followed at each facility type for each waste category, the Agency will establish a system that appears to have minimized the facility owners' or operators' risk while in fact the Agency will only have failed to educate them about the risks associated with the management of industrial solid waste. The facility owner or operator must determine what is an acceptable level of risk for managing industrial solid waste before entering into such a business. It is reasonable to establish the minimum standards to be used by the facility owner or operator in determining the risks associated with various waste categories because it serves as a tool for evaluating particular management techniques. The establishment of minimum standards also allows the facility owner or operator to develop management techniques uniquely suited to the facility and not require a variance request for techniques that may differ from those presented in a rule. It is reasonable to allow such flexibility because no single management technique can be applied to all facilities since the design, construction, operation and end use of these facilities are variable.

Although the Agency does not feel the proposed solid waste rules should contain specific risk criteria and management techniques, it does recognize the need to assist facility owners and operators in understanding various waste categories. The understanding needed to manage particular wastes involves a knowledge of the waste characteristics, the risks associated with improper management of the wastes, and the management options available. The Agency believes that a discussion of how the specific waste categories became listed in the rules for inclusion in an industrial solid waste management plan will form the basis for this understanding. Upon finalizing the rules, the Agency intends to continue its education of facility owners and operators through training seminars, assistance during the development of management plans, assistance during the evaluation of wastes, and by providing additional information on risks and management techniques associated with specific waste categories.

The following discussion presents the Agency's reasons for listing specific waste categories for inclusion in all industrial solid waste management plans. Each waste category will be discussed in terms of risks associated with the waste, possible management techniques that may be employed at facilities including whether a specific facility type would be suitable for management of the waste, and the reasonableness of including the waste in the rule when considering the risks and management options associated with the waste.

Subitem (1) requires that empty pesticide containers be addressed in all industrial solid waste management plans. Pesticides are routinely used in Minnesota as a control mechanism for nuisance insects in the agricultural community and by local homeowners. Pesticides are regulated by the Minnesota Department of Agriculture; however, pesticide containers are often found in the solid waste stream. Pesticides are normally produced from petroleum hydrocarbons and may include such compounds as xylene, naphthalene, coumarin, and chlorinated hydrocarbons such as 1,1,1-trichloroethane. These organic compounds may be toxic to humans, animals and fish when improperly managed.

The major halogenated hydrocarbons like 1,1,1-trichloroethane exhibit toxic properties that make them potentially hazardous. 1,1,1-trichloroethane has been determined to be an animal carcinogen. This compound when found to be a waste product from dry cleaning and other industrial operations is considered to be a hazardous waste and is required to be managed to ensure proper reuse or disposal. Another example, xylene, is considered potentially dangerous because of its low ignitability properties. Associated with the inherent dangers of the wastes themselves, is the high mobility of these wastes in the environment, which enhances their potential to harm human health and the environment.

Pesticides are also known to persist in the environment creating a potential hazard for some time into the future. For instance, 1,1,1-trichloroethane is soluble in water and if present in soils with low inorganic content may move rapidly into the ground water. Once in the ground water this compound reacts very slowly releasing hydrochloric acid, which results in chloride in the ground water. Until 1,1,1-trichloroethane completes this degradation process, it remains a toxic chemical that may enter the human food chain. Once in the air, 1,1,1-trichlorethane will only decompose at elevated temperatures.

A pesticide's effect is to attack the central nervous system or the cardiovascular and pulmonary systems of the unwanted insects or worms. Because these bodily functions are vital to the health of humans, the ingestion of pesticides by humans can be particularly toxic. It, therefore, becomes critical that the container of a pesticide be properly managed to avoid the introduction of pesticides into the environment. Potential problem areas include the introduction of pesticides into compost facilities that may not be capable of decomposing the chemical in question. The compost would be applied on agricultural land and the chemical would eventually find its way into the food chain by direct consumption or movement into surface water or ground water. The Minnesota Department of Agriculture recommends that all pesticide containers be rinsed at least three times with the rinse solution being used as a product. Pesticides are formulated to be mixed with water for dilution prior to applications, thus water would, in most cases, be considered a suitable rinsing agent. Because of the potential hazard associated with the mismanagement of pesticides, it is reasonable to require that pesticide containers be included in the industrial solid waste management plan for solid waste facilities.

Once the potential hazards associated with pesticides are known, the facility owner or operator must determine if the risks are manageable at the facility. The facility owner or operator must decide whether a suitable procedure can be formulated to ensure the pesticide containers are empty and if the containers have been triple rinsed prior to delivery at the facility. If the facility owner or operator decides to assume the risks associated with managing empty pesticide containers, the facility owner or operator must decide if the facility as designed and constructed can be used to manage the waste. It is reasonable to allow the facility owner or operator to make this decision as the ultimate responsibility for the facility's performance remains with the owner or operator. The Agency's function in reviewing the industrial solid waste management plan is approval of the method the facility owner or operator has chosen to handle the waste. For example, accepting empty pesticide containers at a transfer facility for ultimately returning the containers to the product manufacturer for use may be approved while the owner of a compost facility may not be allowed to accept such containers for transfer to a disposal facility because proper storage and removal options are not available at the compost facility. Controlling such actions through the industrial solid waste management plan permits the facility owner or operator to review site operations with respect to the waste and the Agency can ensure that the facility will be able to properly manage the waste and minimize harm to human health and the environment. References 3 and 4.

Subitem (2) requires that all solid waste management facility owners and operators address the management of asbestos in the facility industrial solid waste management plan. Asbestos is a naturally occurring family of fibrous mineral substances. The typical size asbestos fiber is not visible to the human eye. When disturbed, asbestos fibers may become suspended in the air for many hours, thus increasing the extent of asbestos exposure for individuals within the area. The potential of an asbestos-containing product to release fibers depends on the ease with which it may crumble under hand pressure. The fibrous or fluffy spray-applied asbestos found in many buildings for fireproofing, insulating, sound proofing, or decorative purposes crumbles easily under hand pressure. Vinyl-asbestos floor tile does not generally emit fibers unless sanded or sawed.

Medical studies of asbestos-related diseases have shown that the primary exposure route is inhalation. These studies also indicate that there does not appear to be a safe level of exposure below which there is no chance of disease. The diseases that can result from the inhalation of asbestos fibers include asbestosis-scarring of lung tissue; lung cancer; Mesothelioma-cancer of the membrane lining the chest and abdomen, and other cancers of the larnyx, colon and kidney. Symptoms of asbestos-respiratory disease generally do not appear for 20 or more years after initial exposure, but early detection is possible.

Asbestos has been mixed and commercially used in the United States since the early 1900's. Asbestos is used in the brake linings for automobiles, which in themselves do not appear harmful, but asbestos dust is generated during the manufacturing process and from brake drum wear. Substitute nonasbestos brake linings have been developed and are beginning to replace asbestos linings. Asbestos is also used in plastic products, cement pipe, paper products, textile products and insulating products. Asbestos-containing wastes are normally generated during the demolition of buildings, removing old sewer pipe, mining and cleanup processes at a manufacturer of asbestos-containing products.

The U.S. Environmental Protection Agency (EPA) has established federal regulations for the transport and disposal of asbestos-containing waste. Land disposal is recommended as an environmentally-sound isolation method because asbestos fibers are virtually immobile in soil. Other disposal options such as incineration or chemical treatment are not feasible due to inert properties of asbestos. Handling procedures include such methods as misting the demolition area to prevent the fibers from becoming airborne, transporting the waste in leak-tight containers appropriately labeled, and disposal in separate areas at a land disposal facility with cover being placed immediately.

It is reasonable to require that all solid waste management facility owners and operators address the handling of asbestos-containing wastes at their facilities because of the potential health problems associated with the mismanagement of the waste. Because it is critical that a record be kept from the generation of the waste to disposal, the facility owner or operator must not only be willing to accept the management risks associated with asbestos-containing wastes but also have a recordkeeping system established to control the influx of this waste. The Agency must insure that proper management controls are employed by the facility owner or operator to prevent the asbestos fibers from becoming airborne and widely spread throughout the environment, which may in turn impact the health of numerous persons. While the Agency may approve the acceptance of asbestos-containing wastes at specific land disposal facilities; it may not approve the acceptance of this waste at a refuse-derived fuel processing facility that does not have the capabilities to handle this waste separate from other incoming waste streams. References 5 and 6.

Subitem (3) requires that the management of waste containing polychlorinated biphenyls (PCB) at a concentration less than 50 parts per million be addressed by all solid waste management facility owners and operators. Wastes containing PCBs below 50 parts per million are not regulated as a hazardous waste or as a toxic substance. PCBs are known to be toxic to humans and animals alike. Even exposures to small amounts of PCBs can have an effect as this chemical accumulates in the fatty tissue of humans and animals and can exert its toxicity after a period of years. PCBs are also persistent in the environment, meaning they do not rapidly break down.

Because of designation of wastes containing less than 50 parts per million as nonhazardous as long as no more than 100 kilograms of the pure waste are generated per month, it is reasonable that facility owners and operators accepting this waste develop a management technique that will adequately handle the waste. Currently, generators of this waste are encouraged to voluntarily treat the waste as a hazardous waste for disposal purposes. However, economics dictate that this will not always be done, particularly in Minnesota where no hazardous waste treatment or disposal facility exists. Should a solid waste management facility owner or operator decides to accept the risk of managing a waste containing low levels of PCBs, it is reasonable that the facility owner or operator make available to the waste generator and hauler as well as the Agency the procedures to be followed at the facility to minimize any potential effects on human health or the environment. The Agency may permit the acceptance of waste containing PCBs at a lined land disposal facility or a refuse-derived fuel processing facility with final disposal at an incinerator but may find it an unsuitable waste for management at a compost facility. In order for the Agency to make an informed decision on the suitability of a facility to manage this waste, the Agency must understand not only the facility design but also the procedures a facility owner or operator will use to manage the waste, to ensure the waste is acceptable, and to track the incoming waste. Because each facility design is different and there are more than one acceptable methods for handling the waste, it is reasonable for the Agency to obtain the needed information through a facility-specific industrial solid waste management plan. Reference 5.

Subitem (4) requires that the industrial solid waste management plan address how a specific facility owner or operator would manage spilled nonhazardous materials. If a hazardous material is spilled, the material it comes in contact with becomes a hazardous waste and must be handled accordingly. However, many spills occur with nonhazardous materials and the management of these spills must be handled on a case-by-case basis. Therefore, the industrial solid waste management plan must be written in a flexible manner to allow for the variability in waste that may be encountered.

In the majority of cases, nonhazardous spills have involved gasoline or petroleum spills. These spills can be properly managed by landspreading the waste in thin layers to facilitate the breakdown of the petroleum product. Other materials that have been spilled in Minnesota that would be considered acceptable for treatment by landspreading include molasses, whey solids, liquid fertilizer, food coloring, and aspirin. The decision of a facility owner or operator to accept spilled nonhazardous materials will depend on the facility location, the suitability of nearby disposal facilities, and the time required for processing the spilled material. Because only the facility owner or operator can compare the benefits and costs of accepting such material, it is reasonable that the management program be developed in a facility specific plan rather than dictated by rule.

Nonhazardous spills are an excellent example of why a rule cannot establish a particular set of criteria for management of industrial solid waste. Not every spill contains the same material or occurs exactly the same way. An industrial solid waste management plan affords the facility owner flexibility in managing spill waste as it occurs. It is reasonable to use an evaluation procedure in managing these wastes rather than a specific set of criteria.

For some years, the Agency has attempted to designate certain land disposal facilities as suitable sites for the landspreading of spilled wastes. However, no facility owner or operator has been willing to set aside a portion of the site for use as a landspreading site. Instead, spilled nonhazardous wastes are incorporated into cover designs, agricultural lands, or simply disposed of in a land disposal facility. With the increase in alternative solid waste management facilities, it may be possible to incorporate spill materials into these operations. For instance, a compost facility owner may be willing to accept food product spills while not accepting petroleum product spills. Paint spills may possibly be incorporated into the process for a refuse-derived fuel processing facility and incinerated for energy recovery rather than placed in a land disposal facility. Because of the variety of spill materials that may be generated, no one risk determination can be made. Therefore, it is reasonable to permit the facility owner or operator to develop a management strategy for these materials based on the particular facility design and operation. The Agency will assist the facility owner or operator in developing a strategy that will properly assess the potential impacts from a spilled nonhazardous material in order to protect human health and the environment. It is reasonable for the Agency to approve the management strategy on a facility-by-facility basis as it ensures protection of human health and the environment while affording the facility owner or operator sufficient flexibility in determining the level of risk associated with managing spill materials and constructing a management strategy consistent with existing facility operations.

Subitem (5) lists rendering and slaughterhouse wastes as a category of wastes to be addressed in all facility industrial solid waste management plans. Rendering and slaughterhouse wastes are highly putrescible waste that may, if improperly managed, create odor problems and other nuisance conditions as well as operational disruptions. In deciding to accept these wastes, the facility owner or operator will need to consider the specific handling procedures needed to prevent these wastes from developing into nuisance and operational concerns. Because of the difficulty in managing these wastes, it is reasonable to allow the facility owner or operator to decide if the wastes can be handled at the specific facility in question without disrupting existing operations or causing a major change in a planned facility's design.

The potential risk to human health and the environment from rendering and slaughterhouse wastes comes from their potential to disrupt standard facility operations. Rendering wastes normally have a very high content of fat wastes from the processing of animals. Slaughterhouse wastes may have a high amount of blood and internal organ waste from processing animals for human consumption. These wastes, although highly putrescible, may not be acceptable at all compost facilities due to their high moisture content, the difficulty in handling the wastes to obtain good mixing and prevent unwanted compaction creating anaerobic conditions that may stop the composting process, and if the operation is outdoors, the attraction for vectors and other unwanted animals disrupting operations. The nature of the wastes makes them very slippery even though little free moisture may be present. This condition could create problems at a land disposal facility preventing good compaction and covering in the area where the waste is deposited. This in turn allows flies, vectors and other unwanted animals to enter the facility and create potential health problems. The difficulty in operating under these conditions may also cause a disruption of facility structures such as the liner and leachate collection system providing an avenue for contaminants from other sources to reach the ground water. A refuse-derived fuel processing facility accepting this waste may generate a fuel product of less quality than anticipated due to the extra moisture present in these wastes or be unable to generate a compostable fraction because of the reasons discussed previously.

Because a facility owner or operator needs to assess the operating capabilities associated with the particular facility, it is reasonable to use an industrial solid waste management plan as the needs assessment tool. All facility owners and operators must address these wastes in a management plan because no one management technique is suitable for all compost facilities, transfer facilities, etc. The Agency's review will ensure that the management technique chosen by a facility owner or operator will be compatible with the facility and thus, prevent nuisance and operational problems at the facility.

Subitem (6) requires that all industrial solid waste management facility plans address the handling of wastes that could spontaneously combust or that could ignite other wastes because of high temperatures. Examples of wastes that may spontaneously combust or ignite easily include soybean processing waste and paint filters. Should these wastes ignite, the resulting damage to a facility could disrupt solid waste management services as well as create avenues for pollutants to reach the environment increasing the area of impact. Thus, the facility owner or operator must determine the risk associated with these wastes and whether the potential for fires is larger than the facility owner or operator is willing to accept. Should the facility owner or operator decide that the waste can be handled at the facility, a program for determining which incoming wastes are subject to spontaneous combustion, how the wastes can be safely stored, if needed, and how the wastes can be treated or disposed of properly is needed.

The facility owner or operator must be able to decide on the best management technique for existing operations rather than the Agency dictating such practices by rule. For disposal facilities, landspreading of the wastes may be an option while transfer facility operations may need to provide for immediate transportation to a treatment or disposal facility. Only by knowing the specific facility in detail can a suitable management plan be developed to minimize potential fire hazards associated with these wastes and ultimately protect the environment from potential harm resulting from the disruption of facility structures or operations due to the fire. The management technique used will depend on the specific facility design. The Agency must review and approve the chosen technique in order to ensure that minimum standards are met.

Subitem (7) indicates that foundry waste should be addressed in all industrial solid waste management plans. Foundries generate usable products from casting molds. Products generally formed in this manner include valve bodies, gears, faucets, cookware and automotive engine parts. Foundries may be classified according to the types of materials being processed--iron, steel and nonferrous. Nonferrous foundries most commonly work with aluminum, brass, bronze and magnesium. The high temperature necessary for melting the metals are attained by a variety of devices such as the coke fired cupola, gas crucible, electric arc furnace, and the electrical induction furnace. The waste generated is dependent on the type of foundry and the melting process used at the foundry.

In 1981, approximately 98,000 tons of foundry waste were disposed of in Minnesota. The types of waste generated included cupola dust, casting molds, core sand, finishing dust, paint filters, paint residues, and sweepings. Generally, the process by which these wastes are generated is similar regardless of the type of metal process. Sand is the most common medium to form cast molds. Small quantities of binders and conditioners may be added. The majority of metal foundries in Minnesota use about 35 to 105 tons of silica sand per day. The sand is reused as many times as possible before it is discarded as a waste.

Most foundry wastes are land disposed; however, the industry has been very active in attempting to find uses for the waste to reduce the need for land disposal. To the extent possible, molding sands are reused at the foundry. Some wastes have been found suitable for use in the manufacturing of roadbase material. Some material has been found suitable for the production of concrete bricks and other products that totally entrap any constituents that might leach from the waste. Land disposal facilities have found that the sand wastes are useful as daily cover material. The facility owner or operator may wish to handle the entire waste stream from a foundry, dividing it into categories for recycling, land disposal, etc., or only handle those wastes specifically manageable at the facility. In any case, the facility owner or operator will need to evaluate the potential risks associated with managing foundry wastes.

As discussed earlier, the foundry industry generates a variety of waste streams from any one plant. Each of the waste streams will have a different level of risk associated with it. In some cases, the risks may be operational while in other cases, the potential exists for environmental problems due to the leachability of the particular waste. It is beneficial to discuss a sampling of the waste streams generated by the foundry industries and the potential risks associated with those wastes. The facility owner or operator will need to establish a program that reviews the entire waste stream from a particular foundry. The facility owner or operator should establish the procedures to be used for evaluating incoming wastes because each foundry will have different waste types depending on the type of products made and molds used in the process.

Slag generated at foundries binds the constituents in a glass-like state. Slag is generated during the metal melting process to remove impurities in the system. Slag retains heat for a substantial amount of time after its removal from the system. If the storage, transportation, or disposal of the slag is not carefully controlled, unaware persons could be burned or fires started from the placement of slag with ignitable materials such as paper or paint filters. The potential for fires directly relates to the potential for environmental impacts from a solid waste management facility accepting this waste. The destruction of part of all of the facilities could result in the movement of pollutants into the environment because existing controls are also destroyed.

Molding sands may contain heavy metals or organic pollutants depending on the particular foundry involved. Heavy metals such as lead, cadmium, or zinc are toxic to humans and animals as well as limiting growth factors for plants. If wastes containing heavy metals are placed in an acidic environment such as that found at mixed municipal solid waste land disposal facilities, the metals are leached from the waste and have the potential to move into ground water or surface water resources. If large amounts of heavy metals are placed in a composting waste pile, these metals may be taken up by plants after landspreading of the final compost product. If proper landspreading techniques are not used the plant growth may be reduced, thus impacting agriculture production.

Heavy metals are persistent in the environment and may move into ground water at any time. Although heavy metals react with some soils to prevent migration of the metals into the ground water, sufficient leaching of the soils by acidic rainfall or leachate from mixed municipal solid waste land disposal facilities may cause the metals to move into the ground water. Soils containing high amounts of sand do little to retard the movement of polluted leachate into the ground water and do not react with the leachates to remove metal pollutants. Thus, facility owners or operators operating land disposal facilities in areas containing large sand deposits may find the acceptance of foundry waste under these conditions unacceptable. However, the facility owner or operator may also decide that sufficient changes in facility design and operation can make the risks associated with these wastes manageable and move forward with such a program. The proposed solid waste rules provide sufficient flexibility for this decision.

Furnace dust can create environmental problems of a nature different than just the leachability of pollutants. The texture of furnace dust is like a fine talcum powder, easily dispersed by wind. Chemical analyses indicate that high levels of pollutants are contained in the dust particles. The small particles with their corresponding large surface area may leach pollutants more efficiently and, without proper management controls, may be more widespread because of wind dispersal. Core sands and molding sands that contain phenols, formaldehyde or proprietary ingredients must also be closely managed. These materials may be persistent, toxic and organoleptic in water. Certain phenolic compounds are not readily removed from drinking water by conventional treatment. When chlorinated, the phenols in the water may combine with chlorine to form chlorophenols, which give unpleasant taste and odor to the water. Phenols may kill aquatic life. Some compounds are carcinogenic. The facility owner or operator must consider all risks associated with the management of these wastes. Requiring the facility owner or operator to address the management techniques to be employed at a facility affords the Agency an opportunity to review these techniques for their ability to protect human health and the environment. References 7, 8 and 9.

Subitem (8) requires all facility owners or operators to address the management of ash from incinerators, resource recovery facilities, and power plants in their industrial solid waste management plans. Although the potential pollutants contained in the ash may vary, a management plan can be developed to evaluate the types of ash that might be delivered to the facility. It is reasonable to require all facility owners and operators to discuss the management of ash at their facilities because of the reuse options available making an intermediate facility as feasible an alternative as the conventional land disposal methods used in past years.

To understand the risks associated with the management of ash, a discussion on the characteristics of ash is needed. Because of the increased use of resource recovery facilities as a method to reduce the amount of mixed municipal solid waste that is land disposed, this discussion will focus on the risks associated with managing ashes generated from the burning of mixed municipal solid waste. The ash may be classified as bottom ash--a heterogeneous mixture of metals, glass, dirt, organic materials, stones and unburned paper, and fly ash generated from the combustible fraction. The composition of any ash is affected by several factors including community source separation programs, geographic locations, seasonal variations, and any front-end processing of the incoming mixed municipal solid waste before combustion.

During the combustion of mixed municipal solid waste, the waste characteristics are altered both chemically and physically. Metals, which do not burn, increase in concentration in the ash directly proportional to the degree of volume reduction achieved. Combustion may also create products of incomplete combustion including the highly toxic families of organic chemicals known as dioxins and furans. This phenomenon is particularly true for fly ash: toxic metals such as lead, cadmium, and mercury are partially volatilized at the high temperature of the incinerators, become entrained in the combustion gases and as the combustion gases cool the gaseous metals condense onto the surface of the small particles of fly ash present in the gas. These toxic substances may be widely dispersed in the environment because the particles are small and are easily transported by air or water, and readily inhaled or ingested upon exposure. Thus, management of these wastes must be conducted in a manner which minimizes airborne particulates to the extent possible.

Toxic metals--lead, cadmium, mercury, etc., are bioaccumulative. That is, when ingested these constituents accumulate in the fatty tissues of humans and animals and can have long-term effects. Some metals are acutely toxic (arsenic and selenium) and when ingested may have immediate effects. Commonly used leach tests employ acids to digest the waste for analysis and determination of the amount of metals that will be removed from the waste once it is placed in a land disposal facility. It is assumed because the decomposition of mixed municipal solid waste generates an acidic leachate that the only concern for managing wastes in such an environment would be the leaching of potential toxic pollutants under these conditions. However, the increased use of monofills creates the need for an evaluation of the wastes under more neutral conditions. Metals such as arsenic and selenium have a tendency to leach more under neutral conditions than acidic. Some metals like lead leach under acidic and alkaline conditions and must be evaluated depending on the specific process used to generate the waste. Although understood to a lesser extent, dioxins and furans are found in ash generated from the incineration of mixed municipal solid waste.

Understanding the potential pollutants contained in ash is only a part of determining the risk associated with the management of ash. It is also important to understand the routes of exposure. Exposure to toxics present in ash can occur directly, through exposure to airborne or settled dust, suspended particles washed into surface waters, or contaminated soil, and indirectly, through the leaching of its toxic pollutants into ground water or surface water, and bioaccumulation and contamination of food sources. The industrial solid waste management plan must be flexible enough to allow these areas to be addressed through facility design and operation.

Ash is susceptible to airborne transport. The small ash particles can be inhaled or ingested releasing toxic pollutants directly into human tissue. Ash particles may also be deposited onto nearby croplands, grazing areas or surface waters used by domestic animals where they can contaminate human food sources. Precautions must be used during the management of ash to prevent its particles from becoming airborne. The movement of ash or its toxic pollutants can affect human health as well as aquatic organisms. Toxics in surface waters are not only available to fish and other organisms but may also have immediate effects on the organisms. In addition, surface water contaminated with toxics may lead to direct human exposure if used as a drinking water supply. Soils or sediments can be polluted by toxic chemicals by direct disposal of the ash, leaching, or the deposition of these chemicals from the air or water. Because metals do not degrade over time, they may pose a threat to human health and the environment for some time into the future.

The facility owner or operator must determine the risk associated with the management of ash whether it is from a resource recovery facility or a power plant. If the facility owner or operator owns and operates a land disposal facility located in a sandy-loam soil with little ability to attenuate metals, a decision must be made on the need to install a liner system or other management option before accepting the waste. Numerous studies have been conducted on power plant ash, and to some degree on incinerator ash, for reuse rather than land disposal. With these options available, the transfer facility owner or operator or refuse-derived fuel processing facility owner or operator may wish to work as an intermediary between the ash generator and the reuse facility.

The utilization of ash depends on many factors including particle size, distribution, physical composition, chemical composition, density, and moisture content. The common uses for ash are as an aggregate replacement in the subbase of roadway construction and asphalt mixes, replacement for cement in blocks and other structural material, and as the grit on roofing shingles. Each of these processes normally binds the potential pollutants within the product decreasing the risk of a release of the pollutants into the environment and a need for land disposal facilities. Ashes have also been used as daily and intermediate cover material at land disposal facilities where on-site soils are unavailable. Methods are also available to stabilize the ash before land disposal but this is essentially binding the ash up in a cement-like substance. The reuse of ash would be a better alternative.

Because of the variability in ash characteristics and the management techniques available, it is reasonable that a facility owner or operator be given sufficient flexibility to evaluate the potential risks associated with a particular waste and how these risks fit into the overall management program for the facility. The most efficient manner to accomplish this task is to require in rules procedures that adequately address the waste in question without dictating specific management techniques. The development of alternative uses of ash has been rapid in recent years. Specifying certain management techniques in rules would either stifle the creativity of the waste generators or cause the Agency to grant numerous exceptions to the rule. It is reasonable to provide the flexibility in the inital review process when it is known up front that exceptions will be requested and indeed will be reasonable. References 10, 11, 12 and 13.

Subitem (9) lists paint residues, paint filters and paint dust as waste types to be addressed by all facility owners and operators in their industrial solid waste management plans. Paint wastes may contain heavy metals as well as organic residues. The organic residues remaining in the paint waste volatilize during the drying process making the waste extremely flammable. The organics may also be toxic. The management of these wastes must be compatible with the risks associated with the particular waste being evaluated. In some cases, the preferred management option may be incineration rather than land disposal due to the flammability of the product. However, in these instances, the storage of the particular waste becomes a management concern. As discussed earlier, heavy metals are toxic to humans and other animals and when released to the environment the hazard associated with these elements can linger far into the future.

Paint wastes are generated by many manufacturing firms as well as industrial producers of paint. The particular paint characteristics correspond to their uses by manufacturers and commercial uses. The paint used on machine parts does not have the same characteristics as an indoor house paint. Equally important are the differences between paints used near heat sources and those used on outdoor wood products. These differences in characteristics must be reflected in the management plan developed by the facility owner or operator. The facility owner or operator must develop a procedure to evaluate not only the characteristics of the waste but also the adequacy of the facility to manage the waste properly. This flexibility is obtained only through a facility-specific plan. Therefore, it is reasonable that the rule require the facility owner or operator to develop management plans for their specific facility for the waste categories with known risks to the environment if improperly managed and to the facility if not compatible. For a rule to anticipate the numerous waste types associated with the manufacture and use of paint, a lengthy set of requirements would be needed resulting in a loss of ability to make management techniques fit the facility.

Paint sludges present a risk to facility operations in that they often are high in water content. During the painting process, a water mist is often used to minimize the fine spray particles from becoming airborne. The water also decreases the risks of fires from the volatization of organics in the paint overspray. This added water in the paint waste can create operational problems at facilities. For a land disposal facility, free moisture present in the waste can increase the amount of leachate generated at the facility, increasing treatment cost. If the amount of moisture is too great, it can disrupt the integrity of the liner and working face of the fill area. For facility owners and operators accepting this waste as an intermediary facility, the extra moisture could cause storage and handling concerns. A facility owner of a compost facility may wish to reject the delivery of paint wastes because of the length of time needed to compost this material, if it will compost at all, and the potential distribution problems with the end-product, if high in metals.

The risks associated with toxic metals and organics in industrial solid wastes have been discussed earlier. The facility owner or operator must establish a program that minimizes the overall risks associated with the acceptance of the waste. It is reasonable to require all facility owners to address their risk management program for industrial solid wastes in a facility specific plan because of the need for the plan to accurately reflect the capabilities of the facility to manage a waste in a manner that minimizes the threat to human health and the environment. References 2, 3, 5 and 6.

Subitem (10) requires the facility owner or operator to address industrial sludges as part of the industrial solid waste management plan. Industrial sludges may be generated from many manufacturing, treatment, or industrial processes. Sludges of concern include ink sludges, lime sludge, wood sludge and paper sludge. The potential risks associated with these sludges vary with the metal content, moisture content, and organic content. The risks are operational and threatening to human health and the environment.

In developing an industrial solid waste management plan, the facility owner or operator must first understand that the risk associated with all sludges is the excessive moisture. Creating a sludge normally includes washing down work areas with water or collecting used materials, allowing the impurities to settle, and collect the settled material as a sludge. This excess moisture is not allowed in a land disposal facility due to the potential for extra amounts of leachate to be generated and disruptions of operations. For resource recovery facilities, the excess moisture may eliminate the potential for combustion of the waste for energy recovery and as a management option.

The concern with ink sludge is the level of metals present and the organics found in the solvents used to prepare the ink. The metals of concern are generally lead, cadmium, chromium and barium. In most ink sludges, the level of metals is above the criteria that establish the waste as hazardous. Additionally, depending on the solvent used in developing the ink and in the printing process, the waste may be classified hazardous. The facility owner or operator must establish an evaluation program to determine if the waste is hazardous. In general, generators of ink sludges are working to find alternative management techniques other than land disposal in an attempt to minimize the risks associated with this waste.

As discussed earlier, the metals present in waste are normally more mobile in acidic environments than neutral environments. The metals can be toxic to humans, plants and animals when directly ingested or taken up by plant roots. Cadmium, for instance, can accumulate in plants and be transmitted to livestock and humans. Because cadmium tends to accumulate in leafy tissue and be excluded from grain and fruit, landspreading alternatives should avoid land cropped with leafy vegetables. Human and animal muscle tissue accumulates little cadmium; almost all is concentrated in the liver and kidneys. Thus, little cadmium would be transmitted to humans through the food chain when leafy vegetables are not tainted. The potential for metals to move into ground water is minimal. The metals contacting soils of the clay and humus families are normally bound to the soil particles and do not represent a risk at that point. Too great an application of metals to surface soils may result in phytotoxicity to plants grown on the area and exceed the soils ability to bind the metal. This potential for long-term toxicity is high if improper management techniques are followed.

Lime sludge, in addition to having a potential for high moisture content, may also have a high pH and high levels of metal and organic pollutants. The level of concern over lime sludge depends on the process used to generate the sludge. Lime is introduced into water and wastewater treatment facilities to increase the removal of solids and other unwanted particles that may disrupt the plant operations. Lime is alkaline and increases the pH of the water, which in turn causes the metals present in the water to precipitate out as salts. If the lime is then placed in an acidic environment, the potential, although low, exists for these metals to become mobile. Again, the facility owner or operator must evaluate suitable management alternatives for this waste. At land disposal facilities, it may be possible for the facility owner to incorporate the lime sludge into existing cover material to extend the use of the cover material.

Wood and paper sludge may contain metals and organics depending on the process used in the manufacturing of wood and paper products. As with the other sludges, the facility owner's or operator's industrial solid waste management plan must address the procedures used to evaluate incoming wastes for their hazardous nature and the management technique best suited for the particular waste in question. It is reasonable that a site-specific plan be used rather than rule requirements because it allows the facility owner or operator the opportunity to address the evaluation of a waste according to the intended management technique to be employed. For instance, a compost facility may be willing to accept a wood sludge or lime sludge that is compatible with the composting method used at the facility and the intended end-use for the compost.

The Agency will review the proposed evaluation program in conjunction with proposed management options and facility design to ensure the risk to human health and the environment is minimized. The Agency must conduct this review to fulfill its statutory requirements to protect human health and the environment. Reference 1.

Subitem (11) requires addressing fiberglass, urethane, polyurethane, and epoxy resin wastes in industrial solid waste management plans. These wastes may be found in liquid, semi-solid or solid forms. The facility owner or operator needs to establish a program to evaluate the waste as delivered and an inspection program to ensure that the waste has been approved. It is important that the management plan address the potential for these wastes to be delivered in liquid and semi-solid form. For most resins, the hardening process involves the evaporation of organic solvents that leaves a hardened product. The solvents and resins are composed of organics that can be harmful to humans and the environment. Organics in concentrated forms can weaken liners, are potentially flammable, and may spontaneously combust. These wastes should be considered in all industrial solid waste management plans because these waste types are generated from many manufacturing processes and, with the use of regional facilities, more waste types will be accepted at a variety of facility types. The facility owners and operators must be aware of the risks associated with the wastes and devise a program by which they can safely manage them. No rule can adequately address all waste types. References 2, 3, 5 and 6.

Subitem (12) requires consideration of spent activated carbon filters in all industrial solid waste management plans. Activated carbon filters are used to treat water and other liquids. The material found in the filter depend on what liquid is treated. Activated carbon effectively removes organics and metals.

If filters are found nonhazardous during the evaluation required of all waste generators under the hazardous waste rules, the next concern is the proper management of the filters. In most cases, current technology only allows using incinerators or land disposal facilities to dispose of the filters. The owner of a compost facility may refuse to accept this waste under any circumstances while the owner of a transfer facility may decide to act as an intermediary between the waste generator and the final disposal facility. In some cases, such filters can be reactivated and used again allowing the transfer facility owner the option to function as an intermediary with a recycling facility. Because it is very difficult to establish specific criteria in a rule to adequately address all carbon filters, facility owners or operators appropriately should establish an evaluation and management program specific to their facilities. The facility-specific plan allows for the flexibility of management options to be employed as technological advances are made along these lines. Reference 1.

Subitem (13) requires all facility owners and operators to develop management procedures for industrial solid wastes not listed in subitems (1) to (12). It is important to include this evaluation program in industrial solid waste management plans because a rule cannot identify all industrial solid wastes generated in the State and the specific areas of generation in order to inform all facility owners and operators about the industrial solid wastes generated within their service area. The categories of waste listed in subitems (1) to (12) were included because of their widespread generation in the State as identified through the Agency's existing codisposal program, and because of the potential risks associated with the management of these wastes. As time progresses, industries, manufacturers and other businesses start up or relocate in new areas creating the need for management of those wastes. The inclusion of this provision allows the rule to remain responsive to the changing business climate in the State. Each facility owner or operator should include wastes specific to their service area in order for the Agency to adequately address the risk to human health and the environment from the facility.

Item C requires that all facility owners or operators include in their industrial solid waste management plans a list of wastes they will not accept at the facility. It is reasonable to require this list in the plan because it will inform facility users and the Agency of the wastes the facility owner or operator will not handle. It is important for the facility owner or operator to evaluate known industrial solid wastes to determine if the risk associated with these wastes is acceptable and manageable. By eliminating the wastes presenting too large a risk, the facility owner or operator is limiting the scope of wastes to be dealt with at the facility. This, in turn, provides an opportunity for more time to adequately address the wastes to be managed at the facility.

Item D contains a list of waste categories that do not need to be addressed by facility owners and operators in their industrial solid waste management plans. These wastes were placed on this list based on their similarity to household waste, their previous treatment prior to handling at the facility, and the low risk associated with the waste. It is reasonable to exclude these wastes from industrial solid waste management plans because few unique handling methods are needed to adequately manage the wastes in a manner that protects human health and the environment. The facility owner or operator, under this item, has the ability to accept these wastes and manage them at the facility without previous review and approval by the Agency. Allowing the facility owner or operator this flexibility forces more time to be spent on the evaluation and determination of proper management techniques for wastes that present a greater potential for harming human health and the environment.

Subitem (1) lists paper and cardboard wastes from manufacturing processes or packaging as a waste that need not be addressed in the industrial solid waste plan. These wastes under normal conditions would not come into contact with the type of constituents, metals or organics, that are considered hazards to human health or the environment if released due to improper waste management. The wastes do not cause operational difficulties, are similar in nature to household wastes, and represent low potential for adverse impacts. Facility owners and operators may manage these wastes with no Agency input because of lack of risk associated with their management.

Subitem (2) permits food and beverage packaging and handling materials to be managed at solid waste management facilities without Agency review. Food and beverages represent little risk to human health and the environment. It follows that packaging or handling materials in contact with these materials would have little risk associated with them. These wastes may be managed by facility owners and operators with little Agency involvement.

Subitem (3) lists food without free liquids as an acceptable waste at any solid waste management facility. Mixed municipal solid waste contains approximately 18 percent food waste by weight. The concern with food waste from service and commercial operations is the amount of liquid that may be present. This liquid presents operational concerns at solid waste management facilities. If the food waste contains no free liquids, it may be managed at solid waste management facilities without a specific evaluation completed on it.

Subitem (4) lists aluminum, iron, steel, glass, wood, and hardened, cured plastic waste as acceptable without prior evaluation or consideration regarding operational practices. These metals and hardened, cured plastic waste are commonly found in mixed municipal solid waste (10 percent by weight). The metals are listed in their naturally occurring state and present no increased risk to the environment. Glass is refined sand and an inert material and presents no risk. Wood decomposes in the environment on a regular basis. Wood managed at solid waste management facilities represents no larger risk. Hardened, cured plastics are slow to degrade and have released any free organics in the plastic during the curing process and represent no increase in risk.

Subitem (5) lists dewatered sewage sludge that has been treated by a process to significantly reduce pathogens pursuant to parts 7040.0100 to 7040.4700 as a waste exempt from the industrial solid waste management plan. Two waste types specifically prohibited at solid waste management facilities are infectious wastes and wastes with free liquids. Sewage sludge without dewatering is approximately 95 percent liquid and 5 percent solids. The excessive amount of moisture presents operational concerns at solid waste management facilities and excessive leachate generation. The pathogens present in sewage sludge represent a human health concern. Therefore, if the sewage sludge is dewatered and treated to kill pathogens, the management concerns with this waste are eliminated and no further evaluation is required.

Subitem (6) lists compost including sewage sludge compost produced in accordance with part 7035.2835 as needing no evaluation by the facility owner or operator or the Agency is required for management at solid waste facilities. Mixed municipal solid waste compost and sewage sludge compost contain no free moisture and pathogens have been eliminated. As discussed above these would be the concerns with these materials, thus no evaluation is necessary.

Subitem (7) lists grit and bar screenings from a wastewater treatment plant as an exempt from specific discussion in industrial solid waste management plants. Grit and bar screenings consist mainly of sand, rags and other inert materials that present little risk at solid waste management facilities. This composition eliminates the need for specific evaluation in the industrial solid waste management plan.

Subitem (8) lists ash from boilers and incinerators using only wood as a fuel source as a waste requiring no specific evaluation for acceptance at a solid waste management facility. The ash generated from the burning of only wood is similar to the ash generated during a forest fire and presents no risk to the solid waste management facility. Therefore, no evaluation is required.

Item E requires the facility owner or operator to amend the industrial solid waste management plan whenever management practices or wastes included in the plan change. The amended plan must be submitted to the Agency for approval.

It is reasonable to require the plans to be amended and to be reviewed by the Agency because a change in wastes accepted at a facility or a management technique could have an impact on the ability of the facility to prevent harm to human health and the environment. It is the Agency's responsibility to ensure the protection of human health and the environment. Therefore, it is appropriate for the Agency to review the techniques used to manage wastes with a high potential for effects on human health and the environment.

3. Part 7035.2545 PERSONNEL TRAINING.

Subpart 1. General. This subpart requires all solid waste management facility personnel to complete a training program in the classroom, by on-the-job training, or in some combination of the two. The training must occur within six months after the effective date of the rules or after employment. The training must be recorded on the facility operating report and training dates reported on the annual report submitted to the Agency concerning the facility. The training program must provide facility personnel with sufficient expertise to operate the facility in a manner that protects the environment and that ensures compliance with performance standards contained elsewhere in the proposed solid waste rules. It is reasonable to require that all facility personnel take part in a training program specific to the facility they are responsible for operating because if management of the facility is not adequate, the result may be facility disruption or pollution of the environment. Facility personnel have the day-to-day operation responsibility and must understand the importance of their actions.

The proper operation of a facility is critical to its ability to meet performance standards and for distribution of the end-product. If not properly operated, a compost facility will not generate a product that meets specific quality standards for delivery to its consumers. A transfer facility may not store and deliver wastes properly if facility personnel are not aware of the consequences of their actions. It is reasonable that the Agency review the training programs in order that minimal program standards be addressed in each program. The Agency's review will ensure that all solid waste management personnel reach a minimal level of competence on the operation of their specific facility and are capable of handling emergency procedures to minimize facility impacts of a failure. By ensuring a base level of training at all facilities, the Agency will ensure all Minnesota citizens of protection when a solid waste management facility is operating.

Subpart 2. Owner or operator of a land disposal facility. This subpart requires that a certified operator be present at a land disposal facility during operating hours. This provision is a reminder of the requirements already in chapter 7048 of the Agency's rules. Chapter 7048 requires that land disposal facilities be operated by certified persons who have completed some level of classroom training, on-the-job experience, and continuing education. The technology in design, constructing, and operating a land disposal facility is rapidly changing. It requires an understanding how waste placement and the use of liners, leachate collection and treatment, and cover materials are integrated into a system to minimize the potential for ground water, surface water, land and air pollution. Therefore, training of the land disposal facility operator is important and this trained individual is needed at the facility to ensure proper operating policies are followed. Facility owners and operators will be reviewing the rules for basic design, construction and operation requirements. This subpart provides a specific provision with which they must comply.

Subpart 3. Minimum program requirements. This subpart describes the basic components to be included in all training programs. In establishing a minimum program by rule, the Agency informs the facility owners and operators of its concept of a basic, acceptable training program. Establishing basic requirements in a rule provides a consistent statewide approach to preparing facility personnel to properly manage solid waste at any facility. The items to be addressed in the training program are discussed in greater detail in the following paragraphs.

Item A requires training on using, inspecting, repairing and replacing facility emergency and monitoring equipment. Emergency and monitoring equipment alert personnel to the failure of facility equipment or dangerous situations at a facility such as gas leaks, pump failures, or pressure build-up. If these systems are not properly functioning, they serve little purpose. Facility personnel must be trained to know when to take actions to control emergency situations, who to call in local emergency personnel, and how to maintain the equipment in good working order. It is reasonable to require the training program to cover these areas because an uncontrolled emergency can endanger the health of facility personnel, disrupt facility operations, and impact the environment creating a need for corrective action.

Item B requires that all facility personnel be trained in activating communication and alarm systems. It is basic to protecting the integrity of the facility that alarm systems be activated when needed. Unnecessary activation of alarm systems will cause facility personnel to become complacent and not react in a timely manner, which endangers facility personnel and can increase the magnitude of the problem. A delayed alarm system can endanger facility personnel and seriously disrupt the facility. Requiring that the activation of communication and alarm systems be included in the training program does not present an additional burden to the facility owner or operator.

Item C requires training personnel on activating automatic waste feed cutoff systems. It is important that facility personnel be capable of activating waste feed cutoff systems to prevent the uncontrolled expansion of problems that have arisen at the facility. For instance, if a fire should occur in the waste processing areas of a refuse-derived fuel processing facility, the addition of combustible materials to this area would increase the potential for major damage to the facility, long-term disruption of the facility operations, and harm to human health and the environment. Training facility personnel to activate cutoff systems is relatively easy to do, requires no out of ordinary business activities, and can result in long-term savings of repair costs to the facility and the environment.

Item D requires that facility personnel be trained in responding to fires at a facility. Responding to fires may range from the extinguishing of small, segregated fires to activating the alarm system and calling local emergency personnel. It is important that the facility personnel be trained to eliminate an unnecessary delay in reacting to the situation. This requirement does not require the facility owner or operator to institute actions beyond sound business activities.

Item E requires training facility personnel to properly respond to facility failures, including erosion, liner disruption or monitoring devices. A facility is designed and constructed to meet specific performance goals. Should any portion of the facility fail, the facility owner or operator may be unable to monitor the facility performance or operate the facility to meet the performance goals. The failure of facility design features can cause the facility to exceed environmental performance standards and can be hazardous to human health. A gas monitoring system, if failing, may be unable to adequately detect the build-up of explosive gas in facility buildings, which could be set off at any moment by a spark or flame resulting in harm to human health and possibly the environment if the entire facility operations must cease. It is reasonable to require the training of facility personnel to respond to facility failures because the facility operation is integral to the meeting of performance standards, which have been established as control mechanisms for protecting human health and the environment.

Item F requires that facility personnel be trained to respond to ground water or surface water pollution incidents. These incidents may range from elevated levels of pollutants in monitoring well samples to a break in a sedimentation pond causing the discharge of large volumes of sediment into nearby surface water. Ground water or surface water pollution is a major indication of facility performance and can create widespread dangers to human health and the environment. A proper response to these incidents must be addressed in the facility personnel training program.

Item G requires the inclusion of accepting and managing of wastes other than mixed municipal solid waste in the facility personnel training program. This provision relates to the management of recyclables, waste tires, industrial solid waste, etc. It is important that these wastes not disrupt the management of mixed municipal solid waste or increase the potential for harm to human health and the environment by improper management. The management of incoming wastes is critical to the overall facility performance. Facility personnel must be adequately trained to manage these wastes.

Item H requires facility personnel to be trained in rejecting wastes not permitted at the facility. The facility owner or operator and the Agency work together in deciding the types of wastes that a particular facility can properly handle. The acceptance of a waste considered unacceptable for the facility increases the risk of violations of performance standards and disruption of facility operations. For instance, should a load of sludge be delivered to a transfer facility and accepted by facility personnel, there may be no storage or as transportation provisions at the facility resulting in the sludge being stored improperly or transferred to another facility after improper mixing in another load. Because the management of incoming wastes is critical to overall facility performance, it is reasonable to require that facility personnel be adequately trained to manage these wastes.

Item I requires facility personnel to be trained in water sampling. Water sampling and analysis is the most important method used to evaluate the performance of the facility. The ground water and surface water standards require that precise results be obtained from the analysis. The precise analytical results needed require that sampling methods be carefully controlled so that no potential pollutants are introduced into the sample causing misinterpretation of the water quality. If the facility owner elects to use a professionally-trained person to collect samples, it remains necessary that facility personnel be informed about the sampling protocol that will be followed. A specific protocol is used for collecting samples, including the number of samples taken, the equipment used, the order of sampling monitoring points, and the transportation of the samples to the analytical laboratory. The facility owner or operator will want a representative of the facility to accompany the sampler and ensure that proper methods are used in collecting samples for analytical results. Facility personnel must be trained regarding sampling at the facility because of the importance of the analytical results obtained from the samples and the need to minimize any outside pollutants into the sample.

Subpart 4. Training update. This subpart requires an annual review of the training provided facility personnel and more often if changes at the facility dictate such a need. It is reasonable to require an annual review of the training program because facility operations are not static and facility personnel must know how changes might affect facility operations.

4. Part 7035.2555 LOCATION STANDARDS.

This part sets out the areas where no solid waste management facility may be constructed or operated.

Subpart 1. Floodplains. This subpart prohibits the location of a new solid waste management facility in a 100-year floodplain. See definition of "floodplain" in proposed part 7035.0300, subpart 38. The establishment of a solid waste management facility in a 100-year floodplain increases the potential for the waste either being processed, stored, or disposed of at a facility to be washed away from the facility into surrounding areas. Additionally, the waste could stay within the flooding body of water and through this water's movement have a wider impact. The wash-out of waste from management facilities allows pollutants to be released into surface waters rendering recapture difficult or impossible. The disruption of facility operations due to the flooding waters can increase the potential for environmental damage. Prohibiting the location of new solid waste management facilities from 100-year floodplains avoids an increased risk of harm to human health and the environment.

Subpart 2. Other locations standards. This subpart addresses specific areas other than floodplains in which solid waste management facilities may not be located. The listed locations are found in many areas of the State and can affect the operational capabilities of facilities. The three areas where all solid waste management facilities are prohibited are discussed below.

Item A prohibits the establishment or construction of solid waste management facilities within shoreland areas governed by Minn. Rules chs. 6105 and 6120. Each county in Minnesota is required under these rules to develop shoreland management plans. These plans regulate the development of shoreland areas in order to protect them from detrimental impacts. Shoreland areas are intended to act as buffer zones for protection of surface water bodies from impacts associated with development. Prohibiting the construction of solid waste management facilities in these areas avoids the risk associated with the flooding of these facilities and releasing pollutants into surface water.

Item B prohibits the establishment or construction of solid waste management facilities in wetland areas. Wetland areas are protected from destruction because of their importance in maintaining an ecological balance between plants and animals that function either entirely on land or in water. Wetlands also act as a filter for surface water. Wetland areas and shoreland areas are environmentally sensitive due to the fragile balance maintained between the habitat provided for animals and plants and the potential destruction of the habitat by excess moisture, erosion, etc. The protection of these areas involves the need to disrupt them as little as possible.

Item C prohibits the establishment of solid waste management facilities in areas where the emissions of air pollutants would violate the ambient air quality standards. Prohibiting the location of solid waste management facilities in these areas avoids the inconsistency of allowing a facility to be constructed in areas where air quality standards will be violated and the facility owner or operator will immediately be faced with compliance actions.

5. Part 7035.2565 GROUND WATER QUALITY, SURFACE WATER QUALITY, AND AIR QUALITY AND SOIL PROTECTION.

This part establishes general performance standards to be met by all solid waste management facilities in order to protect air, land, and water.

Subpart 1. Duty to protect water. This subpart establishes a general water protection standard. All solid waste management facilities must be designed, constructed, and operated to contain sediment, solid waste and leachate and to prevent ground water and surface water pollution. If any releases occur and any pollution exists, the facility owner or operator must institute corrective actions. This subpart provides a general performance standard used to govern solid waste management facilities and is more precisely defined for each facility in later rules. This subpart explains the Agency's position regarding protection of the waters of the State and goals of facility design and operation. It is the responsibility of all persons managing solid waste to handle it in a manner that does not endanger human health and the environment. This provision clearly explains this duty.

Subpart 2. Designation of compliances boundaries, standards, intervention limits. This subpart provides for the establishment of compliance boundaries, standards, and intervention limits for mixed municipal solid waste land disposal facilities in permits, orders or stipulation agreements. The details for the establishment of these items are contained in the rule governing mixed municipal solid waste land disposal facilities. Compliance boundaries, standards, and intervention limits can be established for other solid waste management facilities if the Agency finds it necessary based on site conditions and the potential for ground water or surface water impacts. It is reasonable to establish compliance boundaries, standards, and intervention limits in the governing document for the facility because the facility design, site conditions, facility operations and waste characteristics are highly variable and no rule could adequately address all facility situations.

As discussed earlier, compliance boundaries are the point at which standards are enforced. The Agency believes the property boundary is not the appropriate point for enforcement purposes because if pollution is detected at the property boundary, there is a high probability that pollution exists off the property also. A property boundary or a compliance boundary is not a barrier capable of preventing the movement of ground water, gas, or pollutants from moving past the boundary. The compliance boundary provides a point or line where pollution can be detected before migration has occurred to any great extent, thus allowing for corrective actions to remedy the situation before off-site places are impacted. By designating the compliance boundary in a permit, order, or stipulation agreement, the Agency is able to be more responsive to facility-specific conditions and designs.

Standards and intervention limits are quantitative figures used to judge the performance of solid waste management facilities. The values for these factors are established in proposed rule part 7035.2815, subpart 4. However, this subpart also provides for deviation from the established values under specific conditions, e.g., existing facilities not designed for leachate containment. In order for the facility owners or operators to know the value applied to their facility, some documentation is needed. The place for this documentation is in the governing document for the facility because it specifies the design, construction, and operation requirements as well. This allows facility owners and operators to be totally informed about their compliance requirements in a single document, eliminating any potential confusion.

Subpart 3. Air quality protection. This subpart prohibits open burning of solid waste in accordance with parts 7005.0700 to 7005.0820 and requires all solid waste management facilities to operate and maintain the facility in conformance with the Agency air pollution control rules, parts 7005.0010 to 7005.3060, of which the open burning prohibition is a part. The air quality protection standard in the proposed rule is an existing set of standards applicable to all facilities. This provision serves as a reminder to facility owners and operators, makes it explicit that the standards apply to solid waste management facilities, and does not represent an extra burden to the facility owner or operator.

Subpart 4. Soil protection. This subpart requires that the design and construction of solid waste management facilities be done in a manner capable of minimizing the pollution of soils from solid waste. This provision excludes soil liners as they are intended to provide some attenuation capacity for pollutants thereby treating the leachate. The soils on or near a facility should be equally as important as air or water and should be protected in a like manner. In Minnesota, the land is used for agricultural activities, forestry activities and recreational activities giving it a high value and need for protection, making this a reasonable standard for the development of solid waste management facilities.

6. Part 7035.2575 OPERATING RECORD.

The provisions of this part set out the required contents of an operating record to be maintained at all solid waste management facilities.

Subpart 1. Record requirement. This subpart requires that all facility owners and operators keep an operating record at the facility. The operating record tracks activities at the facility and shows compliance or noncompliance and follow-up procedures followed during periods of noncompliance. The operating record provides a history of site maintenance activities. Requiring an operating record is a normal practice in operating a facility in a manner to minimize risks associated with handling wastes; it is a tool in determining performance; and it will not be an extra burden to the facility owner or operator.

Subpart 2. Record information. This subpart establishes the type of information the Agency requires to be included in all operating records. This subpart also requires that all operating records be kept for a minimum of five years or until any pending enforcement action is resolved. It is reasonable for the Agency to establish by rule the minimum information to be kept in an operating record because it provides data on day-to-day activities, which could be the cause of enforcement actions. The record also alerts the facility owner and operator to the Agency's informational needs for compliance determinations. The specific items to be maintained in the operating record are discussed in greater detail below. Five years is a reasonable time to maintain operating records because it coincides with permit time periods, and provides for a review during repermitting to determine if modifications to the facility or permit are needed.

Item A requires the facility owner or operator to maintain a record of the amount of mixed municipal solid waste received each day, the management techniques used, and the date received. The amount of waste received may be reported by weight only if scales are available at the facility. It is reasonable to require the facility owner or operator to maintain this information because it is needed to evaluate the amount of waste processed compared to revenues taken in, land disposal capacity used, or end product produced. Maintaining this information in the operating record does not present an additional burden to the facility owners or operators.

Item B requires that the operating record maintain detailed information on industrial solid waste managed at the facility. This information must include the amount and type of waste received each day, the generator's name, the point of generation, and the method of handling the waste. Each waste type must be recorded separately. The information regarding industrial solid waste should be maintained separately in the operating record because, if a release occurs or facility operations are disrupted, industrial solid waste records can be reviewed to determine if industrial solid waste may be the cause of the release as has happened in the past.

Item C requires land disposal facility owners and operators to maintain a record of the location of industrial solid waste received at the facility in quantities greater than 10 cubic yards at any one disposal event. Should a problem arise at a land disposal facility related to compliance with operating and performance standards, the removal or treatment of a specific waste may alleviate potential long-term effects associated with a problem. For instance, an existing facility accepted a load of industrial solid waste that was later found to be hazardous from a particular generator. Because the facility owner or operator knew where the waste had been deposited, the generator was able to remove the waste and properly manage it at a hazardous waste facility. It is reasonable to include this provision in the operating record because of its use in the overall risk management plan of each facility. The facility owner or operator will, with this knowledge, be able to better assess areas that may require closer scrutiny during the postclosure care period or while operating the site. In this way, the facility owner or operator will be able to minimize the potential for impacts on human health and the environment from the facility.

Item D requires the facility owner or operator to retain all summary reports and details of incidents requiring the implementation of the contingency action plan regarding ground water or surface water pollution as part of the operating record. The operating record is used in evaluating the performance of a facility and in determining measures to improve facility operations through modifications to the facility design and construction before a small situation becomes a large problem. By making the summary reports a part of the operating record, the facility owner and operator will be able to provide a complete informational report on the performance of the facility and how it has been maintained. The summary reports are generated in direct response to a specific situation; this provision only indicates where the report must be maintained.

Item E establishes the need to record all inspection results. The facility owner or operator must, under part 7035.2535, subpart 4, regularly inspect all facility systems to determine their condition. The facility owner or operator following normal business practices maintains a log of the inspections in order that any repair needed may be completed. This provision does not require additional work by the facility owner or operator.

Item F requires that all monitoring, testing, or analytical data generated must be maintained in the operating record. This information is gathered as a specific requirement of other proposed rules. This item indicates where the information is to be maintained and for the time period it is to be retained. This information does not require extra work on the part of the facility owner or operator.

7. Part 7035.2585 ANNUAL REPORT.

The owner or operator of any solid waste management facility must submit an annual report to the Agency as required under this part. The annual report must be submitted no later than February 1 for the preceding calendar year. The Agency will provide the facility owners and operators with acceptable forms that may be used in lieu of them developing individual report forms. The annual report provides a summary of the year's activities at the facility. This information is used to review the performance of the facility as well as the State's progress in managing solid waste. The Agency's providing of forms to complete the annual report will provide a consistent data base for the Agency's review process and provide the facility owner an understanding of the Agency's needs in form and content. The Agency is responsible for solid waste management throughout the State and only by understanding the facility activities for each year can the Agency draw effective and reasonable conclusions for changes in State policy. The specific items to be addressed in the annual report are discussed in greater detail below.

Existing solid waste rules require quarterly operating reports from facility owners or operators. In preparing the proposed set of rules, the Agency reviewed its need to have quarterly reports compared with annual reports. The Agency believes under normal operating procedures an annual report provides sufficient information to evaluate a facility's performance. Other provisions of this rule provide for interim reports, if incidents of the facility dictate a need. The annual report does not decrease the Agency's ability to review facility performance.

Item A requires that the annual report contain the facility permit number, name and address of the solid waste management facility. It is reasonable to require this basic identifying information to allow accurate review of specific permit requirements for the facility against actual operating conditions.

Item B requires noting on the annual report the year covered by the report. This information is needed for accurate filing and review of the annual report and is easily accomplished by the facility owner or operator.

Item C requires the annual report to discuss the type and quantity of each type of waste handled at the facility. This information provides information on the amount of solid waste generated in Minnesota, how the waste was managed, and what type of facilities managed the waste. The Agency will use the information to compare permit conditions for facilities against actual activities. This information is maintained by the facility owner or operator as a matter of course. Requiring it does not present an additional burden on the facility owner or operator, while providing significant information regarding solid waste management in Minnesota.

Item D requires the facility owner or operator to make a determination of remaining capacity for storage or disposal based on the amount of waste received at the facility and the original site capacity approved. This determination allows the facility owner or operator and the Agency to evaluate future capacity needs for solid waste management. For mixed municipal solid waste land disposal facilities, this information becomes critical in determining remaining capacity as issued in the Certificate of Need for the county or facility. Minn. Stat. §§ 115A.917 and 473.823 require all mixed municipal solid waste land disposal capacity to be determined based on comprehensive solid waste management plans. This capacity is based on a ten-year planning period. The information supplied in the annual report will be used to evaluate the rate at which the capacity is being used, how valid the solid waste management plan is, and what steps should be taken, if any to conform with the solid waste management plan.

Item E requires the submittal of rate changes at the solid waste management facility for the year and anticipated charges for the upcoming year. Data on solid waste management costs are necessary and valuable for determining the best solid waste management system. An understanding of where waste is being managed and the costs associated with the management choices better explains how or why wastes reach their final disposal sites. The information on rates is also used in determining the amount of money to be set aside in financial assurance funds for facility owners and operators who have found the cost to be prohibitive and have shown the need for reduced payments under part 7035.2705, item D. In order for the Agency to understand the burden of calculated financial assurance payment rates, the Agency must also have a statewide perspective on the costs associated with facility operations similar in size, design and operation. The information on solid waste management rates must be evaluated by facility owners and operators to determine operating budgets. The reporting of these rates does not require extra calculations by the facility owner or operator while providing necessary information on the solid waste management costs in Minnesota.

Item F requires the submittal of most recent cost estimates for closure, contingency action, and, for disposal facilities, postclosure care. Other proposed rules require the facility owner or operator to update cost estimates for closure, contingency action, and postclosure care at least annually and whenever changes at the facility cause a change in those areas. The Agency is responsible to ensure that sufficient funds are available at mixed municipal solid waste land disposal facilities, in particular, to complete the actions under closure, contingency action, and postclosure care. Without updated costs by the facility owner or operator, the Agency would be unable to ensure that the necessary funds are available. Recent cost estimates are used by the facility owner or operator to determine costs at the facility for the upcoming year. The reporting of the cost estimates does not require additional work of the facility owner or operator.

Item G requires the facility owner or operator to review and discuss the adequacy of the facility closure, contingency action, and postclosure care plans. These plans are used to calculate funds needed to establish the financial assurance instruments required under parts 7035.2665 to 7035.2805. The plans are the guiding documents under which the facility owner completes particular actions to close the facility, take corrective actions to remedy problems at the facility, and monitor the facility after closure. If the plans are not routinely updated to reflect changing costs, work completed, and facility design changes, the facility owner or operator will be ill-prepared at the time the plans must be implemented. The Agency is responsible to insure that the actions under these plans can be adequately completed to protect human health and the environment. By having the facility owner or operator complete the adequacy assessment, the proposed rules allow for facility-specific changes to be incorporated into the review.

Item H requires a summary report on the ground water monitoring program. Other proposed rules establish a specific ground water monitoring program for land disposal facilities, in particular, and for other facilities, if needed. The ground water monitoring program is a critical factor in determining the adequacy of a facility's performance. The annual review provides for an understanding of changes in ground water quality that may indicate a facility failure requiring corrective changes in facility design, construction, or operation. An annual review provides an early review and finding of problems before these problems become large, impacting areas beyond the facility boundaries. The summary report is a reporting of the yearly analytical results and an analysis of trends shown by these results. The annual review will provide the facility owner or operator the earliest warning about the facility's performance resulting in cost savings to the facility owner or operator.

Item I requires the submittal of facility-specific operation reports completed under specific proposed rules for demolition debris land disposal facilities, compost facilities, recycling facilities, and refuse-derived fuel processing facilities. These reports require the facility owner or operator to summarize the amount of waste managed at the facility, the methods used to manage the wastes, and any analytical results for monitoring tests taken during the year at the facility. For instance, the owner of a compost facility must submit the analytical results on the quality of compost generated at the facility and end-use distribution of the final product. This provision of the proposed rules does not require additional work by the facility owner, but only a summarization of daily operating records.

Item J require the facility owner or operator to submit with the annual report a record of all personnel training provided during the previous year. Proper personnel training is critical to good facility performance and protection of human health and the environment. The Agency is responsible to ensure that a program exists at each facility for training personnel not only about their specific job function but also emergency response actions. The submittal of training records provides the Agency with the opportunity to verify the training program at each facility and critique its effectiveness in facility performance.

Item K requires the facility owner or operator to certify the accuracy of the information in the annual report. This certification ensures that the facility owner or operator is aware of how the facility is performing and the actions needed to improve facility performance, if appropriate. This knowledge allows the facility owner or operator and the Agency to work from a common understanding of facility performance to protect human health and the environment. This provision does not create any additional work by the facility owner or operator.

8. Part 7035.2595 EMERGENCY PREPAREDNESS AND PREVENTION.

This part sets out the program the facility owners or operators need to establish to adequately respond to emergencies at the facility.

Subpart 1. Design and operation of a solid waste management facility. This subpart requires all facility owners and operators to design, construct, maintain, and operate their facilities to minimize the possibility of a fire, explosion, or any release to air, land, or water of pollutants that would threaten human health and the environment. This provision reminds all facility owners and operators of their responsibility to prevent impacts on human health and the environment. It is reasonable to establish such a responsibility for all facility owners and operators because the management of solid waste has a potential for impacting human health and the environment whether the facility is used to transfer, to process, or to dispose of wastes. Because of the variability in facility management activities no rule could adequately specify provisions to minimize the possibility for a fire, explosion or impacts on human health or the environment. Therefore, it is reasonable to provide a general performance standard allowing for facility-specific designs to be developed to address this standard.

Subpart 2. Required equipment. This subpart describes the minimum amount of equipment that must be maintained at all solid waste management facilities for use in an emergency situation. Item A requires assistance-summoning communication devices and item B requires the maintenance of fire extinguishers and fire control contracts. The provisions of this subpart include the equipment, design and operation requirements needed to minimize the possibility of serious hazards to human health and the environment due to fires, explosions or unplanned releases of solid waste or other pollutants.

Subpart 3. Testing and maintenance of equipment. This subpart requires the facility owner or operator to test emergency equipment at least annually and maintain all equipment in operating conditions. The incorporation of emergency equipment into a facility design and operation program is intended to minimize serious hazards to human health and the environment. If this equipment is not maintained in proper working condition, the facility personnel will be unable to take the actions necessary during an emergency.

Subpart 4. Arrangements with local authorities for emergencies. This subpart requires all solid waste management facility owners and operators to work with local police and fire departments on the response to emergencies at the facility. Facility owners and operators should meet with the local authorities who should respond to an emergency at the facility. These responders need to know the facility layout and the properties of the waste they might encounter so that proper precautions can be taken against personal injury and proper equipment made available for responding to the emergency.

Subpart 5. Procedural manual. This subpart requires all solid waste management facility owners and operators to prepare and maintain a procedural manual for facility personnel use during an emergency. The procedural manual must contain a number of items critical to the timely and proper response to emergency situations. The development of the manual will minimize hazards to human health and the environment in most events of fires, explosions or releases of solid waste or other pollutants to air, land, or water by increasing facility personnel's awareness of the types of emergencies that might occur. A procedural manual will also decrease response times to such occurrences because proper response procedures are clearly delineated. The items to be included in the manual are further discussed below.

Item A requires the manual to include a list of names and telephone numbers of local fire and police departments. Including this information in the manual provides a central, easy-to-locate reference for these numbers, thus minimizing response time in an emergency.

Item B requires the facility owner or operator to list emergency equipment available at the site and briefly describe when and how the equipment will be used. Since the emergency procedural manual is submitted with the facility's permit application and maintenance and compliance with it becomes a condition of the permit when approved, it is reasonable that the manual address emergency equipment available at the facility to minimize hazards to human health and the environment. The Agency is responsible to review the manual to determine the adequacy of procedures to be followed by facility personnel in the event of an emergency.

Item C requires the facility owner or operator to specify steps to be followed during an emergency. These procedures are to explain exactly how facility personnel will respond to an emergency until the situation is corrected or the contingency action plan is activated. These procedures should include a facility coordinator, notification procedures to local authorities and the Agency, control measures to be initiated, and how cleanup after the emergency will be completed. One person should be in charge during an emergency with the responsibility and authority to direct response actions to the emergency. This will assure proper and timely actions will be taken in an emergency, thus minimizing the hazards associated with the situation. The Agency must be able to review the procedures anticipated for emergency situations to ensure that control measures are enacted quickly to control any potential pollutants from endangering human health and the environment.

Item D requires the facility owner or operator to describe in the procedural manual the prior arrangements made with local police and fire departments. It is reasonable to have these arrangements included in the procedural manual because it commits the facility owner or operator and the local authorities to specific actions during an emergency. This also provides the Agency assurance that local authorities are aware of the hazards associated with a particular facility and any special requirements needed to respond to emergencies at the facility.

Subpart 6. Assessment of hazards. This subpart requires all solid waste management facility owners and operators to assess the possible hazards to human health and the environment from a release, explosion, or fire. This subpart also requires the facility owners and operators to notify the Agency within 48 hours after a release, explosion, or fire. These hazards must be understood for the facility owners and operators to develop emergency procedures capable of minimizing impacts to human health and the environment. The facility owner or operator should notify the Agency in the event of a release, explosion or fire because Agency personnel could assist in responding to the emergency. The notification also allows the Agency to initiate proper technical and administrative procedures to address the situation.

9. Part 7035.2605 EMERGENCY PROCEDURES.

This part sets out the minimum procedures to be followed by solid waste management facility owners and operators in preparing for and dealing with emergencies.

Subpart 1. Containment measures. This subpart requires facility owners and operators to take all reasonable measures to ensure fires, explosions, and releases do not occur, recur, or spread. Liquids that have come in contact with the waste during an emergency response action must be contained, recovered, and treated. These performance standards establish a common understanding of what the Agency expects the facility owner or operator to do to prevent liquids from migrating off-site during an emergency response action and impacting human health and the environment. It is important to deal appropriately with liquids because they have been in contact with materials capable of releasing pollutants or becoming pollutants, thereby endangering human health or the environment if mismanaged. Because unexpected and unplanned events can occur at a facility leading to an emergency situation, the general performance standard requires the facility owner or operator to take reasonable actions to prevent emergency situations rather than a provision dictating total prevention of the possible scenarios from happening. No one specific set of standards can be applied to the variety of facilities managing solid waste. The emergency procedures used at a facility are to protect human health and the environment generally as well as address the situation at hand.

Subpart 2. Report. This subpart requires facility owners and operators to submit a written report to the Agency within two weeks after an emergency. The report must address the nature of the emergency and the procedures used to minimize potential hazards to human health and the environment. After the emergency is under control, the facility owner or operator must refer to the contingency action plan to determine the necessary follow-up actions. The facility owner or operator must also assess the emergency procedures used and make appropriate changes. The report is needed to enable the Agency to evaluate whether the emergency procedures addressed the situation and whether a change is necessary. The report supplies information necessary to ensure procedures established at facilities are adequate to protect human health and the environment.

10. Part 7035.2610 CONSTRUCTION CERTIFICATION.

This part requires the Agency's approval of the construction for any design feature at a new or existing facility. The construction must be certified by an engineer registered in Minnesota and the facility owner or operator. The construction certification must describe any design features constructed different than approved in the permit. All as-built plans, test results, samples taken and modifications must be included in the certification. A site inspection by the Agency must be conducted before approval is granted. The facility owner or operator may not open or place into operation any design feature before the Agency's approval is granted. A construction certification for all design features is the Agency's source of information for comparing the design approved in a permit against actual construction results. This comparison should result in a determination by the Agency that the facility has been constructed in a manner to protect human health and the environment. Prohibiting the use of these features until the Agency approves the construction certification should prevent harm to human health or the environment by a design component constructed below standards.

11. Part 7035.2615 CONTINGENCY ACTION PLAN.

This part sets out the standards by which a facility owner or operator must develop a contingency action plan.

Subpart 1. General requirements. This subpart requires all solid waste management facility owners and operators to prepare and maintain a contingency action plan. The plan must identify occurrences that would endanger human health and the environment and establish procedures to minimize these hazards. The Agency will review and approve this plan prior to the issuance of a facility permit. The plan enables the facility owner or operator to initiate corrective actions at the appropriate times rather than merely proposing a course of action. A timely response will minimize the potential hazards to human health and the environment. The plan provides the facility personnel with information on what to do and who to contact in the event of an emergency. The plan will ensure facility personnel are aware of possible occurrences to prevent them or minimize their impact.

Subpart 2. Implementation of plan. This subpart requires the facility owner or operator to implement the contingency action plan within the period specified in the plan to minimize adverse effects on human health and the environment. The intent of the contingency action plan is to provide a proper response to a potential pollution or injurious situation. Because of the variability in facility design, location, and operation, no one reaction time can be established by rule. Allowing the contingency action plan to reflect facility-specific conditions ensures that the facility owner or operator can meet the needs of the situation.

Subpart 3. Content of contingency action plan. This subpart outline the specific areas that must be addressed in a contingency action plan. Establishing by rule the contents of all contingency action plans provides consistency in level of effort by all facility owners and operators and ensures response actions are available to repair problem situations. By establishing the areas to be addressed in a contingency action plan, the rule provides guidance to the facility owner or operator on what the Agency expects in the plan, yet allows sufficient flexibility for the plan to reflect specific facility conditions. The variability in facility design makes the establishment of one contingency action plan in a rule unfeasible. The specific items to be discussed in the contingency action plan are discussed in greater detail below.

Item A requires facility owners and operators to identify the possible events that may need corrective action. These events may include violations of intervention limits or water quality standards, failure of design features, settlement of completed fill areas, surface drainage problems, and excessive delivery of waste to the facility for management. Some concern was expressed by reviewers of the proposed rules that no list of specific events to be addressed in the contingency action plan is included in the proposed rules. They felt that contingency action plans would be more consistently developed if all facility owners and operators were required to address the same events. Additionally, they felt the general statement afforded the Agency an opportunity to be arbitrary and capricious in its review of the plans as no specific guidelines are presented in the rules for either Agency staff or facility owners and operators.

The Agency believes that a rule could not contain the numerous possibilities of events requiring implementation of a contingency action plan. Within each class of solid waste management facility types, there are many design options. Each possible design option comes with a different set of potential events requiring corrective actions. For instance, a land disposal facility lined with a synthetic membrane will have different concerns than a facility lined with clay soils. A single rule cannot address all possibilities. The rule contains general guidelines for the types of events that should be addressed in the contingency action plan. However, additional events will need to be addressed in particular facility plans. Because the contingency action plan becomes a condition of a facility permit, it is critical that the plan reflect actual facility conditions and not merely address a list of possible events presented in a rule. The process of closely evaluating facility conditions in developing a contingency action plan will give the facility owner or operator a better understanding of the facility design and operation. This knowledge will allow the facility owner or operator to better prepare and prevent the types of events that would cause the need to implement corrective actions.

Unless two facilities are designed, constructed, and maintained in exactly the same manner, the review of the contingency action plan cannot be exactly the same. The contingency action plan is intended to address events that would adversely impact human health and the environment if no corrective actions are taken. The plan is not intended to address issues such as typewriter breakdowns and lack of office supplies. Surface water drainage at any facility is an issue because surface water coming in contact with solid waste may leach pollutants from the waste, carry them over land to a receiving stream, and cause both soil pollution and surface water pollution; whereas, the quality of end product from compost facilities can only be reflected in contingency action plans for these facilities. Common sense must dictate the events to be addressed in a facility-specific contingency action plan.

Item B requires the facility owner or operator to describe the actions, sequence and timetable for initiating and completing these actions, and the costs associated with each corrective action. In order to minimize the hazards associated with any event requiring corrective actions, the facility owner must assess what corrective actions are involved in each event. Without some planning on the facility owner's or operator's part, long delays may be experienced before corrective actions are taken by facility personnel or greater harm may result from improper actions. If the operator at a refuse-derived fuel processing facility does not understand the need to shut down feed mechanisms in the case of a fire, the fire may be intensified by the additional waste added to the already burning waste. The time involved in starting and completing corrective actions is critical to the proper scheduling of solid waste management while corrective actions are in progress. The need to shut down operations during corrective actions forces the facility owner or operator to address the availability of facility storage capacity, disposal options or processing techniques. The need for approval of land disposal capacity presents a particular problem. For instance, a compost facility receiving more waste than it can process may be forced to reject incoming waste. This rejected waste must then be processed at another facility or be delivered to a mixed municipal solid waste land disposal facility. It is reasonable that the facility owner or operator address the corrective actions intended to resolve a particular situation and the schedule for completing these actions because the Agency needs to review the intended actions to ensure these responses will adequately protect human health and the environment.

The facility owner or operator will use the costs associated with planned corrective actions to develop budget projections and set tipping fees needed to cover these costs. Requiring that the contingency action plan contain cost estimates for the projected corrective actions ensures sufficient funds will be available should corrective actions be necessary.

Item C requires the facility owner or operator to discuss the equipment needed to undertake corrective actions and its on-site and off-site availability. That information ensures proper equipment is available to respond to the events and that facility personnel are aware of what equipment is to be used during specific corrective actions.

Item D requires that any prior arrangements with contractors be discussed in the contingency action plan. A discussion on arrangements the facility owner or operator has with particular contractors provides the Agency with information to be assured timely actions can be taken to correct problems at the site. Timely response to events requiring corrective actions is critical to minimizing harmful impacts on human health and the environment.

Item E requires the facility owner or operator to discuss what actions will be followed during planned and unplanned down times for maintenance at the facility. Waste will continue to be generated during those periods. The facility owner or operator must plan for how the waste will be managed during these periods. If waste is to be diverted to a mixed municipal solid waste land disposal facility, the projected volumes must be calculated into the design and operation plans for the land disposal facility. If industrial solid waste is not accepted at the facility, the waste generator and facility owner or operator should work together to find a suitable alternative facility. It may be possible to store the waste in designated areas at the waste management facility until processing can be renewed. The occurrence of an event is not an acceptable reason to manage solid waste in a manner that will not protect human health and the environment. The Agency will use this information to ensure the facility owner or operator has made suitable plans for solid waste management during down times at the facility.

Item F requires the contingency action plan to include cost estimates for each type of corrective action addressed in the plan. The most costly corrective action that may be required at a facility must be included in the plan. Such incidents may include supplying a new drinking water source for private homes, reconstruction of portions of a refuse-derived fuel processing facility due to a fire or explosion, or reinstallation of a liner beneath an area used for composting solid waste. Cost estimates in the contingency action plan are used to determine financial assurance funds needed to ensure sufficient money is available should the need for corrective actions occur.

Subpart 4. Amendment of contingency action plan. This subpart requires the facility owner or operator to review and amend the contingency action plan whenever: the facility permit is reissued (item A); the plan did not provide for an adequate response to a facility failure or release (item B); or the design, construction, maintenance, or operation of the facility changes so as to require modifications to the response proposed for a failure or release (item C). The contingency action plan is intended to provide timely and adequate responses to facility failures, releases, or other unplanned events that may lead to impacts on human health and the environment. In order to meet these goals, the plan must be updated to meet the needs of the facility.

Subpart 5. Copies of the contingency action plan. This subpart requires that a copy of the contingency action plan and any revisions to the plan be submitted with the facility permit application. Compliance with the plan becomes a condition of the facility permit and the plan must be maintained at the solid waste management facility. The contingency action plan is to be followed by the facility personnel in the event of failures and releases. It must be maintained at the facility.

12. Part 7035.2625 CLOSURE.

This part sets out the minimum requirements for the development of a closure plan by facility owners and operators and the times when a facility must be closed.

Subpart 1. Closure. This subpart addresses the circumstances under which facility owners and operators must cease to accept waste and close the facility. The circumstances the Agency believes, if allowed to continue, will have serious impacts on human health and the environment are the circumstances that will cause the Agency to revoke the facility permit and require closure.

This subpart requires the facility owner or operator to cease accepting waste and close the facility if any of the specific conditions defined in items A to I exists. Closure must be completed in accordance with closure provisions contained in the facility permit, this part, part 7035.2635 and parts 7035.2815 to 7035.2875. The procedures are necessary to ensure that solid waste management facilities are closed in a way that will protect human health and the environment. The general closure procedures of this part and part 7035.2635 apply to all solid waste management facilities because there are activities that need to be completed at the time of closure at all facilities, and owners and operators should be made aware of them in rules to ensure consistency between facilities. Specific closure standards established in parts 7035.2815 to

7035.2875 and in facility permits address specific conditions found at particular types of facilities.

Item A acknowledges that the facility owner or operator may elect to close a facility at any time. The Agency can not require an owner or operator to continue a business after a decision is made to discontinue operations.

Item B requires closure at land disposal facilities when all fill areas have reached permitted final grade. At this point the site has no room to accept additional solid waste without increasing the potential for harm to human health and the environment. No additional waste should be brought to the site and proper closure activities should be initiated.

Item C requires closure when a facility permit expires and the facility owner or operator does not apply for renewal of the permit or the Agency does not reissue the permit. Closure activities must be initiated when a facility is no longer permitted because the permit is the controlling document for facility operation. If the permit is no longer in effect operations should cease and steps be taken to mitigate any potential problems taken.

Items D and E refer to enforcement actions taken by the Agency. The facility must be closed when the Agency modifies or revokes a facility permit or issues an order to cease operations. These actions are taken by the Agency in circumstances where continued operation of the facility would pose a threat to human health and the environment. These provisions inform facility owners and operators that, if such action is taken by the Agency, the facility is to be closed in accordance with the procedures and standards specified in the rules and the facility permit.

Item F requires the closure of all unpermitted land disposal sites. In 1970, the Agency first published a set of solid waste rules requiring all final disposal sites to be permitted. Part 7035.2300 required all nonconforming sites to be brought into compliance with the rules by July 1, 1972. During the period between 1970 and the proposal of these rules, the Agency has been working with local governments to bring the disposal sites into compliance, either through the permitting process or closure. The Agency believes the seventeen years since the original solid waste rules were enacted have been sufficient for site owners to have instituted proper activities to obtain a permit or close the facility. This subpart once again alerts owners and operators of unpermitted land disposal facilities to their responsibility to obtain a permit for operation of a facility.

Item G requires the closure of a facility if certified capacity for the disposal of mixed municipal solid waste is no longer available. Minn. Stat. §§ 115A.917 and 473.823 require a Certificate of Need before mixed municipal solid waste land disposal facility permits can be issued. If a Certificate of

Need has been fully utilized, the Agency is not allowed by statute to permit the facility to continue accepting mixed municipal solid waste. When the certified capacity has been exhausted, the waste management activity is no longer permitted at the facility and steps must be taken to mitigate any adverse impacts on human health and the environment.

Item H requires closure of the facility if the owner or operator cannot maintain the required financial assurance for closure, postclosure care and contingency action. The closure provision is consistent with the requirements of parts 7035.2665 to 7035.2805 and alerts the facility owner or operator to the duty to close upon noncompliance. If closure were not required when financial assurance funds are not maintained, the financial assurance mechanism would mean little and funds would not be available to ensure proper closure. This could lead to impacts on human health and the environment. Additionally, financial responsibility is required by Minn. Stat. § 116.07, subd. 4h as a condition of retaining a permit.

Item I requires the closure of unpermitted facilities, which are not land disposal facilities, required to have permits but have not applied for permits within 180 days of the effective dates of parts 7035.2525 to 7035.2875. The determination to permit these facilities is based on the potential risk associated with the chosen management process. The potential risk for impacts on human health and the environment will increase if such facilities are allowed to operate without a proper controlling document.

Subpart 2. Closure performance standard. This subpart establishes a general performance standard for the closure of all solid waste management facilities. This standard requires the facility owner or operator to take all steps necessary to eliminate, minimize, or control the escape of pollutants to ground or surface waters, soils, or the atmosphere during the postclosure care period. This is basically the same standard as for operating facilities. There is no reason the standard for a closed facility should be lower. All solid waste management facilities should be closed in accordance with this performance standard because some risk to human health and the environment exists at all facilities. This provision alerts the facility owners and operators to the Agency's expectations for facility closure.

Subpart 3. Submittal and contents of closure plan. The objective of this part is to ensure that all solid waste management facilities are closed in a manner that will protect human health and the environment. The Agency believes that planning in advance of closure is needed for this objective to be met. Therefore, facility owners and operators are required to prepare and submit a closure plan for review and approval. Compliance with the approved plan then becomes a condition of a permit, order, closure document, stipulation agreement or other enforcement document of the Agency. Unpermitted land disposal site owners must submit a closure plan within 90 days of the effective date of parts 7035.2525 to 7035.2875.

Preplanning by facility owners or operators is critical to estimating the amount and type of solid waste that must be handled at closure. Without adequate planning, long periods of time may pass before waste is removed, sufficient cover is placed, or equipment dismantled. The plan is used to estimate costs for use in developing proper financial assurance funds. The plan serves as an impetus to adequate planning and funding and provides the Agency with an opportunity to prevent harm to human health and the environment that might result from inadequate closure.

A copy of the approved closure plan and all revisions must be maintained at the facility. At the time of closure, the Agency will issue a closure document governing closure and postclosure care activities at the facility. Since the facility owner or operator must follow the closure plan in order to adequately perform closure activities, a copy of the approved plan must be kept at the facility for easy reference.

The closure plan must identify steps needed to close each fill phase, if appropriate, and the entire site at the end of the facility's operating life. In order to evaluate if the facility will be properly closed using the closure plan, the Agency needs to know how and when the facility will be closed (item A) and the maximum inventory of wastes to be stored at the facility at any time during the life of the facility (item B). The Agency also needs to know the cost estimates for closure of the facility and the schedule for the closure procedures of part 7035.2635 and parts 7035.2815 to 7035.2875 (item C). This information will help ensure that adequate funds are available for closure and that closure will be properly completed. Requiring this information will enable the Agency to review and approve the closure plan to ensure closure activities will take place in a timely manner and the facility will be closed in a manner to protect human health and the environment.

Subpart 4. Amendment of plan. This subpart informs the facility owner or operator to the changes in circumstances that the Agency believes require an amendment to the plan. It also authorizes the facility owner or operator to amend the plan at any time. The facility owner or operator may choose to amend the plan if it seems necessary based on information available to the owner or operator. The closure plan must be amended if changes in the operating plan or facility design affect the closure procedures or if the expected year of closure changes. The circumstances affecting the facility may change during the facility's operating life, and a provision is needed to change the plan to allow for the changes in the facility design or operation. The amended plan must be submitted for review and approval. Since the Agency is responsible for reviewing and approving the initial closure plan, amendments to the plan must also be reviewed and approved to ensure that the amendments provide for proper and timely closure of the facility.

Subpart 5. Notification of final facility closure. This subpart requires the facility owner or operator to notify the Commissioner at least 90 days before final closure activities are to begin. If the facility permit has been terminated and a closure document issued, this provision does not apply. The notification is needed to allow the Agency to review the alternative solid waste management scheme intended to be followed after closure to ensure it will adequately handle the waste, to ensure sufficient funds are available to achieve proper closure, and to schedule the necessary construction inspections during closure activities. The Agency is responsible to ensure closure activities are completed in a manner that protects human health and the environment. Requiring the facility owner or operator to notify the Agency of planned closure activities does not require additional work on the part of the facility owner or operator, who must schedule the closure work in advance to take into account weather and contracts needs.

13. Part 7035.2635 CLOSURE PROCEDURES.

This part sets out the procedures necessary to close a solid waste management facility in a manner that protects human health and the environment.

Subpart 1. Completion of closure activities. This subpart requires the facility owner or operator to begin final closure activities within 30 days of receiving the last shipment of waste. Closure activities must be completed in accordance with the approved closure plan, closure document, or stipulation agreement. The Commissioner may allow a longer schedule than established in these documents if factors beyond the facility owner's or operator's control impact the activity. However, the longer a facility remains uncovered or unattended, the greater the possibility of damage to the facility resulting in harm to human health and the environment. The financial assurance requirements also make it reasonable to have time constraints for closure activities so that the Commissioner may gain access to the funds if the facility owner or operator fails to comply. The time constraints should be established on a facility-specific basis rather than in rule to allow for differences in facility operations exist.

Subpart 2. Closure procedures. This subpart sets forth the minimum procedures required to close a facility so that human health and the environment are protected.

Item A requires the facility owner or operator to complete the activities outlined in the approved closure plan, closure document, stipulation agreement, and parts 7035.2815 to 7035.2875. They have been established, reviewed, and approved based on their appropriateness to protect human health and the environment. These documents are already required in other parts of the proposed rule; this item does not require extra work of the facility owner or operator. This item merely reminds the facility owner and operator of the documents and proposed rules that govern closure activities.

Item B establishes specific procedures to be followed at the time of final closure of any solid waste management facility. These procedures are applicable to all facilities; therefore, including them in the rule will alert facility owners and operators to the standards the Agency will require at final closure.

Subitem (1) requires that a notice be posted at the facility entrance at least 60 days before final closure indicating the date of closure and alternative solid waste management facilities. Such a notice will inform the public that the facility will be closed and not be accepting solid waste, and where the waste may be delivered. Such information will allow persons using the facility to properly deliver the waste to another facility for adequate management or make arrangements to have it done.

Subitem (2) requires the facility owner or operator publish in a local newspaper a notice of the planned closure at least 30 days before closure and provide a copy of the notice to the Commissioner within ten days after the date of publication. This publication ensures the public is alerted to the facility owner's or operator's intention to close the facility so that they might make alternative arrangements for the management of the waste. The Agency is responsible for ensuring that closure activities are properly completed and that solid waste is properly managed at a new facility when the existing facility is closed. The Agency should receive a copy of the notice published in the local paper to ensure proper alternatives are made known to the public.

Subitem (3) requires that local land authorities be notified of all closure activities at the facility and provided with a survey plat indicating the location and dimension of disposal areas and the type of waste accepted at the facility for disposal. This subitem also requires that a notation be placed on the property deed informing any future owner of the property of any restrictions placed on the use of the site. The local authorities with jurisdiction over land use must understand what waste was accepted at the facility, how it was managed, and where any waste remains at the site in order to ensure that all future activities on the property are compatible with site conditions. Additionally, should corrective actions be needed in the future, the survey plat will provide information on where waste is located. It is necessary to notify new owners what has occurred at the site, what type of waste remains, and what land use limitations are in effect so that a new landowner does not unwittingly use the property in a way that could endanger human health and the environment. The most appropriate method to guarantee this notification is the deed since it is routinely reviewed during any change in ownership.

Subpart 3. Certification of closure. This subpart requires the facility owner to submit certification to the Commissioner that final closure and fill phase closure for land disposal facilities has been completed. The certification must contain as-built plans, test results, a signed Site Closure Record, and other documentation, as needed, to indicate that construction was properly completed. This information ensures that proper closure is completed at all facilities. Upon receiving the documentation, Agency staff will inspect the facility and review the certification for proper closure so that closure may be verified and to ensure all duties of the facility owner or operator required by these rules and the facility permit or other governing document are followed. Also, due to the financial assurance requirement, a closure certification will enable the Commissioner to release the facility owner or operator from the financial assurance requirements for closure.

14. Part 7035.2645 POSTCLOSURE.

This part requires the submittal of a postclosure plan detailing the activities to be conducted at a solid waste management facility after closure to ensure the protection of human health and the environment. During the normal course of events, only land disposal facilities will have any extended activity occurring at the site after closure. Postclosure activities at transfer facilities, compost facilities and other processing facilities would only be required if solid waste is to remain at the facility after closure. However, closure of a facility does not immediately eliminate the possibility of pollution as it is virtually impossible to immediately render all solid waste innocuous and disposal facilities may deteriorate over time. Therefore, some minimum standards for postclosure care must be established and the facility owner or operator required to address these standards in a plan.

Subpart 1. Submittal of postclosure plan. This subpart requires the landowner and the facility owner to submit a postclosure care plan for review and approval. Compliance with the approved plan will become a condition of the facility permit, closure document, or other governing document. Because the Agency is responsible to ensure that proper actions are taken after closure of facility to prevent harm to human health and the environment, the Agency should have the opportunity to review the facility owner's and landowner's plans for the maintenance and monitoring of the facility after closure. The plan should be submitted with the permit application or in accordance with another governing document since compliance with the plan is a condition of the permit and the plan must be found acceptable before a permit may be issued by the Agency. The facility owner and landowner, if different, should be involved in the development of the postclosure care plan because, even though the facility owner may have the direct responsibility for carrying out the plan, the landowner must be aware of these activities so that no interference with postclosure care develops from the landowner's use of the site.

Subpart 2. Postclosure plan. This subpart establishes the requirements for the development of a postclosure care plan. A copy of the plan must be kept at the facility until the postclosure care period begins and with a contact person thereafter. The plan should be kept at the facility during operation of the facility in order that all documents governing the activities of the facility are available for facility personnel to review and act accordingly. For disposal facilities, postclosure activities may begin over portions of the facility before the entire facility enters the postclosure care period. These instances would occur when new fill areas to be lined and operated substantially different from existing unlined fill areas are separated allowing for postclosure care activities to begin at the existing fill areas. Including requirements for the completion of postclosure care plans by facility owners in the rule alerts the owners to the Agency's standards and provides consistency in the development of these plans.

Item A requires the postclosure care plan to include a discussion of the type and schedule and associated costs of monitoring for ground water and surface water pollution. The monitoring of ground water and surface water at a facility is necessary to detect and minimize potential harm to human health and the environment. The monitoring program serves as a warning system for deterioration allowing pollutants to move into water sources that may serve as drinking water sources. Requiring monitoring after closure allows for timely actions to minimize the movement of pollutants into the environment. Including cost estimates for the monitoring program ensures that postclosure care activities can be carried out after closure. The submittal of the monitoring plan and associated cost estimates allows the Agency to review these items to ensure they are sufficient to protect human health and the environment.

Item B requires a description, schedule and estimated costs of inspection and maintenance activities to ensure final cover integrity and the functions of the other facility systems during postclosure. Requiring the postclosure care plan to include these items allows for Agency review of the adequacy of the planned activities for maintaining facility integrity and minimizing impacts to human health and the environment. Requiring the cost estimates with these items ensures that sufficient funds will be available to complete the planned activities.

Item C requires that the name, address, and telephone number of a contact person or office for the facility during the postclosure care period be included in the plan. This person or office must keep a copy of an updated postclosure plan during the postclosure care period. Requiring this information in the plan ensures that a responsible party is overseeing postclosure care activities and enables the Agency to contact someone about the need for information or action during the postclosure care period. The designation of a responsible party ensures a timely response to problems at the facility during the postclosure care period.

Subpart 3. Amendment to plan. This subpart allows for the amendment of the postclosure care plan by the landowner and the facility owner at any time. This subpart also requires that the plan be amended whenever activities at the facility necessitate changes in postclosure care activities and whenever the expected year of closure changes. The amended plan must be approved by the Commissioner. Allowing the landowner and the facility owner to amend the plan at any time allows them to be responsive to planned changes in facility operation or site use. It is also reasonable to require amendments to the plan when changes at the facility affect the postclosure care plan and when the expected year of closure changes in order to ensure that sufficient funds are available to complete postclosure care activities, alter schedules accordingly, and ensure that proper postclosure care activities will be completed to maintain the integrity of the facility and prevent harm to human health and the environment.

15. Part 7035.2655 POSTCLOSURE CARE AND USE OF PROPERTY.

This part establishes the requirements the Agency believes are necessary for the maintenance and monitoring of a facility after closure. These activities are intended to ensure that basic activities are completed during the postclosure care period to maintain the facility and prevent harm to human health and the environment.

Subpart 1. Postclosure care requirements. This subpart establishes the time period for postclosure care and the factors governing modification of the closure document during this period. If no time limit were placed on the postclosure care period, the facility owner or landowner may not understand whether monitoring is required into perpetuity or not at all. In specifying a minimum period of 20 years (item A), the Agency is being consistent with the time period established in Minn. Stat. § 116.07, subd. 4h, requiring a minimum period of 20 years. The Agency also believes that any breach in the containment system should be detectable during this period. An allowance has been made for lengthening or shortening the postclosure care period based on technical documentation that conditions warrant change (item B). This allowance rewards or penalizes the facility owner or operator for activities taken during the life of the facility that decrease or increase the need for action after closure. This system allows the facility owner or operator to incorporate risk management into the scope of the facility operation and maintenance. Item C requires that all postclosure activities be conducted in accordance with the postclosure care plan. That plan is the document reviewed, approved and enforced by the Agency to ensure proper actions are being used to maintain the integrity of the facility and minimize potential impacts on human health and the environment. Additionally, the amount of financial assurance developed for the facility is based on cost estimates supplied in the postclosure care plan. If activities are not completed as indicated in the plan, sufficient funds may not be available to complete these activities properly.

Subpart 2. Postclosure use of property. This subpart establishes limitations on the landowner's rights to use the facility property. Limiting the postclosure use of property will protect the integrity of the site containment system and prevent the release of pollutants into the environment. This requirement does not prevent all uses of the property. Rather it limits the use to that which will not disturb the integrity of final covers, liners or any other component of the containment system. The entire facility design, construction and operation were intended to minimize the potential for impacts on human health and the environment. To allow uncontrolled use of the property would conflict with the intent of these rules to develop a risk management approach to contain pollutants and minimize their potential for impacts on human health and the environment from releases caused by disturbance of the site.

This subpart allows for the Commissioner to permit the disturbance of the facility's containment system if it can be documented that the disturbance will not cause a violation of performance standards (item A) or that the disturbance is needed to remedy a violation of standards (item B). Under these circumstances the impact on human health and the environment will be nonexistent or lessened, depending on the situation. These provisions allow for flexibility in addressing site-specific conditions while maintaining the ability of the site to comply with standards established for the protection of human health and the environment.

I. Reasonableness of Parts 7035.2665 to 7035.2805 FINANCIAL REQUIREMENTS.

The Agency's legislative directive to adopt the financial assurance rules reads, in full:

> The agency shall adopt rules requiring the operator or owner of a solid waste disposal facility to submit to the agency proof of the operator's or owner's financial capability to provide reasonable and necessary response during the operating life of the facility and for 20 years after closure, and to provide for the closure of the facility and postclosure care required under agency rules. Proof of financial responsibility is required of the operator or owner of a facility receiving an original permit or a permit for expansion after adoption of the rules. Within 180 days of the effective date of the rules or by July 1, 1987, whichever is later, proof of financial responsibility is required of an operator or owner of a facility with a remaining capacity of more than five years or 500,000 cubic yards that is in operation at the time the rules are adopted. Compliance with the rules is a condition of obtaining or retaining a permit to operate the facility.

Minn. Stat. § 116.07, subd. 4h (1986).

The Agency believes that there are limited means a facility owner or operator can use to meet the intent of the cited statute. Current financial assurance rules for hazardous waste facilities provide a useful model. Minn. Rules pts. 7045.0498 to 7045.0529 (1987). The proposed financial responsibility rules derive their basic format from the hazardous waste facility rules on financial responsibility. Some requirements, procedures and models for financial instruments are taken directly from the hazardous waste facility rules. However, the proposed rules are not complete copies of the hazardous waste rules.

"Capability" is the critical word in the legislative directive to write financial responsiblity rules for solid waste facilities. A dictionary reference provides two operational definitions of the word "capable." This word can mean: "potential ability"; or "the capacity to be used, treated or developed for a specific purpose" (Reference 14). Construing capability in this sense gives the Agency no useful guide for writing rules. The definition is too loose to serve any reasonable purpose or legislative intent.

All owners and operators of operating mixed municipal solid waste land disposal facilities have the "potential ability" to pay the costs of long-term care. If the "potential" were sufficient, there would be fewer financial problems at these facilities. Private sector facility owners and operators could meet the letter of the legislative directive's goals by simply showing that they charge for their services and claim that they will raise, or have raised, rates enough to meet long-term care costs. Likewise, public sector facility owners and operators could claim they will raise taxes to meet long-term care costs. Both demonstrations would show capability, or potential ability. But, in neither case would there be any security that rates or taxes would indeed be raised and maintained or, if raised, that the specified funds would actually be spent on long-term care at a land disposal facility. Potential is a necessary, but not a sufficient, condition to meet the legislative intent.

The situation of the facility owner or operator and the Agency is much like that of a borrower and a lender. Once the borrower receives the loan, there is an obligation to repay according to specified terms. Lenders ordinarily will not lend money unless borrowers agree to the lender's terms. Lenders customarily require assurance that they will be repaid. Collateral often provides this assurance. Sometimes third parties, cosignatories, can also serve this purpose. If the borrower defaults, the lender can recoup the loss by taking control of the collateral.

The point is that when there is a future obligation to pay, as in the mixed municipal solid waste land disposal facility owner's or operator's obligation to pay for long-term care, custom and standard business practice require the person undertaking the obligation to provide more than "potential ability" to meet the obligation. The obligated one is normally required to give the person who holds the obligation some independent security that the obligation will be met. "Independent," in this sense, means that the security remains even if the person who contracts the obligation proves unable or unwilling to pay. Society and the law accept such requirements as reasonable, as long as they remain within specified legal limits.

The proposed financial assurance rules adopt a "reasonable and necessary" approach. That is, permittees obliged to perform closure, postclosure care and contingency action are required to show more than just a "potential ability" to meet these obligations. The proposed rules require facility owners and operators to contract with financial intermediaries (trustees, sureties, etc.) or to provide collateral. The intermediaries share the permittees' obligations. If the facility owners and operators do not perform as required, the intermediaries will then pay the costs of performance. This requirement is reasonable in the same way that collateral requirements by lenders are reasonable. Most people would consider a borrower's request for an unsecured loan as unreasonable. Similarly, it is unreasonable to allow a facility owner or operator to undertake an unsecured obligation to perform long-term care.

Allowing self-insurance arrangements without independent security would put the Agency in a position that is rejected by private sector financial intermediaries. Sureties and banks issuing letters of credit customarily include collateral requirements in the arrangements. They require the added security that collateral affords. (Trustees do not need this security, because their liabilities do not extend beyond their fiduciary responsibility for trust fund assets.) There is no reason for the Agency to take on risks that are avoided by intermediaries who have substantial experience with risk assessment.

The proposed rules allow complying permittees to use one of four types of financial medium - trust funds, letters of credit, surety bonds, and self-insurance coupled with bonds provided as collateral.

1. Part 7035.2665 SCOPE.

The rules apply to all owners and operators of mixed municipal solid waste land disposal facilities. Among those who reviewed earlier drafts of the proposed rules there was some discussion whether the rules legally can be applied to all such facilities.

These reviewers relied on a partial reading of the Agency's legislative directive to adopt the rules. The relevant part of this directive states:

> Within 180 days of the effective date of the rules or by July 1, 1987, whichever is later, proof of financial responsibility is required of an operator or owner of a facility with a remaining capacity of more than five years or 500,000 cubic yards that is in operation at the time the rules are adopted.

Minn. Stat. § 116.07, subd. 4h (1986).

The reviewers claim that this sentence exempts the defined class of facilities from compliance with the rules. However, the Agency must consider the entire directive, not just one sentence. This directive begins with:

> The agency shall adopt rules requiring the operator or owner of a solid waste disposal facility to submit to the agency proof of the operator's or owner's financial capability to provide reasonable and necessary response during the operating life of the facility and for 20 years after closure, and to provide for the closure of the facility and postclosure care required under agency rules.

Minn. Stat. § 116.07, subd. 4h (1986).

This part of the directive exempts no facility owner or operator from compliance. The latter portion of the directive separates disposal facility sites into two classes: those facilities with more than five years or more than 500,000 cubic yards of capacity and all other facilities. The directive then sets a compliance schedule for the first class of facilities. In other words, the part of the directive that some reviewers believe exempts a class of facilities simply says when, not whether, one class of facilities must comply with the rules. The other class of facilities is not exempted from compliance. Rather, the compliance schedule for that class is left indeterminate. It is reasonable to assume that if the Legislature chose to exempt a defined class from rule compliance, that exemption would have been made explicit within the legislative directive. The directive would then state, for example, that "all owners or operators with sites falling outside the defined class are exempt from complying with the rule." The Agency finds no such language in the legislative directive. The proposed rules therefore set separate compliance schedules for the two classes of facilities, with appropriate consideration given to equity concerns. Later discussion of parts 7035.2705 through 7035.2745 will consider the compliance schedule set for both classes of facilities.

Language considerations aside, equity and the conditions of Minnesota's solid waste management system support compliance by all operators. The exemption some facility owners and operators want could well lead to serious service disruptions and unfair results.

Consider a very likely case in which neighboring facilities compete for some portion of the same waste stream. This is a common condition throughout the State. Assume an original condition in which:

	Facility A	Facility B
Volume of remaining capacity	400,000 c.y.	600,000 c.y.
Average annual waste receipts	135,000 c.y.	100,000 c.y.
Remaining operating life	about 3 years	6 years

If one accepts the argument presented by some reviewers that one class of facilities need not comply with the proposed rules, then Facility A is exempted and Facility B has to comply. This means Facility B will have to raise its charged rates. Facility A will not be compelled to raise its rates. Facility owners and operators and waste collectors have assured the Agency that waste flows are quite sensitive to rate changes. As Facility B's rates increase, some waste haulers who once used Facility B will switch to Facility A. Consider what happens if Facility B loses half of its waste receipts, a circumstance that facility operators have assured the Agency could happen if rates differ by as little as ten percent.

	Facility A	Facility B
Change in annual waste receipts	135,000 c.y.	100,000 c.y.
	+ 50,000 c.y.	- 50,000 c.y.
	185,000 c.y.	50,000 c.y.
Operating life after change	about 2 years	12 years

After two years of increased waste receipts. Facility A will be full and Facility B will have to take the waste. Then:

	Facility A	Facility B
Change in waste flows after two years	185,000 c.y.	50,000 c.y.
	-185,000 c.y.	+185,000 c.y.
	0	235,000 c.y.
Remaining operating life after two years	0	about 2 years

The changes in waste flows actually force both facilities into premature closure. Facility A closed a year earlier than planned because haulers brought more waste to the site when Facility B raised its rates. Facility B closed two years earlier than planned because it was not designed to handle the total waste flow to both sites. This results in the odd case that Facility B qualifies for the exemption, after the fact.

This is the likeliest series of events that will result from exempting one class of sites. Other likely possibilities remain. For example, Facility B could anticipate the revenue loss that would result from a rate increase and close. Then:

	Facility A	Facility B
Change in annual waste receipts	135,000 c.y.	100,000 c.y.
	+100,000 c.y.	-100,000 c.y.
	235,000 c.y.	0

The result is two facilities that have closed before they were intended to close, neither facility having complied with the rules.

Another likely possibility is that Facility A will raise its prices and preserve the "competitive boundary" between its service area and Facility B's service area. The owner and operator of Facility A can then use the new revenues to either voluntarily comply with the rules or reap a windfall profit. Prudence requires that this choice not be left to the individual owner or operator.

These examples serve not as predictions of actual events, but as illustrations of the disruptions that very likely will result if the rules afford competitive firms differential treatment. There is no claim that a condition like that of Facilities A and B will definitely occur. Instead, the Agency presents a reasoned anticipation of the likely consequences of exempting some facilities from compliance. It is reasonable to assume that uniform application of the rules will result in fewer disruptions in the waste management system.

2. Part 7035.2685 COST ESTIMATES FOR CLOSURE, POSTCLOSURE CARE AND CONTINGENCY ACTION.

The Legislature directed that rules require land disposal facility owners or operators to demonstrate that they can provide for facility closure, postclosure care and response action. That is, facility owners and operators must prove they will have financial resources sufficient to meet the stated needs when they arise. The owner or operator and the Commissioner must have a way to measure the adequacy of the proof. Cost estimates for facility closure, postclosure care and contingency action will provide the needed measure. These cost estimates will be compared with the facility owner's or operator's demonstrated resources to determine compliance with the rules.

The methods used to estimate costs must be the same for all sites. If different methods are used at different sites, then cost estimates will vary from site to site. This will introduce variations in total costs and in facility charge rates. This would result in less protection and lead to unnecessary changes in waste flows.

Problems result from the application of different cost estimating methodologies; all land disposal facility owners and operators must use the same methods to make cost estimates. This part of the rule provides land disposal facility owners and operators with the guidance needed to estimate costs in a consistent manner, to adjust those estimates and to demonstrate compliance with the rules.

Subpart 1. Cost estimate requirements. This subpart contains directions for estimating the different costs for which estimates are required.

All three items in this subpart require that basic cost estimates be stated in current dollar terms. This means that estimators should not adjust the estimates for inflation. Subparts 2 and 3 provide estimators with guidelines for making inflation adjustments.

This subpart also does not allow cost estimates stated in present value terms. Present value estimates take into account the time value of money. The value of money is sensitive to time because the value of a future dollar is less than the value of a present dollar. This proposition holds because the future is uncertain. Risk erodes the value of the future dollar. No one can be certain that a given financial event will occur. This uncertainty is often referred to as risk, although measurement criteria allow for some important distinctions between the two terms. Interest compensates investors for assuming risk. The investor forgoes the use of current resources for the promise of repayment, plus some extra return from interest earnings. This means that the investor who is promised a ten percent annual return on an invested dollar must be repaid $1.10, if the term of the investment is one year. So the present value of $1.10 invested for one year at ten percent interest is $1.00. Likewise, the present value of a dollar received under the same conditions is $0.91. Present value analysis is a commonly used financial planning tool. Investors need to be able to set rates and charges so that investments earn maximum returns, consistent with other policy goals.

Although present value analysis proves useful in financial planning, it is unnecessary in these rules. The rules are set up so that all financial values are set in the current period. Adjustments for inflation and interest earnings are made only after they are realized. This means that adjusted cost estimates will lag behind actual values by about a year. Contingency factors built into the cost estimating guidelines can make up for this lag.

The individual facility owner or operator may want to develop an individual present value analysis for personal financial plans. The rules will not require that this analysis be made. Since there is no need to adjust initial cost estimates for inflation and interest earnings, these initial estimates will be defined in current dollar terms.

Item A refers the reader to other parts of the rules, parts 7035.2625 and 7035.2635, which give the details of the contents of the closure plans. These parts of the rules require that the plans include cost estimates.

This item also requires that the closure cost estimate be maximized. That is, the estimator has to take into account all the conditions of the site that can make closure more expensive. These maximizing conditions will normally consist of waste flow and facility management practices.

It is helpful in this context to think in terms of the amount of open area, acreage not under final cover, at the site. Closure costs will vary in nearly direct proportion to open area, all other things being equal. The maximizing requirement thus requires the estimator to determine what the greatest amount of open area will be from the present until the site is closed. This amount informs the closure cost estimate.

The proposed rules impose this maximizing requirement because the Agency and the facility's users must be prepared for the possibility that the owner or operator may abandon the site. Instances of this sort define the need for the proposed rules. Since sites have been abandoned in the past, it is likely that more site abandonments will occur. Therefore, prudence and reason require that the financial responsibility rules consider the chance of site abandonment.

This is why the rules cannot be written to allow estimators to minimize or optimize the cost estimates. If such estimating conventions were allowed and the site were abandoned, then there might not be enough money available through the facility owner's or operator's chosen financial assurance medium to finance site closure. It is reasonable to prepare for a very real possibility. The maximizing requirement is a solution to this problem.

Item B refers the reader to other parts of the rules, parts 7035.2645 and 7035.2655, which give the detailed contents of the postclosure care plans. These parts of the rules require that the plans include costs estimates.

This item requires the estimator to make an estimate, in current dollars, of the annual cost of postclosure care and maintenance. The estimator then multiplies this cost estimate by the number of years of postclosure care required. This operation yields the total cost of postclosure care.

The estimator is further required to make explicit allowance for inflation expected to occur during the postclosure care period. In this respect, the postclosure care cost estimate differs from the cost estimates for closure and contingency action. This postclosure estimate differs because the postclosure period will not begin until the site is closed and it will continue for a number of years after closure. This means there is no way to adjust, on a current basis, for inflationary cost increases that will occur during the postclosure period. The estimator has to make assumptions about these inflationary increases and add expected inflation costs into the total cost estimate. History shows that inflation will occur. The uncertain quantity (see earlier discussion on present value analysis) is just how much inflation will occur.

The estimator can only approximate the value of expected inflation, just as all other values in the cost estimate are approximate. This item requires the estimator to base the inflation projection on current data available through the U.S. Department of Commerce. That agency's publication, "Survey of Current Business," provides a statistic called the "implicit price deflator for gross national product" which serves as a measure of the inflation that has occurred throughout the national economy over the reported period. The implicit price deflator is an index number.

Index numbers are relative value measures. They compare measured values in a base case with measured values in other observable cases. The base year for the statistic used is 1982. So that, given a reported index value of 111.7 in 1985, we can say that prices rose by ([111.7/100.0] - 1) x 100 = 11.7 percent during the period 1982-1985. The index numbers can be used to determine inflation for any reported periods. The reported values for 1980 and 1984 are 86.1 and 108.5. So the inflation that occurred during that period is ([108.5/86.1] - 1) x 100 = 26.0 percent. The Commerce Department constructs this index from surveys of goods and services purchased throughout the economy.

The system set up in the proposed rules adjusts the postclosure cost estimate for inflationary changes reported up to the year in which the site closes. The estimator thus sets the expected inflation rate equal to the rate current in the year of closure. This procedure does not assume that future rates will actually equal current rates. This is a very shaky assumption, disproved by daily experience. Inflation rates change all the time.

The procedure instead assumes that the earnings rate for invested funds will exceed future inflation. This assumption is well-grounded in economic experience. The amount by which earnings exceed inflation is referred to as the real rate of return. Analytical tests of the real rate hypothesis have confirmed that a real rate exists. The tests tend to find the real rate in the two to three percent range (Reference 15).

Statistical tests of documented historical evidence support the assumption that earnings will exceed inflation. This assumption is incorporated into the cost estimating procedures required under the proposed rules.

Item C refers the reader to another part of the rules, part 7035.2615, which gives the details of the contents of a contingency action plan. A contingency action plan must include a cost estimate.

The contingency action cost estimate departs from the cost estimating procedure used for closure and postclosure care. The closure/postclosure care cost estimates cover costs that the facility owner or operator is certain to incur, because each facility will have to be closed and maintained for a set period of time. Although there may be some dispute about the magnitude of these costs, engineering and accounting conventions normally can resolve these disputes.

Contingency action costs are exclusive of closure and postclosure care costs. Contingency action costs result when an unanticipated problem arises, such as liner failure or massive settlement. This means contingency action costs have a significant probabilistic dimension that the other cost categories do not have. There are not enough data on contingency action costs, both in Minnesota and nationwide, to support statements about the probability with which a given event will occur at a particular time at a specified facility. The most that can be said is that classes of events are either likely or unlikely. For example, it is likely that some contingency action costs will be incurred at nearly all land disposal sites in the State. Available monitoring results support this statement (Reference 16). However, it is unlikely that contingency action costs will be maximized at all sites. This statement is supported only by the general observation that extreme outcomes do not often occur in any field investigated.

Probability is an important element in defining extreme conditions. One thing that makes extremes seem so great is their contrast with normal or expected conditions. Very tall people stand out in average crowds precisely because there are not many tall people. The very tall person would not seem quite as out of place if he stood with a group of basketball players, but that is not an average group. This phenomenon of low likelihood at extreme values is often found when the event measured is a continuous variable, like height. Such observations provide the basis for the "normal" distribution; the bell-shaped curve familiar to most students at grading time. If a specified event, height, for example, is normally distributed, then the average value is more likely to occur than any other value. As values move away from the average, they become less likely.

The unpredictability of contingent events at land disposal facilities means that a reasonable approach to rules must consider the fact that any given level of response action costs is only likely, not certain, to be incurred at a specific facility. The proposed rules handle this problem by using expected value analysis. The proposed rules will require the mixed municipal solid waste land disposal facility owner or operator to demonstrate financial assurance for the expected value of estimated contingency action costs.

The expected value of an event is its cost times its probability of occurrence. For example, if two people bet ten dollars on a coin toss, the expected value of the bet, for both of them, is five dollars ($10 x 0.5 = $5). Applying this method to contingent events at land disposal facilities requires reference to the owner's or operator's contingency action plan. That plan will contain:

a) an identification of the possible events such as violations of intervention limits or water quality standards, failure of design features, settlement of completed areas, and surface drainage problems that may require corrective actions.

b) a description of the actions, the sequence in which they will be taken, and the costs associated with each action that facility personnel must take to prevent air, land or ground water and surface water pollution including methods used to: identify the nature and extent of the problem; evacuate the facility; contain, recover, and treat water quality pollutants; control air emissions; repair monitoring systems; and repair leachate collection systems. The plan will also have an implementation timetable.

c) a description of the equipment available on-site and off-site to repair each condition.

d) a description of any prior arrangement with contractors.

e) a statement of the scheduled and unscheduled down times for maintenance at the facility.

f) an estimated cost for each action and a cost for the most severe action that may be needed and the total cost for all the estimated actions.

Calculating the expected value of contingency action costs will require estimating a probability of occurrence for each event identified in the contingency action plan. The facility owner or operator will identify the most costly sequence of actions presented in the plan. This is the "worst case of series of events." The cost of each event in this sequence is then multiplied by its probability of occurrence. The result is an expected value for each event. The total expected value of contingency action costs is the sum of the expected values of the worst case series of events identified in the contingency action plan. This amount defines the level of financial assurance required. For example, if the facility owner or operator chooses to use a surety bond to comply with this part of the rule, the penal sum of the bond must equal the total expected value of the estimated worst case series of contingency action costs.

The proposed rules require the estimation of expected values because it is not reasonable to assume that a given facility will incur no contingency action costs. Likewise, it is not reasonable to assume that a given site will incur costs equal to the worst case estimate. Recall here the earlier discussion on extreme values and probability. That discussion focussed on known and tested experience with natural events. Contingency action events have generated very little data. Moreover, although natural elements influence these events, there is considerable human intervention also present. That is, manmade laws and rules influence the distribution of contingency action costs, as do rainfall and ground water flow. This human intervention could well skew the probability distribution of costs in one direction or another.

The point to remember is that the scarcity of data makes it impossible to tell for sure the extent, or even the sign, of any skewing introduced by human intervention. This data problem makes prediction extremely difficult. Acceptably accurate estimates of contingency action cost distributions would require very extensive risk assessments at all land disposal facilities. Some reviewers have considered the expected value analysis as though it were a proxy for the more comprehensive analysis needed to make accurate probability statements. They have criticized the proposed rules' use of expected value analysis because they maintain that the analyses, as described in the rule drafts, will not be accurate. The reviewers have not understood that the expected value analysis is not proposed as a predictive tool. These analyses should not be considered as predictors, but as cost distributors. The expected value analyses will require owners and operators to use the same cost estimating techniques. These techniques will assume the only two probability statements that can be made with some certainty; namely, 1) it is unlikely that any facility will incur no contingency action costs and 2) it is unlikely that all facilities will incur costs equal to the worst case series of events.

The proposed rules require that all facility owners and operators will make some provision for unexpected events while, at the same time, avoiding the very costly results of requiring all facility owners and operators to prepare for the worst case. The expected value estimate relies on data provided in the site contingency action plan. The estimate thus becomes sensitive to each site's unique conditions. The cost-estimating methodology is custom-made to suit each site. The proposed rules allow facility owners and operators to choose one of two means to estimate the expected value of contingency action.

Subitem (1) establishes the first estimating method to develop probability distributions for all events listed in the contingency action plan. The distributions must be made based on investigations made at the site. Facility owners and operators choosing this option send the Agency a probability analysis, along with supporting details sufficient to allow the Commissioner to evaluate the analysis. The Commissioner will need the same information as the facility owner or operator has to determine the accuracy of the estimated probability distribution. If the facility owner or operator cannot justify a finding (say, an extremely low probability estimate for a very costly event), then approving the financial assurance cost estimate under these conditions would increase the risk that incurred costs will be greater than estimated costs.

Only new sites can use this option. The rules make this restriction because the required analysis cannot be made at existing land disposal sites. Too many critical variables at existing sites (e.g., underlying geologic features, the characteristics of the wastes received) are unknown and/or indeterminate with acceptable accuracy. A recent survey of risk assessment professionals shows which data are most important in evaluating environmental risks (Reference 17).

ELEMENTS REQUIRED FOR A RISK ASSESSMENT

Elements	Very Important	Important	Somewhat Important	Not Important	Total Respondents
Identification of solid and liquid wastes or raw materials stored or dumped and circumstances that could cause an environmental occurrence	95%	5%	--	--	22
Present disposal information	86%	14%	--	--	22
Identification of water pollution sources and evaluation of controls	77%	23%	--	--	22
Past disposal information	77%	23%	--	--	22
Site visits	74%	17%	4%	4%	23
Past incidents history	73%	23%	5%	--	22
Types of processes and materials	68%	32%	--	--	22
Prior claims	59%	36%	5%	--	22
Identification of air pollution sources and evaluation of controls	57%	14%	24%	5%	21
Regulatory notices of non-compliance	54%	32%	14%	--	22
Information on corporate loss prevention organization	50%	41%	9%	--	22
Legally required spill prevention control and countermeasure program	50%	36%	14%	--	22
Existence of environmental engineering department and qualifications of staff	36%	50%	14%	--	22
Written corporate policy on environmental loss prevention	32%	45%	23%	--	22
Contact with regulatory officials	26%	48%	17%	9%	23
10-K and annual reports	5%	27%	59%	9%	22

The respondents said the most important information required in a risk assessment is the identification of wastes already in the facility. Facility owners and operators of existing land disposal sites in Minnesota cannot provide this information because they have not systematically recorded waste receipts since operations began. The facility owners and operators also cannot provide adequate information about the "circumstances that could cause an environmental occurrence" because they do not have adequate descriptions of the hydrogeologic conditions that underlie the sites. Risk assessments lacking these critical data could not be accurate enough to develop acceptable probability distributions for response action costs. The rules may appropriately deny existing sites the option of making their own probability analyses. New sites can be allowed this option since the information needed can be found and operational controls instituted.

Subitem (2) establishes the second option for estimating probability distributions. The second option, available to all facility owners and operators, is to assume that contingency action costs are normally distributed with respect to their probability of occurrence. This assumes that, given a large number of sites and accurate probability distributions for these sites, the distribution of probabilities over the full range of possible costs will approximate the function known as the normal distribution. Before considering the specifics of this method, recall the earlier discussion about normal distributions. The rules will not require facility owners and operators to use this distribution because the Agency believes it will be accurate in each individual case. Rather, the normal distribution provides a reasonable means to prepare for the unexpected with consistency and fairness.

The functional description of the normal distribution is:

$$f(x) = \left[\frac{1}{\sqrt{2\pi\sigma}}\right] e^{-(x-\mu)^2/(2\sigma^2)}$$

in which:

x = the random variable being evaluated

μ = the mean value of x

σ = the standard deviation of x

π = 3.1416

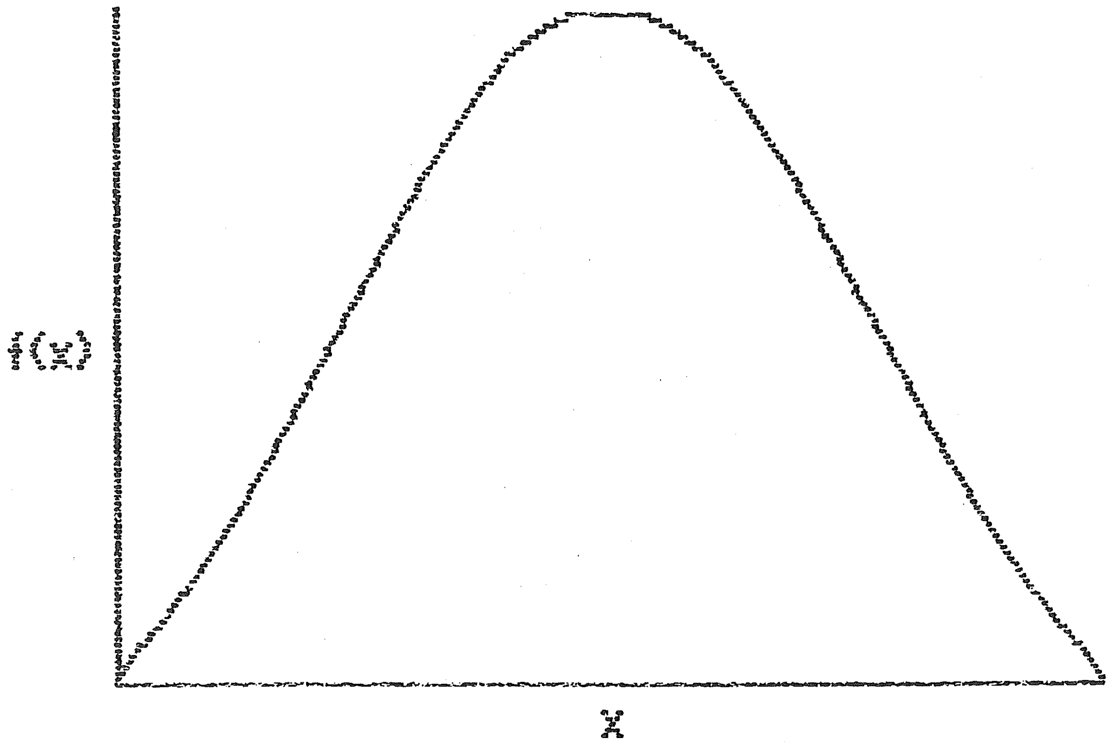
e = 2.7183

Reference 18.

This function specifies the familiar bell-shaped curve shown in Figure 1. This curve is symmetric with respect to the mean, or average, value of the random variable, x. That is, half the possible values of x lie to the right of the average, and half the possible values lie to the left of the average.

FIGURE 1

Normal curve



The value on the Y axis, f(x), gives the probability with which the random variable will take the specified value. The proposed rules will construe this value, f(x), as the probability that the cost of contingency action will equal the specified value of x.

The proposed rules must provide facility owners and operators with a way to take this theoretical construct and put it into practice. The rules do this by setting conditions on the calculations. These conditions ensure that all facility owners and operators use the same methods. The conditions thus help the rules meet reasonable goals of uniformity and fairness. The conditions are:

a) The value, x, is a specified interval which defines the number of times that the value of x will be evaluated. For example, if the evaluated range is $100,000 and the specified value of x is $10,000, then the x variable will be evaluated ten times.

b) The value of the last event evaluated must be equal to the worst case series of events identified in the contingency action plan. This condition, combined with the specified x value, limits the number of times the value of x must be evaluated.

c) The sum of the probabilities derived from repeated evaluations of x must equal at least 1.0. This condition forces the calculations to consider all possibilities. The sum of the probabilities (p) of all possible events in a probability distribution must equal 1.0. For example, in the coin toss case, the possible outcomes are heads (p = 0.5) or tails (p = 0.5). The probabilities of these outcomes equal 1.0. If we consider the case of casting a die, the probability that any one face will lie face up is p = 0.1667. Six times 0.1667 is one. Again, this requirement assures that the evaluations "leave out" no possibilities by requiring that the sum of the probabilities derived be at least one.

d) The probability of the most costly series of events (WC) must equal at least 0.01. This condition sets a lower limit on the assumed likelihood that incurred costs will equal WC. There must be a finite probability associated with this value, simply because all likely events have a finite probability. This condition, in combination with the next condition, limits the likelihood assumption to a reasonable range.

e) The probability of the most costly series of events, p(WC), must be at least four times greater than the probability that no costs will be incurred, p(0). This condition places an effective upper limit on the value of p(0) equal to 0.0025. This condition imposes on the calculations the assumption that it is more likely that the site will incur costs equal to WC than that the site will incur no costs.

Monitoring results discussed earlier indicate that few sites will incur zero cost. The interests of both site owners and operators and site users argue for a conservative, although not too conservative, cost estimate. That is, if the estimate is wrong, it is better that it be too high than that it be too low. If the estimate is too high, the set-aside funds can be returned. But if the estimate is too low, owners, operators and users will have to pay even more for contingency actions at the site. This will add to the economic burden the facility operation imposes on its community of users at a future date when they will very likely not be prepared to assume this burden. Again these concerns favor a conservate approach to cost estimation.

An example of how the expected value calculations will proceed may help to illustrate how the process will work.

Assume the site's contingency action plan estimates $1,000,000 as the cost of the worst case series of events. The calculations made below present the total cost for the expected value of the events identified in the plan.

EXPECTED VALUE ESTIMATE

[Costs and expected values reported in $10,000s]

Evaluation Number (a)	Cost Evaluated (b)	Probabilities Derived Individual (c)	Cumulative (d)	Expected Value [(b)(c)]
1	$ 0	.00333218	.00333218	$ 0.00
2	5	.00555111	.00888329	0.03
3	9	.00885207	.01773535	0.08
4	14	.01351209	.03214744	0.19
5	18	.01974301	.05099046	0.36
6	23	.02761324	.07860370	0.64
7	28	.03696687	.11557243	1.02
8	32	.04737688	.16294911	1.53
9	37	.05811763	.22106674	2.14
10	41	.06824396	.28931071	2.83
11	46	.07670675	.36601746	3.53
12	51	.08253080	.44854825	4.18
13	55	.08499856	.53354682	4.69
14	60	.08379540	.61734222	5.01
15	64	.07907549	.69641771	5.09
16	69	.07142934	.76784705	4.93
17	74	.06176245	.82960950	4.55
18	78	.05111936	.88072886	4.00
19	83	.04050041	.92122927	3.35
20	87	.03071471	.95194398	2.68
21	92	.02229701	.97424099	2.05
22	97	.01549387	.98973486	1.50
23	100	.01151091	1.00124577	1.15
			Total expected value =	$55.51

The following graphs present pictures of the information contained in the tables.

FIGURE 2

Probabilities of individual events

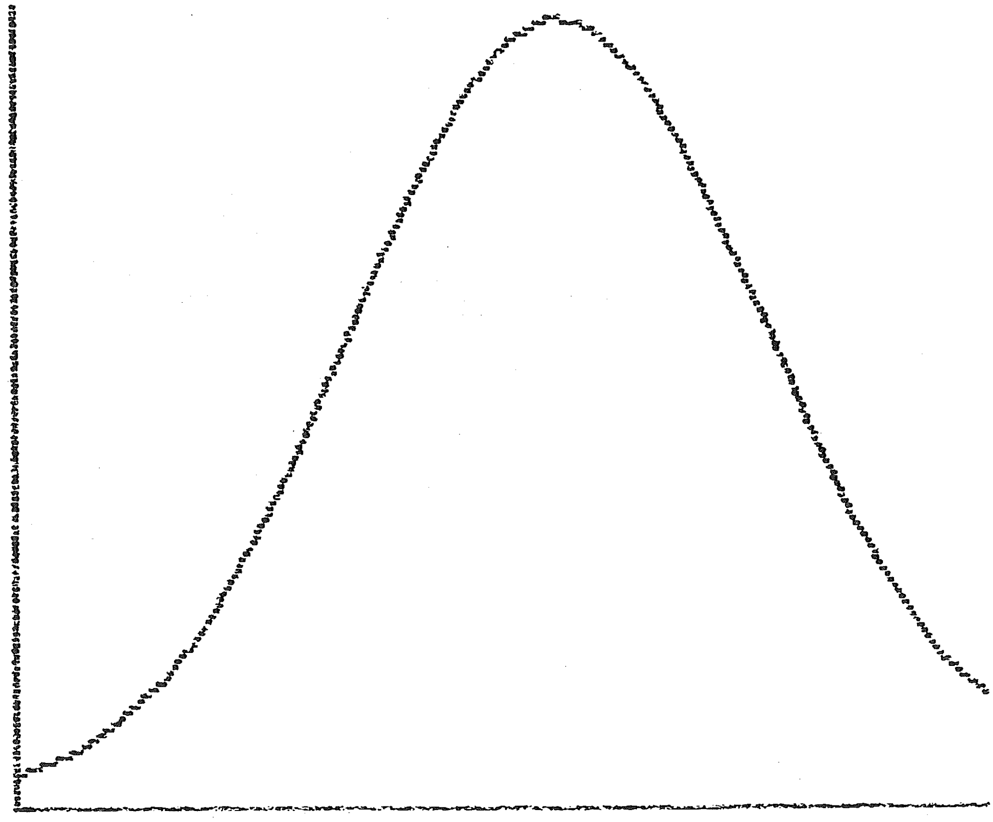


FIGURE 3

Cumulative probabilities of events

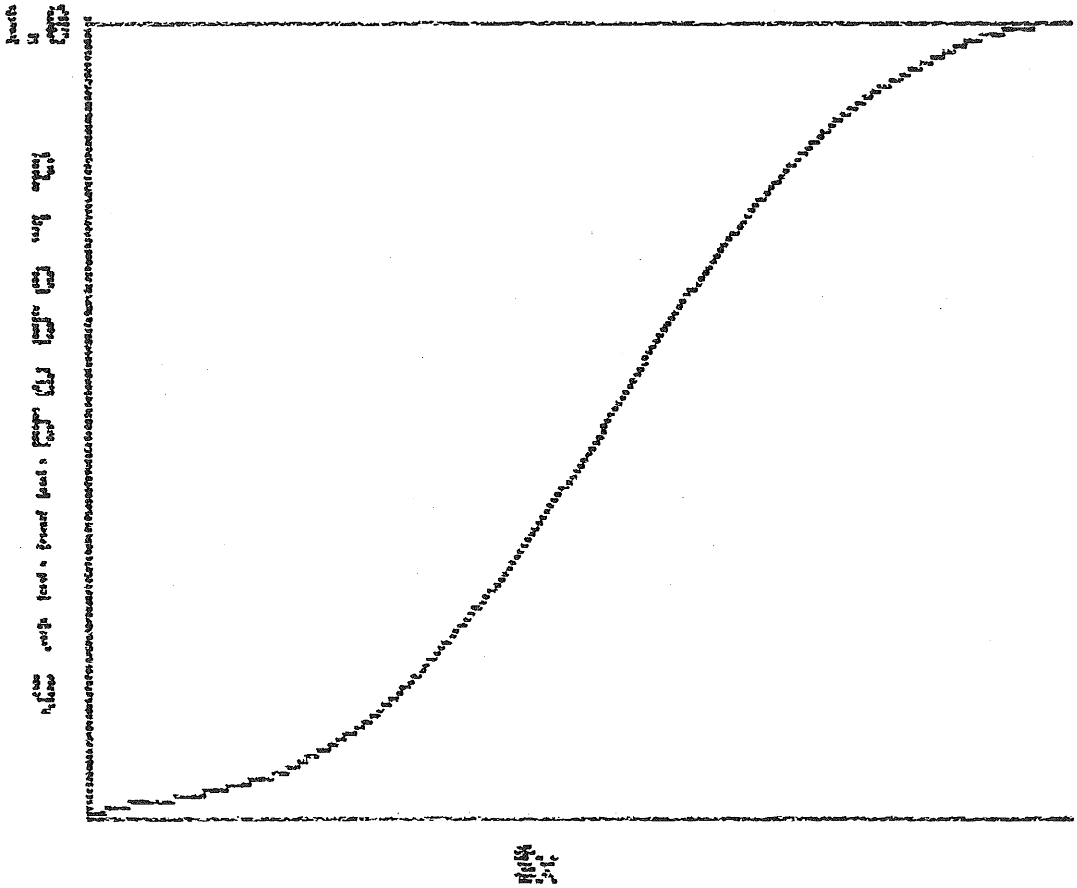
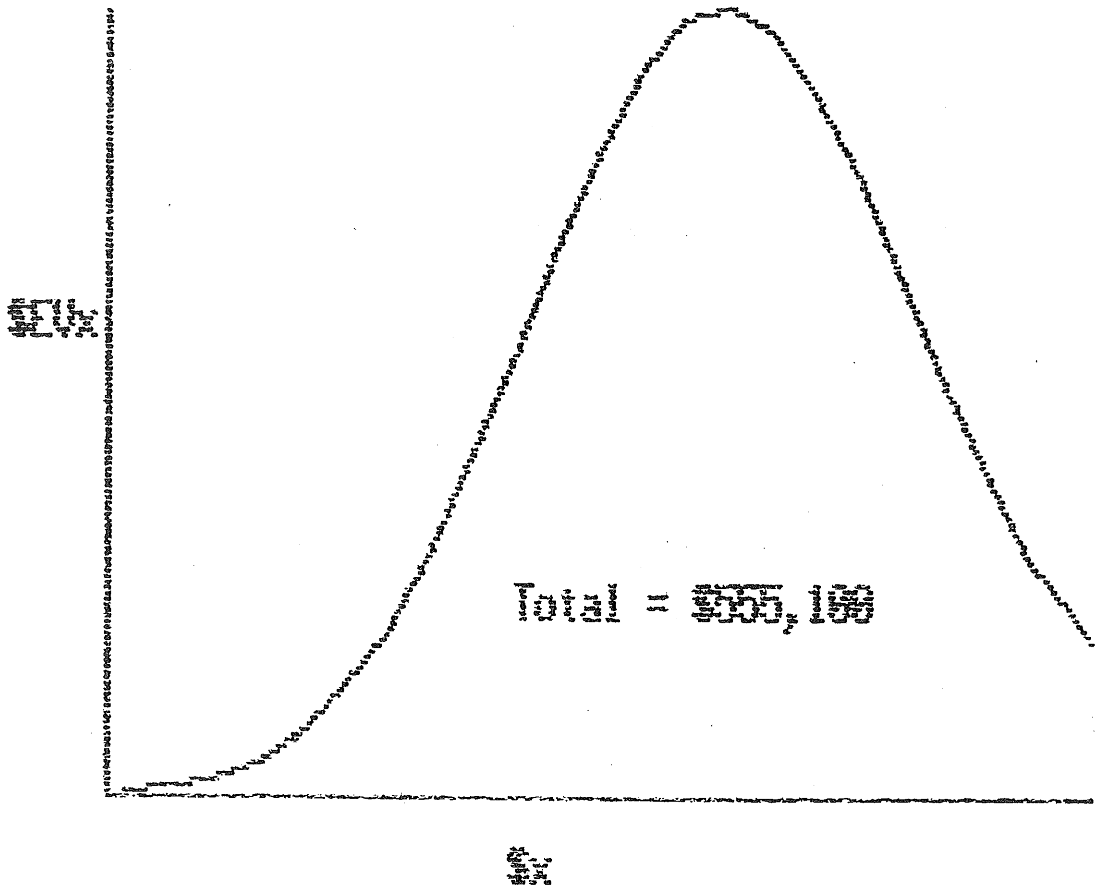


FIGURE 4
Expected values



The assumption that contingency action costs are normally distributed is reasonable because:

a) this system distributes costs among owners and operators with uniformity and fairness;
b) this system avoids the unfair alternative of requiring owners and operators to develop funds sufficient to meet a "worst case scenario"; and
c) many events that vary in a continuous manner conform to the normal distribution with respect to their probability of occurrence.

Subpart 2. Yearly update of cost estimate. This subpart requires the permittee annually to adjust the cost estimates to account for changes induced by inflation. Earlier discussion on inflation adjustments (under subpart 1, item B) provides the reason for this requirement. Inflation invalidates cost estimates. If no adjustment is made, the cost estimate becomes too low.

The procedure used is described under item B of subpart 1. Data from the Commerce Department's "Survey of Current Business" provide the basis for the cost adjustment.

This subpart also requires the Commissioner to inform all facility owners and operators of the inflation factor needed to adjust cost estimates. This will save time and money and help to make sure all facility owners and operators use the same adjustment factor. Facility owners and operators must adjust their cost estimates to account for known inflationary changes. These adjustments must be based on a single, authoritative measure.

Some reviewers have argued that the annual inflation adjustment imposes unnecessary costs on facility owners and operators. These reviewers believe that inflation will not have an impact large enough to justify the expense incurred. These reviewers suggest that a longer period, say five years, be allowed between inflation adjustments.

This argument fails on two counts. First, the reviewers assume that the inflation adjustment will be very costly. They expect the process will require lengthy negotiations between the facility owner or operator and the chosen financial intermediary.

Actually, the adjustment process will be quite routine. Two of the instruments allowed, bonds and letters of credit, normally have a one-year term. This means that a new agreement must be executed each year, at which time it should be easy to make the inflation adjustment, particularly since the intermediaries will be expecting these changes. Trust agreements will also be rather easy to adjust since there is no need to change the basic agreement. The information that must be changed is found in an ancillary document labelled Schedule A. Again, it will be a rather easy matter to adjust a cost estimate, when the adjustments are routine and expected.

The second error made in the argument presented is that inflationary impacts are and will remain slight. The argument would have validity if the reviewers could predict with confidence that the three to five percent inflation rates of the recent past will extend into the indefinite future. However, the reviewers do not make this prediction. Monetary and fiscal experts will seldom hazard predictions of this sort.

If the five-year review period were adopted and three percent inflation rates occurred during a five-year period, then inflation would erode cost estimates by slightly more that 15 percent. If that rate were to double, the erosion over five years would exceed 30 percent.

It is not reasonable to accept the chance that such losses could occur, especially since the risk of loss can be minimized at low cost.

This subpart also requires facility owners and operators to make further changes in their cost estimates if changing conditions lead to cost increases. This provision considers the very real possibility that sometime during a site's operating life circumstances can change. For example, a site investigation could uncover a ground water problem beyond the scope identified in the contingency action plan. Local government policies could also introduce substantial changes through planning efforts that either lessen or increase the importance of a land disposal facility in the county's solid waste management system. These examples do not describe extreme cases. Rather, they suggest the very real possibilities that accompany the development of a dynamic system. Since change is very likely to occur, facility plans and cost estimates must take account for change.

Subpart 3. Record retention. This subpart requires the facility owner or operator to maintain cost estimate records. The facility owner or operator must keep a copy of the latest cost estimates at the facility. The facility owner or operator must also keep a copy of any adjusted cost estimates.

This requirement keeps the facility owner or operator responsible for the cost estimates and the plans from which they are derived. The cost estimates and the plans from which they are developed will likely prove valuable planning tools for facility owners and operators. The estimates and plans will also prove useful to Agency inspectors as they examine on-site conditions during the facility's operating life. Conversely, if the plans and estimates are not available, facility operations, planning and regulatory inspections will be more difficult. Since the plans and estimates provide valuable information and having the copies at the site will make evaluation easier, facility owners and operators must retain copies.

3. Part 7035.2695 FINANCIAL ASSURANCES REQUIRED.

This part of the rules restates the legal requirement imposed on facility owners and operators by Minn. Stat. § 116.07, subd. 4h (quoted in full in the introduction to "Financial Requirements"). This requirement is restated so that facility owners and operators have a clear understanding of what they are required to do. The rules could have simply cited relevant law, but this would force the facility owners and operators to look up the reference so that they could understand this part. Many facility owners and operators are unlikely to have easy access to Minnesota Statutes. A few sentences added to the rules thus save some time and effort for the facility owners and operators.

This part also refers the reader to the next seven parts, which describe in detail the financial arrangements and contracts owners and operators can use to comply with the rules. This makes it clear to facility owners and operators that the steps they must follow are limited and fully contained within the rules. The rules thus present a reasonable guide that will help facility owners and operators understand how to operate under the new regulations.

4. Part 7035.2705 TRUST FUND.

The first compliance option described is the trust fund. A trust agreement is the contract that establishes a trust fund and governs its administration. The trust agreement involves three or more persons. The person who finances a trust is called the grantor. The fund's administrator is called a trustee, who holds legal title to the property in the trust. A trustee holds and administers a trust for the benefit of one or more persons, referred to as the beneficiary or beneficiaries. A trustee charges a fee for services.

A description of how this relationship will work may prove helpful to understand the details of the trust agreement. Once a facility owner or operator chooses to comply with the rules by using a trust fund, the facility owner or operator must choose a trustee authorized under State law to administer trusts. Payments to the trust will be based on the cost estimates developed under part 7035.2685. These payments will be set at levels that make the entrusted funds, at the time of facility closure, equal to the sum of closure, postclosure care and the expected value of contingency action costs. Disbursements from the fund will require approval from the Commissioner. This approval is given after a review of evidence that qualifying expenses have been paid. Qualifying expenses are those associated with the closure, postclosure care and contingency action plans developed for the site. The rules provide for release of the facility owner or operator from financial assurance responsibilities once the goals of the plans have been met. Any balances remaining in the trust fund after the facility owner or operator has been released from financial assurance responsibilities will be returned to the grantor.

Item A refers to the parts of the rules that relate to trust funds, items A through M of this part. The facility owner or operator is required to send the Commissioner an originally-signed duplicate of the trust agreement and a certificate of acknowledgment. The Agency must know when and under what conditions the facility owner or operator has complied with the rule.

This item also limits the choice of trustees. Not all financial institutions in the State have the authority to administer trust agreements. See Appendix VIII. Financial institutions that administer trusts must comply with extra reserve and reporting requirements. This limitation helps facility owners and operators to exercise appropriate care in choosing a trustee. This limitation keeps facility owners and operators from wasting time setting up trust agreements with financial companies that legally cannot administer trusts.

Subitem (1) requires that a copy of the trust agreement accompany the final permit application for a new land disposal facility. This means that a facility owner or operator who wants to develop a new site must establish a trust fund before the facility begins operations. This requirement provides the owner or operator of a new site with reasonable notice of the requirement to be completed before a permit can be approved.

Subitem (2) requires one group of facility owners and operators to send copies of their trust agreements to the Agency within 180 days of the effective date of the rules. This group contains those who have more than five years or more than 500,000 cubic yards of remaining capacity at their sites. This requirement puts into effect the compliance schedule directed by the Legislature in Minn. Stat. § 116.06, subd. 4h.

Subitem (3) requires all facility owners and operators not included in the group described in subitem (1) or (2) to send in copies of their trust agreements within one year of the effective date of the rules. This requirement is necessary, if the rules are to avoid serious disruption of local solid waste management systems (discussed previously under part 7035.2665, "SCOPE").

Subitem (4) pertains to any facility owner or operator who cannot meet the requirements of subitems (1) through (3). These are the facility owners and operators who cannot execute trust agreements because they have not made the appropriate cost estimates. The Commissioner will provide these persons with cost estimates that they can use until they complete their own site investigations. The facility owners and operators can then execute trust agreements and revise them when more accurate estimates derived from on-site data become available. This group of facility owners and operators is given 60 days following their initial compliance deadline to provide the Agency with executed copies of the trust agreement.

The rules cannot allow facility owners and operators to avoid the rate increases implicit in compliance with financial assurance requirements. Significant dislocations in solid waste management systems will result. It is reasonable to find and implement means to avoid these problems.

Item B refers the facility owner or operator to two other parts of the rules. These parts contain models of a trust agreement and a certification document. The rules require that the facility owner's or operator's financial instruments duplicate the models provided in part 7035.2805. This requirement reasonably limits the kinds of trust arrangements facility owners and operators can use. If all facility owners and operators use the same form, then planning and financial management will proceed from the same basis at all facilities. This is another provision that helps avoid potential disruptions. It also helps to ensure equitable treatment of all facility owners and operators.

The certification of acknowledgement is required because an independent authority must certify the authenticity of a copy of the trust agreement.

Part 7035.2720 has provisions that are the same as the provisions of this part. The following discussion will cover the similar provisions of both parts.

Item C and part 7035.2720, subpart 5, require facility owners and operators to make uniform monthly payments into the trust fund. Periodic payments will help make fund development orderly and systematic. Payment schedules that vary could cause disruptions in the solid waste management system. Steady and consistent fund development is preferable.

The first draft of these rules required annual payments. Reviewers suggested that monthly payments would be more convenient for business firms. The payments can then be arranged to fit in well with other elements of the firm's routine financial management. This suggestion was accepted and written into the rules.

Subitem (1) (and part 7035.2720, subpart 5, item A) sets the payment schedule for facility owners and operators who have new sites. These persons must make the first payments into their trust funds before they begin to receive waste at their facilities. The rules thus require these facility owners and operators to "prepay" a portion of their financial assurance responsibilities. This is similar to other customary business arrangements. Insurance and rent, for example, are ordinarily prepaid. The requirement puts financial assurance expenses on the same basis as other normal business costs.

The rules require the facility owner or operator to send the Commissioner a trustee's receipt for the first payment into the trust fund. This gives the

Commissioner a way to tell whether and when the facility owner or operator complies with the rules. The Commissioner must have this information to administer the rules.

This subitem also provides the method to calculate the required trust fund payments. The first payment must equal the sum of the cost estimates divided by the number of periods available for payment. There is no need to take inflation and earnings into account for this first payment because this is handled in the calculation methods for subsequent payments. The requirement puts all facility owners and operators on the same accounting basis, thus avoiding disruptive differences in rates and billing systems among firms.

The rules require that all following payments be made by the last day of each month following the first payment. That is, if the first payment is made on February 14, the next payment must be made by March 31; the next payment must be made by April 30; and so on. This requirement is designed to make sure trust funds develop in an orderly manner.

The rules provide a series of formulas to guide the facility owners and operators in calculating the size of trust fund payments after the first payment is made. The basic estimating formula is:

$$\text{payment} = \frac{CE - CV}{Y \times 12}$$

in which: CE = the sum of the current cost estimates,
CV = the current value of the trust fund, and
Y = the number of years remaining in the operating life of the site.

This formula is straightforward. It calculates uniform payments that, over a fixed period, will yield a desired sum. The required adjustments to cost estimates (part 7035.2685, subparts 2 and 3) will build inflationary and other cost changes into the CE variable. Annual reports from the trustee (part 7035.2805, subpart 1) will build fund earnings into the CV variable. The number 12 converts the value for the operating life of the site from years to months. However, the calculation of the operating life of the site is somewhat more complicated and requires more equations.

Tax matters lead to the more complicated equations. The tax question arose while the first draft of the financial assurance rules was being developed. That draft required that facility owners and operators fully develop trust funds within either the operating life of the site or ten years, whichever is less. Reviewers noted that patterning trust fund development in this way could have adverse tax consequences for private facility firms. Specifically, there was some question about whether money deposited in trust funds would be considered as business expenses or income by tax authorities. (Bear in mind that private firms manage nearly 70 percent of the State's mixed municipal solid wastes, so the implications affect a substantial part of the sector.) The Agency did not want to develop rules which would require an excessive drain on the resources of the solid waste management system. Allowing revenues collected for postclosure care to become general government income would not have been reasonable. The rules are developed to solve problems specific to the management of the mixed municipal solid waste stream. General revenue goals have no place in these rules.

A series of communications between the Agency and federal and State tax authorities ensued. See Appendix IX. These communications took place over a period during which Congress and the Legislature enacted significant changes in tax laws. Without going into the details of this correspondence, the final status of the issue is that revenues a facility owner or operator puts into a trust fund dedicated to closure and postclosure expenses are considered business expenses by both federal and State tax authorities. However, the facility owner or operator has to use a unit of capacity method to calculate deductions. This means that the owner or operator can deduct only the expenses attributable to production (disposal, in the land disposal site case) that occurs within the tax year. A further implication is that if the trust is to be fully funded before the site closes, then the portion of set-aside revenues associated with expenses attributable to wastes received after the fund reaches its final value are subject to the tax.

This situation could have occurred under the first draft of the rules. For example, if a facility had 15 years of remaining capacity, the facility owner or operator would have had to develop a fully-funded trust within ten years. However, a significant portion of the funds set aside in the first ten years would have been subject to the tax because some of the money collected in the first ten years would have been spent on costs attributable to wastes received during the last five years. Again, sending a greater than necessary part of facility revenues to federal and State government general funds advances no proper goal of these rules. This problem can be avoided if the trust fund pay-in period equals the operating life of the land disposal site. Then, every dollar set aside in a trust fund will be associated with a unit of waste received during a current or previous tax year.

This requires building into the trust fund payment formula a method to calculate the remaining life of the facility. The final method chosen divides into a measure of remaining capacity all of the volume expected to be used in the coming year. The formula set in the rules is:

$$Y = \frac{DC}{A \times W \times (1+B)}$$

in which:

DC = design capacity,
A = the ratio of loose to compacted waste volume achieved at the site,
B = the ratio of cover material to waste received at the site, and
W = a five-year, weighted moving average of reported annual waste receipts.

Design capacity is defined in another part of the rules (part 7035.0300, subpart 32). The ratio of compacted to loose waste converts the waste measure in the denominator to a measure of how much capacity that waste will use up when it has been compacted in the facility. The ratio of cover material to waste receipts is used to account for the amount of capacity that will be devoted to cover systems. Operators send annual reports to the Agency on the amount of waste they receive. The moving average measure will take the latest five years' reported volumes and weigh them according to a schedule that places the greatest importance on the latest data received. The weights applied are:

previous year = 0.50
two years ago = 0.25
three years ago = 0.15
four years ago = 0.07
five years ago = 0.03

An example will help illustrate how this calculation will proceed. Assume that a facility has: 1) a design capacity of 500,000 cubic yards, 2) a compacted to loose waste ratio of 0.50, and 3) a cover material to waste ratio of 0.30. Assume also the wastes received values in the following table.

Period	Wastes Received	Weight	Weighted Receipts	Five-Year Weighted Average
previous year	125,000	0.50	62,500	
two years ago	95,000	0.25	23,750	
three years ago	130,000	0.15	19,500	
four years ago	115,000	0.07	8,050	
five years ago	85,000	0.03	2,550	116,350

Using the assumed values, the estimated operating life of the site (Y) becomes:

$$Y = \frac{DC}{(A)(W)(1+B)} \qquad DC = 500{,}000,\ A = 0.5,\ B = 0.3,\ W = 116{,}350$$

$$Y = \frac{500{,}000}{(0.5)(116{,}350)(1.3)}$$

$$= 6.61 \text{ years}$$

This value of Y would be used to calculate the first year of payments into the trust fund. A recalculation of the operating life of the site would then be made along with other adjustments when the year of payments is finished. This means that the process of developing the trust fund will be regularly updated and made to account for local conditions. It also means that each dollar set aside for the trust fund will reach the fund, and none will be taken for taxes. This system for calculating trust fund payments is consistent with the legislative directive to adopt financial assurance rules and it avoids taxation.

Subitem (2) (and part 7035.2720, subpart 5, item B) sets the payment schedule for owners and operators who have existing land disposal sites. The rules require these facility owners and operators to make the first payments into their trust funds one year after the effective date of the rules. This requirement makes no distinction about the size of the site or its remaining life. This means that the financial impact of the rules will be felt at all sites at the same time.

This removes an objection some reviewers had to the first draft of the rules. That draft had a staggered payment schedule that corresponded to the staggered compliance schedule. Recall that the facility owners and operators have different dates by which they must notify the Agency that they have executed the required financial agreements. The 500,000 cubic yard or five-year remaining life criterion determines whether the facility owner or operator has six months or a year to send copies of financial instruments to the Agency. The first draft of the rules required facility owners and operators to make their first payments at the same time they sent in evidence of financial contracts. This would have meant that some sites would incur financial assurance costs while others, perhaps competitors, would have six months of grace. This would lead to the sorts of disruptions in solid waste management that the Agency wants to make every effort to avoid. The simple and reasonable solution is to set up the rules so that all persons incur financial assurance costs at the same time.

The rest of the subitem gives owners and operators the details of how to calculate their trust payments. This system is the same as the system discussed in subitem (1) above which covers the permittees who have new sites.

Subitem (3) (and part 7035.2720, subpart 5, item C) covers situations in which the owner or operator has established a trust fund before the rules become effective. Such cases have occurred as permits are upgraded and individual financial assurance requirements are imposed, usually only for closure and postclosure care expenses. These facilities have, in effect, begun to comply with parts of the rules before they are adopted. It would not be reasonable to require them to begin a new financial assurance program. This would ignore the balances already accumulated. Instead, this subitem of the rules takes previous balances into account.

The owner or operator is required to consider the amounts in the pre-existing trust fund as the value CV in the payment formula. The permittee then calculates payments according to the system presented in subitem (1).

Subitem (4) (and part 7035.2720, subpart 5, item D) requires owners and operators annually to revise the operating life estimate. This recalculation must be made so that the trust fund payment will reflect actual site conditions. If the value for the operating life of the site remains constant, then the denominator of the payment formula becomes a constant. This means the payment would decline with time because the numerator will decline as the value of the trust increases.

Recall the basic formula used to calculate trust fund payments:

$$\text{payment} = \frac{CE - CV}{Y \times 12}$$

Apply this formula to two different cases; one in which the operating life estimate does not change (Y constant) and one in which new estimates are made annually (Y variable) as required in the proposed rules. Assume that the cost estimate (CE) is $500,000 and the initial operating life estimate is ten years. The table below presents the results in current dollar terms.

Trust Fund Payments
(Constant Dollars)

CE = $500,000
INITIAL Y = 10

	Monthly Payments		Cumulative Balances	
Year	Y Constant	Y Variable	Y Constant	Y Variable
1	$4,167	$4,167	$50,000	$50,000
2	$3,750	$4,167	$95,000	$100,000
3	$3,375	$4,167	$135,500	$150,000
4	$3,038	$4,167	$171,950	$200,000
5	$2,734	$4,167	$204,755	$250,000
6	$2,460	$4,167	$234,280	$300,000
7	$2,214	$4,167	$260,852	$350,000
8	$1,993	$4,167	$284,766	$400,000
9	$1,794	$4,167	$306,290	$450,000
10	$1,614	$4,167	$325,661	$500,000

As demonstrated, it is reasonable to adjust the operating life estimate because the facility owner or operator would not be able to develop adequate funds before site closure without such adjustments.

Subitem (5) (and part 7035.2720, subpart 5, item E) places a voluntary ceiling on the unit-based trust fund pay-in rate. A unit-based rate is one that is defined in terms of a constant unit of measure; a cubic yard of solid waste, in this case. The facility owner or operator can determine the unit-based rate by dividing into the total payment the amount of waste receipts expected for the appropriate period. Refer again to the example presented in the discussion regarding subitem (4). If the land disposal site in that example takes in 100,000 cubic yards of waste a year, then the unit-based pay-in rate is $50,000/100,000 cubic yards = $0.50 per cubic yard.

This subitem allows the facility owner or operator to limit the size of the unit-based pay-in rate. That rate need not exceed the unit-based rate charged for disposal services (usually referred to as a tipping fee) in the previous period. Consider another example in which a facility owner or operator charges $2.50/cubic yard and the unit-based pay-in rate is estimated at $3.50/cubic yard. The facility owner or operator does not have to add the full $3.50 to the tipping fee during the first year of compliance. Instead, the facility owner or operator can add only $2.50 in the first year. Further adjustments must be made during the second year, when the voluntary ceiling is raised from $2.50 to $5.00.

Some facility owners and operators do not charge tipping fees. They receive their revenues from tax sources. These persons could not make use of a voluntary ceiling based only on tipping fees. This item makes a special provision for such instances. Facility owners and operators who do not charge tipping fees can calculate their voluntary pay-in rate ceiling by dividing total annual costs by total annual waste receipts. This amounts to the same sort of calculation that most facility owners and operators make when they establish their tipping fees. This provision reasonably puts all facility owners and operators on an equal footing with respect to the voluntary pay-in rate ceiling.

This provision was added to the first draft of the rules in response to reviewers' claims that the financial impact of rule compliance would be too great. The voluntary ceiling provides a way for facility owners and operators to ease the initial impact of the rules on their rates. The ceiling thus avoids disruptions without hindering the goals of the financial assurance rules.

Item D (and part 7035.2720, subpart 6) describes a way for facility owners and operators to pay even less than the amounts calculated under item C. This provision, like the voluntary ceiling, was made part of the rules to avoid disruptive financial impacts. This item puts in place a test of the facility owner's or operator's ability to pay the costs of compliance. The test consists of a demonstration that strict compliance with the rules will cause specified financial or economic indicators developed at the owner's or operator's facility to exceed criteria written in the rule.

Subitem (1) specifies the ability-to-pay test for private firms. The test criterion is:

test value = cash flow - 150% (depreciation costs)

in which: cash flow = net income
+ depreciation costs
+ amortizations of intangible assets

net income = total sales
- (cost of goods sold + expenses)

This criterion relies on cash as the basic measure of how much the facility owner or operator can afford. Cash available to the business firm consists of net income from operations plus the class of costs referred to as noncash expenses. These expenses are legitimate business costs, but they do not make any claim on current cash. Thus, depreciation of asset values, although an expense the firm must account for, does not take up any of the firm's cash assets. The only other noncash expense likely to appear on a facility's financial statement is the amortization of intangible assets. These assets have value because of some right or benefit that they give to the facility owner or operator, even though they have no physical existence. Examples of intangible assets include: patents, copyrights and trademarks; leases, leaseholds, and lease improvements; licenses and franchises; formulas and processes; and goodwill. These assets, if claimed, are valued initially at cost and their value is lowered each year, a process referred to as amortization.

The first measure in the test establishes how much cash the firm has on hand. Cash-on-hand cannot serve as the single test of ability-to-pay because business firms must reinvest in assets if they are to maintain operations. The need for reinvestment arises because equipment wears out or becomes obsolete. If the firm were to be left with no cash available for reinvestment, its capital stock would dwindle and become unproductive. The firm could not continue in business under these conditions. The need for reinvestment is the reason why the test reduces cash flow by 150 percent of depreciation costs. This amount defines the level of investment needed to maintain business operations at current levels. The 150 percent measure was developed by the U.S. Environmental Protection Agency (EPA) for use in negotiations with private firms over superfund settlements (Reference 19).

EPA derived this estimate from an examination of the financial statements of 25 chemical and hazardous waste management firms. These are publicly-held firms which the Securities and Exchange Commission (SEC) requires to file financial statements. (Minnesota's facilities are seldom publicly-held corporations, so the Agency does not have access to a comparable sample which would more accurately reflect regional and sectoral conditions.) This investigation showed that the average value these firms reported for current depreciation was nearly 150 percent of depreciation measured at historic cost levels. The adjusted measure accounts for inflation in reporting depreciation costs; a requirement the SEC adopted in 1979.

Combining the two measures results in a value that can be thought of as a limit beyond which the business firm cannot afford to take on more expense. The equation can also be shortened through some simple algebra.

$$\begin{aligned}\text{test value} &= \text{cash flow} - 150\% \text{ (depreciation costs)}\\ &= \text{(net income + amortization + depreciation)} - 1.5 \text{ (depreciation)}\\ &= \text{(net income + amortization)} - 0.5 \text{ (depreciation)}\end{aligned}$$

This test provides a prudent measure of the facility owner's or operator's capability to perform the activities required in the rules. A test of this sort fits in well with laws already in effect. Minn. Stat. ch. 400 gives counties outside the metropolitan area a great deal of responsibility for solid waste management. Among other responsibilities, counties must make a financial assessment of facilities that receive county licenses or permits.

> No permit or license shall be issued for a mixed municipal solid waste facility unless the applicant has demonstrated to the satisfaction of the county board the availability of revenues necessary to operate the facility in accordance with applicable state and local laws, ordinances, and rules. . . .

Minn. Stat. § 400.16 (1986).

Experience indicates that counties have not systematically applied this test to facilities in their jurisdiction. The ability-to-pay test included in the proposed rules could serve county governments as well as the Agency. Counties could use the findings of these tests to discharge their responsibilities under chapter 400.

Consider an example in which the trust fund payments calculated are $250,000 per year. This means that if that firm's net income plus amortizations less half the firm's depreciation costs exceed $250,000, then the rules require the firm to make full payment into its trust fund. However, if the test value falls short of the calculated payment, the facility owner or operator begins a review process that is explained under subitem (3) below.

This provision of the rules imposes a reasonable condition on facility owners and operators. If the facility owner or operator has enough resources to develop the trust fund, it should be done. However, if the facility owner or operator maintains that a trust fund cannot be developed, then this assertion must be proven. The proof required consists of three years' financial statements. Facility owners and operators who argue excessive cost must send the Agency the three previous years' balance sheets, income statements and funds statements, along with a certified public accountant's statement that the financial reports are accurate. These reports will provide Agency reviewers with information to verify the claim.

Subitem (2) of this part and part 7035.2720, subpart 6, item A, describe the ability-to-pay test for a nonprivate facility owner or operator. Most public sector facility owners and operators are county governments. However, the Agency has also issued permits to cities and authorities. These facility owners and operators would not benefit from using the same ability-to-pay test that is designed for private firms. Public sector facility owners and operators do not use the same accounting conventions and they do not manage their facilities so that they can maximize net income. These facility owners and operators require a different test.

A complication in estimating a public sector facility owner's or operator's ability-to-pay is that not all use the same revenue system. Some charge tipping fees at facilities, just as private firms do. However, a significant number of others rely on local tax revenues. In some cases the revenue picture is mixed; with facility owners and operators taking in tipping fee revenues and also receiving a local government subsidy. The test selected relies not on facility financial data, but on economic and census data gathered in the service area.

The test relates to per capita income in the service area. The criterion value is 0.1 percent of per capita income. If the unit-based trust fund pay-in rate is shown to increase disposal costs per capita by more than 0.1 percent, then this is construed as a compliance burden worth examination and the review process described under subitem (3) begins.

Facility owners and operators using this test will also present evidence for their claim that they cannot afford to comply with the rules. Since the Agency will have cost estimates available, the owner or operator will only have to provide evidence on per capita income. This information is available through the State Demographer's Office of the State Planning Agency.

Returning again to the example presented under subitem (1), the $250,000 annual payment can be used to show how the ability-to-pay test for public sector facility owners or operators works. Assume the permittee is a county government and the county has a population of 25,000, with a per capita income of $10,000. (These values are nearly equal to the latest statewide averages.) This yields an annual cost of compliance per capita of $250,000/25,000 = $10. This number is below the trigger value of $10,000 x .001 = $50/year. This case would not trigger the review process.

The assumptions can be changed to approximate conditions in some of the poorest counties. Assume per capita income is $5,000 and the population of families is 3,500. The annual cost of compliance is $250,000/3,500 = $71.40/year. And the trigger value is $5,000 x .001 = $25. The calculated cost per family exceeds the trigger value. This means the review process described in the next subitem would begin.

This approach to measuring a public sector facility owner's or operator's ability-to-pay is reasonable because it is the best use of data that are both appropriate and available. Public sector facility owners and operators do not have uniform accounting methods, so the test cannot rely solely on data generated at facilities. The rules select the reasonable alternative of relying on data generated by an independent party, the State Demographer's Office. The demographic data play a role analagous to that of the certified public accountant in the ability-to-pay test for private firms. That is, both serve as independent checks of the facility owners' or operators' claims. Since facility data will not serve as a basis for the test, it is reasonable to use information on per capita income as the test basis. Individual facility users will have to bear the costs in any case, so consideration of their available resources is appropriate.

Subitem (3) (and part 7035.2720, subpart 6, item B) describe how the facility owner or operator should proceed if the test indicates that compliance costs will exceed test criteria. The rule requires the Commissioner to consult with the facility owner or operator. They have to determine together whether it is possible for the facility to earn enough revenue to comply with the rules. The information needed to make this determination consists of:

a) waste stream data - both current data and ten-year forecasts;
b) financial management data - ten-year pro forma statements of operating income and expense;
c) ten-year forecasts of demographic and economic trends expected to prevail in the service area;
d) documents developed in support of the above analyses; and
e) any other data the owner or operator believes have a bearing on the question of whether the facility's likely revenue stream can both support the facility and develop a trust fund of the required size.

These data will provide the information needed to judge whether the facility owner or operator can comply with the rules. These judgments will take into account the data listed above and any other data the facility owner or operator thinks are appropriate. The Agency will be required to consider all the circumstances that will affect the site's operating life and revenues. These analyses are required of any planning effort. Decisions about the future of facilities must be informed by the best available data.

Subitem (4) and part 7035.2720, subpart 6, item C, describe what will happen when the Commissioner and the facility owner or operator have finished the data analysis and decided what they believe are the facility's reasonable prospects for the future. If it is determined that the facility will operate beyond the limits imposed by current fees and plans, then the calculations made under item C can be changed. For example, the operating life may be increased, with the Commissioner's approval, so that it both reflects the site's likely future and results in full development of a properly sized trust fund.

The facility owner or operator may also decide to make trust fund payments greater than those that would cause the facility to fail the ability-to-pay test. This option accommodates facility owners and operators who believe they must have a facility regardless of the cost.

Finally, if the Commissioner determines that the facility owner or operator cannot feasibly comply with the rule, a closure schedule as described in other parts of the rules (parts 7035.2625 and 7035.2635) must be developed. This is the only reasonable answer to the problem. The analytical process will consider all relevant data, and will solicit additional data from the facility owner or operator. This means the facility owner or operator will be given every possible consideration. If available information proves only that the facility owner or operator will not have enough time or waste receipts to develop a trust fund large enough to meet estimated costs, then site closure makes sense. Continued operations will only make matters worse, as more waste is disposed of at a site where the facility owner or operator cannot meet the postclosure obligations.

The closure procedure will not be an instantaneous event. It is not expected that the Commissioner will find a need to close a facility on one day and the site will be fully closed on the next day. Since all parties will understand that the closure process takes time, the closure schedule will be developed so that reserved funds commensurate with the facility owner's or operator's ability to pay will at least meet closure costs.

Item E of this part and subpart 7 of part 7035.2720 allow the facility owner or operator to pay into the trust fund at a rate faster than that determined under item C. This provision makes the rules more flexible. It allows the facility owners and operators, especially those in the public sector, discretion to set financial management plans. This could prove useful for some facility owners and operators. For example, an owner or operator may fully fund the trust with the first payment and amortize this cost over the life of the site. A public sector facility owner or operator could do this through bond sales. The advantage is that this standardizes costs. If trust fund earnings exceed inflation rates, as expected, there would then be no need for periodic changes in tipping fees. The portion of tipping fees needed to pay financial assurance costs would be fixed; determined by the bond payback schedule. The rules thus allow for the special planning needs of some facility owners or operators.

Item F of this part and subpart 8 of part 7035.2720 relate to cases in which facility owners and operators begin to comply with the rules through the use of some financial instrument other than a trust fund. This item requires those who switch to a trust fund to make their first deposit equal to the fund balance that would have resulted if they had chosen a trust fund from the beginning.

For example, assume a facility owner or operator first submits a surety bond in compliance with the rules and maintains the bond for three years. If the facility owner or operator then wants to set up a trust fund, the calculation of the first payment made into the trust fund will be different than the provisions written in item C. The facility owner or operator will have to follow the directions provided in item C, but the site operating life assumptions change.

Instead of taking a current point of view, the facility owner or operator must make the operating life estimate from the initial point of compliance, i.e., when the surety bond is first submitted. Given a pay-in amount determined from the initial compliance date, the facility owner or operator then has to multiply that amount by the number of periods in which trust fund payments were not made. This makes the initial payment equal to the amount that would have been in the fund if the facility owner or operator had chosen to develop the trust fund from the start.

This provision allows further flexibility in financial planning, while at the same time protecting the interests of facility users. A number of reviewers raised opportunity cost objections to the trust fund alternative. These reviewers did not like the idea of setting aside resources and not using them until a future date. They want to be able to use the set aside funds in a productive manner. Item F allows facility owners and operators to do that, as long as they are prudent in using the resources that will be needed to finance postclosure costs.

For example, a facility owner or operator can execute surety agreements for an entire site. The facility owner or operator can at the same time set aside postclosure funds that remain under individual control. When the time comes to close the site, the facility owner or operator can execute a trust agreement using the reserved fund for this purpose.

This provision reasonably protects the interests of all parties. The facility owners and operators retain use of set-aside funds and facility users get the protection offered by the surety. When the site has closed, a trustee provides the needed security. The same advantage is obtained if the facility owner or operator chooses to purchase a letter of credit. This arrangement is made formal in another part of the rules (part 7035.2725). This provision provides facility owners and operators with as much flexibility as possible.

Item G and subpart 9 of part 7035.2720 cover situations in which events cause a change in cost estimates. There are circumstances that could lead to changes in cost estimates (e.g., local waste designation, response action work or changes in State laws or rules). Provisions in this item give facility users and the Agency assurance that such changes will be taken into account in the development of trust funds.

If a change increases costs and the trust fund is not large enough, the facility owner or operator has 60 days to make appropriate adjustments. The facility owner or operator can either adjust the trust fund pay-in rate or rely on other financial instruments to cover the difference. This requirement gives facility users and the Agency assurance that the trust fund will be developed to reflect current conditions.

Item H and subpart 10 of part 7035.2720 give facility owners and operators the same assurances provided to facility users and the Agency under item G. This provision makes it possible for the facility owner or operator to get a refund if site conditions change and the value of the trust fund exceeds cost estimates.

The facility owner or operator must send the Commissioner a written request for release of the excess funds. The facility owner or operator must submit evidence of the difference between the cost estimates and the fund balance. Facility owners and operators should not have to set aside more resources than are needed.

Item I and subpart 11 of part 7035.2720 allow the facility owner or operator to substitute another financial instrument for the trust fund. When this occurs, the facility owner or operator must send the Commissioner a written request to release funds held in trust. This allows the facility owner or operator to free up the resources held in the trust fund. Once the facility owner or operator has executed an acceptable alternate instrument, there is no further need for the trust fund.

Item J and subpart 12 of part 7035.2720 set limits on the time the Commissioner has before responding to requests sent in under items H and I. Facility owners and operators should not have to wait indefinitely for excess funds to be returned. This item requires the Commissioner to instruct the trustee to release the requested funds within 60 days after receiving the request. The release is limited to amounts in excess of current cost estimates.

Item K and subpart 13 of part 7035.2720 relate to missing or late trust fund payments. If a facility owner or operator misses a scheduled trust fund payment, the trustee has to notify both the facility owner or operator and the Commissioner within ten days. This notice requirement is customary. Representatives of trust companies have said they can easily manage such reporting requirements.

The facility owner or operator has 60 days after the Commissioner receives notice of nonpayment to make up the payment. This allows the facility owner or operator a reasonable time in which to correct the error.

The facility owner or operator may not accept any waste during the period that begins when the trustee sends notice of nonpayment and ends when the 60-day grace period is over. This requirement gives the facility owner or operator an incentive to make up the missing payment. The orderly development of the trust fund is important enough to merit strong disincentives to breaking the pattern of regular payments. The requirement presents the facility owner or operator with two disincentives. First, the facility owner or operator cannot continue to do business. Second, the facility owner or operator will have to place intermediate cover over any open surface (part 7035.2815, subpart 6, item B).

If the facility owner or operator does not make the missing payment within the 60-day grace period, the site must be closed. This requirement makes sense because the facility owner or operator who cannot make the missing payment within 60 days is unlikely ever to make the needed payment. The alternative to this requirement is allowing the site to stay open. This would simply worsen the problem caused by missing trust fund payments. The problem is that more waste adds to costs at a time when the facility owner or operator is not setting aside funds to cover those costs.

The best that can reasonably be done when a facility owner or operator refuses to further develop the trust fund is to ease the problem by closing the site. Since the in-payments are set on a monthly basis, the difference between incurred and estimated costs may be small enough to fall within contingency allowances included in the appropriate plans.

Item L and subpart 14 of part 7035.2720 describe how money in the trust fund is to be used. The first part of this item specifies that money in the trust fund can only be used to reimburse someone for expenses incurred. This means that the money cannot be released as an advance for upcoming expenses.

Some reviewers have said this provision will make it difficult for facility owners and operators to find contractors to do the work needed. This criticism has little basis. First, contractors are not ordinarily paid in advance. Instead, they receive regular payments for orderly progress on a specified work schedule or they are paid as they complete specified major features of the project. Second, contractors do not have to be paid directly from the trust fund. An alternative arrangement could have the facility owner or operator pay the contractor. The trust would reimburse the facility owner or operator in such a case. Facility owners and operators could incur financing expenses under such arrangements, but there is no prohibition against including these costs in closure, postclosure care or contingency action plans.

This requirement may increase cost estimates by an amount that represents the short-term (90-day) opportunity cost incurred while the contractor or the owner or operator waits for reimbursement. This amount will not likely grow to any large fraction of total project costs. The savings in reduced risk justify the nominal cost increases. Risks fall because the funds withheld form a powerful incentive for facility owners or operators and contractors to do a good job. The disincentive should encourage contractors to avoid front-end loading, which happens when the contractor schedules the largest costs during the early part of the project period. Front-end loading lets the contractor recoup the greatest portion of cost during the earliest phases of the project, which dilutes performance incentives during later phases.

Advance payment would also add substantial risk of fund shortfalls if any project work is so poorly done that it either incurs added cost or has to be done over. This condition would mean that the portion of the trust fund advanced would be lost. The trust would then be underfunded. Since most costs will be incurred after site closure, the shortfall would likely be permanent.

The advantage that advance payment offers facility owners and operators and contractors will not likely offset the risks that an advance payment system adds to a process that must take a conservative approach to long-term care at facilities. Reserving trust fund resources for reimbursement is a prudent and reasonable measure.

Item L allows the Commissioner up to 90 days to approve the release of funds. This time is allowed so that the Commissioner can review the requests for reimbursement and inspect the site to make sure that work is properly done. Ninety days is needed to make sure reviews and inspections can be accomplished with due care. Although review and inspection at an individual site may not take long, the Agency has responsibility for sites throughout the State. The demand on Agency staff time could be too great at any given point to perform needed review and inspection in less than 90 days. The 90-day review period is reasonable because any shorter period could easily do a disservice to facility users and neighbors.

When the Commissioner is satisfied that the reimbursement request is proper, the trustee will be told to release the funds to the facility owner or operator or an authorized contractor. However, if the Commissioner has reason to believe that costs will exceed the value of the trust fund, reimbursement may be withheld. This provision drew some criticism from reviewers. The reviewers said that this provision served no useful purpose. Once the funds have been gathered and the facility site is closed, there will be no way an owner or operator can take in more revenue. The criticism assumes that the withholding provision is designed to make the facility owner or operator pay more. In fact, the provision is designed to protect the integrity of the trust fund. If closure or postclosure operations have begun and it becomes obvious that something has gone wrong and the work will have to start over, there is no point in using the limited resources of the trust fund to pay for inadequate work. That failure should be the responsibility of the facility owner or operator or contractor who made the error. Using the resources of the trust fund to assume normal contracting risks dilutes needed incentives. Instead, the fund's resources should be used only for correcting the initial mistake. The only reasonable guide for trust fund management is the economic use of limited resources. The Agency has to assume a conservative approach in approving disbursements. Requests for reimbursement and the completed work associated with the expense must be carefully reviewed to make sure that expenses are appropriate and that once an expense is incurred it will not appear again.

The rules also constrain the Commissioner's discretion in withholding funds. Facility owners and operators should not have to face losses without reason. Unit costs in engineering plans and cost estimates will provide the Commissioner with the criteria needed to make the withholding decision. To withhold funds, the Commissioner must demonstrate that unit costs incurred at the site have exceeded the contingency allowances made for these costs. The units of measure will likely vary for different cost elements. For example, cover material expenses will likely be estimated as costs per acre or costs per cubic yard, while some postclosure costs will be reported in costs per well or costs per well per foot of depth. Using the unit cost criterion will ensure that any decision the Commissioner makes to withhold reimbursement will be well grounded in a thorough review of the reimbursement request and the appropriate site plan. This requirement reasonably constrains the Commissioner's ability to limit trust fund disbursements.

The rule further requires that the Commissioner give the facility owner or operator written notice of the decision to withhold reimbursement. This notice must be sent within 30 days after the decision is made. The notice has to contain a statement of the Commissioner's reasons for making the decision. This provision reasonably gives facility owners or operators and contractors timely and appropriate notice if they are to be refused reimbursement from the trust fund.

Some reviewers believe this item should contain more procedural detail. They think this section should describe the steps the Agency must use to take control of the trust fund if the facility owner or operator proves unable or unwilling to do required work. The question is not a matter of the Agency's control of a trust fund. The Agency's role with respect to the trust will not change, regardless of the owner's or operator's actions. The Agency cannot receive money from the trust. The Agency is limited to directing the trustee's reimbursement payments.

The question is more correctly understood as a consideration of the steps the Agency must take to use a trust fund to reimburse someone other than the owner or operator of the facility. The proposed rules allow the Commissioner to make reimbursement to "an owner, operator or other person authorized to perform those actions . . . ." No one is likely to undertake unauthorized closure, postclosure care or corrective actions at a land disposal site. Another person may receive authority to conduct such operations only from the owner or operator or from the Agency. If the permit is active, only the facility owner or operator can authorize someone to do the work. The Agency can only grant such authority if the permit has been revoked.

The Agency believes existing rules (Parts 7001.0170, 7001.0180 and 7001.0190) give facility owners and operators sufficient procedural protection in these circumstances. It is not reasonable to add new procedures when existing procedures have proven adequate and when these existing procedures offer facility owners and operators the protection they seek.

Item M and subpart 15 of part 7035.2720 describe the conditions under which the Commissioner must allow the trust agreement to end. The first condition is met if the facility owner or operator substitutes another allowable instrument for the trust fund. The second condition is met if the Agency releases the facility owner or operator from responsibility to comply with the financial assurance rules under part 7035.2775, which is described below. Both conditions describe circumstances under which the trust fund no longer serves a purpose. The trust agreement should be ended when it is not needed.

5. Part 7035.2715 TRUST FUND FOR UNRELATED SITES.

This part describes an alternative way that facility owners and operators can use trust funds to comply with the rules. The phrase, unrelated sites, in the title for this part refers to sites that do not have the same facility owner or operator. Groups of facility owners and operators can execute agreements with a single trustee. This allows the facility owners and operators to take advantage of economies of scale that would not obtain if they each developed individual trust funds.

Trustees charge for their services. Charges generally are based on the size of the trust fund and the amount of service required. Trustees charge less per dollar as the size of the trust increases. This means that a group of facility owners and operators who set up a single trust will incur lower unit-based administrative costs. Allowing combined trust funds saves money without compromising the goals of the rules.

Trusts set up in this manner are required to operate in the same way as trusts set up under part 7035.2705. The two systems cannot be exactly the same, since there will be a need to keep individual sites' contributions and other activities separate. The rules establish this separation by specifying the ways in which the group trust funds differ from the individual trust funds.

Item A requires the trustee to keep separate accounts for each facility owner or operator. The facility owners and operators, the trustees and the Agency need to know who put how much money into the trust. Without proper accounting, no one could tell how much is available for each site. This item also requires trustees to make annual evaluations of the separate accounts.

This provision ensures that everyone knows the size of each site's trust fund. The accurate accounting required under this item protects the interests of all parties.

Item B requires the trustees to provide the Commissioner and the facility owners and operators with annual evaluations of the separate accounts. This gives information needed to make financial plans. It also gives the Commissioner information needed to decide whether the facility owners and operators have complied with the rules. This provision serves the interests of all parties.

Item C specifies that any releases authorized by the Commissioner should be made only from the account of the individual site. This requirement helps to keep each facility owner's or operator's account separate from the others.

Item D requires trustees to make reimbursements for qualified costs only from appropriate accounts. That is, if the Commissioner tells a trustee to make a reimbursement, the trustee must take the money from the account developed by the facility owner or operator who has the site at which the costs are incurred. This is included so that individual contributions and deductions from the trust are kept separate. The interests of all parties are protected.

Item E is included so that decisions to withhold reimbursement affect only individual sites. The rules require the Commissioner to refer to an individual facility owner's or operator's account when making a decision not to reimburse for expenses. The Commissioner cannot consider the size of the whole trust fund when comparing incurred expenses with estimated costs. This is another way of making sure that individual facility owner's and operator's accounts do not get mixed up. Again, the provision protects the interests of all parties.

6. Part 7035.2720 DEDICATED LONG-TERM CARE TRUST FUNDS.

This part applies to dedicated long-term care trust funds. Only public sector facility owners or operators may choose this option. The dedicated long-term care trust funds are to be established in the treasuries of governmental subdivisions. The funds will remain under local managerial control, subject to constraints specified in this part. This option is quite different from the conventional trust arrangement allowed under part 7035.2705.

The Agency expects that most private sector facility owners or operators will establish conventional trust arrangements. This is appropriate because bankruptcy law allows private firms to dissolve. Allowing private sector facility owners or operators to keep control of local reserves would magnify the risks associated with business failure that are incurred by facility users, nearby property owners and the Agency.

This type of risk does not occur in cases that involve public sector facility owners or operators. These facility owners or operators cannot liquidate, as a private firm can. This means that even in extreme cases, such as complete site abandonment and defiance of legitimate orders, an identifiable responsible party will be available.

Item A allows qualified public sector facility owners or operators to comply with the rules by establishing special funds in their treasuries. The rules specifically require the development of a fund because public sector accounting is organized to report activities financed by individual funds.

Private sector financial reporting is organized to give managers and reviewers information about the way a firm's activities interact to produce profit or loss. A private firm's activities are similar enough that only a few conventional categories are needed to provide meaningful information. For example, income statements can often suffice if they report expenses incurred under production (cost of goods sold), administrative (overhead) and operational categories, with a miscellaneous category used to handle incidental expenses and taxes. There is often no purpose served by further disaggregating the reporting of activities.

However, diversity can make it useful for a firm to depart from this general rule. As a firm's productive activities become differentiated, reporting on the financial results for broad enterprise categories begins to make sense. For example, a diversified firm may want to provide separate information on production-oriented and service-oriented subsidiaries. Likewise, if subsidiaries behave as trading partners, buying and selling goods and services to and from each other, separate financial reporting for enterprise groups can be a meaningful addition to consolidated financial statements. Such reporting gives reviewers a better understanding of how the firm's diversified elements relate and which elements are contributing the most to the firm's performance.

Public sector accounting is organized like the disaggregated reporting of a diversified private sector firm. Public sector facility owners or operators are not concerned with profit performance, but they must be concerned with budget performance. Their responsibilities cover a variety of quite different activities. For example, funded activities found in a selection of local government financial statements include: public safety, highways and streets, sanitation, recreation, libraries, civil defense, agricultural society, cooperative extension, parks, and retirement. Each activity has its own budget allocation and some activities have separate revenue sources. The public sector financial manager's concern is to make sure that none of the activities' costs exceeds budget allocations. A common reporting format will organize similar revenue and expense types for each individual fund established in the municipal treasury. Such a report usually includes a summary which aggregates all costs and revenues for all activity funds. Reports will often compare budget estimates with actual costs incurred. Ancillary reports can be developed to provide more detail about individual funds.

Another reason for the fund orientation of public sector accounting is the lack of an equity balance that can absorb earnings or pay for losses. Customary public sector accounting requires that any surpluses remaining at the end of a budget period must be turned back to the general treasury fund from which all activity funds receive allocations. That is, activity funds cannot save money and accumulate balances. Special sinking fund arrangements can be used to allow accruals when appropriate, but these arrangements are not common. Budget and tax (revenue) estimates depend on forecasts of activity fund surpluses or deficits. Without a way to accumulate surpluses or undischarged liabilities, public sector accounting systems have focused on activity funds to provide useful information.

Part 7035.2720 is thus written in a way to accommodate the fund orientation of public sector accounting systems.

The fund established must be dedicated to pay for expenses identified in the closure, postclosure care and contingency action plans required under other rules. Facility owners or operators who choose this option must enact resolutions which establish the funds and restrict their uses. This requirement is included to prevent financial reserves from being used for other purposes. It is reasonable to use Agency rules to restrict public sector facility owners' or operators' use of reserves accumulated for long-term care at facility sites because there is no other law or rule which provides similar restrictions. In fact, Minn. Stat. § 385.32 specifically allows activity fund transfers to make up for shortfalls. Prudence dictates that the rules allow no possibility that locally-developed financial reserves be misallocated.

A facility owner or operator choosing this option must designate a trustee for the dedicated long-term care trust fund. The facility owner or operator in this case would be a governmental unit or a body created by government(s). This facility owner or operator is responsible for meeting all permit conditions and complying with all rules. However, there must be a clear designation of a named person who has managerial responsibility for the fund. This clear designation of authority means the Agency and the facility owner or operator know who must perform the activities required in this rule. Without such a designation the Agency and the facility owner or operator could waste considerable time sorting out detailed responsibilities each time some action is required. This provision is reasonable because it eliminates a potential source of confusion. The named trustee incurs a fiduciary responsibility for the dedicated long-term care trust fund. Following are some general statements of law regarding fiduciary responsibility.

> FIDUCIARY CAPACITY:
>
> One is said to act in a "fiduciary capacity" or to receive money or contract a debt in a "fiduciary capacity," when the business which he transacts, or the money or property which he handles, is not his own or for his own benefit, but for the benefit of another person, as to whom he stands in a relation implying and necessitating great confidence and trust on the one part and a high degree of good faith on the other part. The term is not restricted to technical or express trusts, but includes also such offices or relations as those of an attorney at law, a guardian, executor, or broker, a director of a corporation, and a public officer.
>
> FIDUCIARY RELATION:
>
> An expression including both technical fiduciary relations and those informal relations which exist whenever one [person] trusts and relies upon another. It exists where there is special confidence reposed in one who in equity and good conscience is bound to act in good faith and with due regard to interests of one reposing the confidence. A relation subsisting between two persons in regard to a business, contract, or piece of property, or in regard to the general business or estate of one of them, of such a character that each must repose trust and confidence in the other and must exercise a corresponding degree of fairness and good faith.
>
> Out of such a relation, the law raises the rule that neither party may exert influence or pressure upon the other, take selfish advantage of his trust, or deal with the subject matter of the trust in such a way as to benefit himself or prejudice the other except in the exercise of the utmost good faith and with the full knowledge and consent of that other, business shrewdness, hard bargaining, and astuteness to take advantage of the forgetfulness or negligence of another being totally prohibited as between persons standing in such a relation to each other. . . .

Reference 20.

This provision places on the designated trustee the responsibility to act solely in the interest of the trust. The Agency cannot take part in all decisions that involve the trust. However, the designated trustee will be involved in all such decisions. The imposition of fiduciary responsibilities requires the trustee to place the trust's interests above all other interests and to act accordingly.

This requirement is placed on the trustee because no provision of this rule or current law can prohibit a local government from acting on resolutions. This means that a public sector facility owner or operator could comply with the rule at first, develop a sizable reserve fund, then rescind the initial resolution and use fund assets for any purpose. Likewise, resolutions can be amended in ways that dilute or confound original purposes. The trustee's fiduciary responsibilities require that he or she speak out against such actions and report them to the Agency if such actions take effect. This provision is reasonable because it gives local facility users and the Agency the secure knowledge that at least one local official is bound to act to preserve the dedicated long-term care trust fund for its original purposes. If the trustee acts in any way against the trust's interests, he or she will become liable for civil penalties.

Item A requires that a copy of the resolution that establishes the fund must accompany the final permit application for a new land disposal facility. This means that a facility owner or operator who wants to develop a new site must establish a dedicated long-term care trust fund before the facility begins operations. This provision gives the facility owner or operator of a new site notice of a requirement that must be met before a facility permit can be approved.

Item B requires one group of facility owners and operators to send copies of establishing resolutions to the Agency within 180 days of the effective date of the rules. This group contains those who have more than five years or more than 500,000 cubic yards of remaining capacity at their facility sites. This requirement puts into effect the compliance schedule directed by the Legislature in Minn. Stat. § 116.07, subd. 4h.

Item C requires all facility owners and operators not included in the group described in item B to send in copies of their establishing resolutions within one year of the effective date of the rules. This requirement is reasonable because it puts into effect the compliance schedule directed by the Legislature in Minn. Stat. § 116.07, subd. 4h. This requirement also will help to avoid serious disruptions of local solid waste management systems.

Item D pertains to any facility owner or operator who cannot meet the requirements of items B or C. These are the facility owners and operators who cannot establish dedicated long-term care trust funds because they have not made the appropriate cost estimates. The Commissioner will provide these facility owners or operators with cost estimates they can use until they complete their own site investigations. The facility owners and operators can then establish dedicated long-term care trust funds and revise them when more accurate estimates derived from on-site data become available. This group of facility owners or operators is given 60 days following their initial compliance deadline to provide the Agency with copies of their establishing resolutions.

The rules cannot allow facility owners and operators to avoid the rate increases implicit in compliance with financial assurance requirements. Significant dislocations in solid waste management systems will result. Means to avoid these problems must be found and implemented.

Item E requires that public sector facility owners or operators meet specific qualifying criteria in order to exercise this financial assurance option. The Agency believes there must be qualifying criteria if the financial assurance rules are to have any positive effect. The Agency makes the dedicated facility long-term care trust fund option available at the request of representatives of public sector facility owners or operators. The Agency agrees with their argument that a public sector facility owner's or operator's inability to liquidate decreases the risk of site abandonment. The Agency also agrees that the lessened risk justifies a somewhat greater degree of local control of reserved funds. However, the Agency does not believe this justification is unqualified.

Past experience with both private sector and public sector facility owners or operators shows that some will casually ignore Agency directives if they believe they can save money by doing so. Facility owners or operators sometimes consider the costs of noncompliance small enough to justify the risk. This leads to delays and refusals that accomplish little more than to increase the burden improper site management places on local facility users and taxpayers. Timely performance of all specified responsibilities is the course likeliest to minimize costs and environmental damage.

The Agency believes there must be enforceable qualifying criteria that define the conditions under which a facility owner or operator is considered to be out of compliance with this rule's provisions. The Agency has, in the past, relied on the gains derived from sound facility management to provide positive compliance incentives. Unfortunately, many of these gains are either deferred (e.g., improved future resource quality) or intangible (e.g., environmental niceness). Facility owners or operators seldom realize such gains in current periods. However, they do incur compliance costs in current periods.

This rule contains disincentives that take effect if a facility owner or operator decides not to meet specified qualifying criteria. The Agency believes that the qualifying criteria provide reasonable performance incentives. They make fair distinctions between classes of facility owners or operators. The distinctions are based on verifiable experience. The facility owner's or operator's status is a matter of individual choice. The facility owner or operator chooses whether to meet specific criteria and, in so doing, chooses whether to qualify for the dedicated long-term care trust fund option. Without such incentives, some facility owners or operators are not expected to comply fully with the provisions of this and other rules. This will result in needless environmental damages and cost increases.

This item defines three qualifying criteria. Each qualifying criterion is discussed in detail in the following paragraphs.

Under subitem (1) the facility owner or operator must perform closure, postclosure care and corrective action work when it is needed. The required activities and their schedule will be specified in the facility permit and, perhaps, other compliance documents.

Local government officials assert that their service orientation will compel them to perform required activities on time. Their responsibilities to their constituents cannot be ignored or evaded. This public service motivation is presented as an important justification for allowing greater local control of financial reserves. This first qualifying criterion simply codifies behavior that local government officials maintain now prevails.

This requirement thus provides a reasonable reinforcement for responsible local administration. Only those public sector owners or operators that responsibly manage facility sites will have the greater local control of financial reserves allowed under this rule. Facility owners or operators that refuse to do required work on time will have to give up some degree of local control.

This requirement also provides facility users, nearby property owners and the State with a reasonable security measure. If a facility owner or operator refuses to perform needed work, that owner or operator could also prevent the release of funds from the dedicated long-term care trust fund. Such an impasse effectively prevents the Agency from meeting its environmental protection responsibilities. This provision makes an impasse very unlikely. A facility owner or operator that refuses to do required work would have to either find an intermediary or provide collateral for a self-insurance demonstration. In either case, the Agency would then have a usable source of funds that could pay for the work the facility owner or operator refused to do. Thus, the requirement provides a remedy for a potential problem that could cause damage to human health and the environment.

Under subitem (2) the facility owner or operator must manage the dedicated long-term care trust fund according to this rule's provisions. This means: the fund must grow at a specified rate, it must be maintained at specified levels, and there can be no disbursements without the Commissioner's permission. If the facility owner or operator does not meet any of these conditions, the financial statements required under subpart 3 of this rule will provide the needed evidence.

The required pattern of dedicated long-term care trust fund development is set so that the fund will provide security that the facility owner or operator will be able to meet specified responsibilities. Fund growth patterns less than those specified in this part lessen the facility owner's or operator's abilities to pay for needed work. The implicit shortfalls mean some work may not be done on time, thus increasing environmental risks.

This requirement provides facility users, nearby property owners and the State with security that the facility owner or operator will meet its financial responsibilities by one means or another. If the facility owner or operator does not manage responsibly the dedicated long-term care trust fund on its own, it should not be allowed the greater amount of local control this option affords. The Agency must have assurance that the facility owner or operator will be a responsible financial manager as well as a responsible facility manager.

Under subitem (3) the facility owner or operator must maintain in effect the resolution which establishes the dedicated long-term care trust fund. This resolution provides the legal basis for the fund. It explicitly prohibits any use of fund assets for purposes other than those specified. The dedicated long-term care trust fund is not safe unless the original resolution is in effect until the end of the required period of postclosure care. Without this security, the dedicated long-term care trust fund balance would be available to cover any future budget shortages. This requirement provides facility users, nearby property owners and the Agency with a reasonable assurance that the facility owner or operator will maintain the integrity of the dedicated long-term care trust fund.

This requirement does not preclude all change. The Agency realizes that a need may arise for some change in the resolution. This requirement allows facility owners or operators to make changes if they have written permission to do so from the Commissioner. This provision makes a reasonable accommodation for future uncertainty.

If a facility owner or operator becomes disqualified, the Commissioner has to send notice to the facility owner or operator that another form of financial assurance for the dedicated long-term care trust fund must be substituted. The facility owner or operator then has 60 days in which to make the required substitution. Under this provision all of the alternative financial assurance methods can be made effective within 60 days.

This item further requires that a facility owner or operator who does not make the substitution within 60 days must close the facility. A facility owner or operator in this situation clearly has no intention of complying with the rules. Since compliance with the rules is a condition of keeping a solid waste management facility permit (Minn. Stat. § 116.07, subd. 4h), a facility owner or operator who does not comply should lose the permit. Facility closure is a first step in the process of permit revocation.

Subpart 3 describes the materials facility owners or operators must use as evidence that they have met the requirements of these rules. The Agency must have proof that facility owners or operators are properly managing the funds reserved for long-term care at the facility site.

Item A requires the facility owners or operators to send copies of financial statements that provide information about fund balances. State law requires local governments to make financial reports to the State Auditor's Office. Minn. Stat. §§ 375.17, 471.697 and 471.698. This provision allows facility owners or operators to use the statements they must send to the State Auditor as evidence that their dedicated long-term trust funds are being properly developed and managed. The provision places no new burden on facility owners or operators. The required statements have to be prepared regardless of the Agency's requirements.

Item B requires that the facility owner or operator submit an independent Certified Public Accountant's (CPA) report on the status of the fund. The report must find that the fund's status meets this rule's provisions. This provision will give the Agency needed confidence in the data that inform an important decision. The burden of this certification is placed on a third party, the independent CPA, who has no interest in the outcome of the Agency's decision. The CPA's sole interest is in the credibility of the analysis. The requirement also relieves the Agency of the need to review unaudited materials.

Subpart 3 further requires that the financial statements and the CPA's report be submitted a year after the establishing resolution is sent to the Agency. Updates of the financial statements and CPA reports are then due in each succeeding year. The reporting period for the updates corresponds to the facility owner's or operator's fiscal year. This requirement provides the Agency with the information it must have to administer responsibly this rule without imposing a great burden on facility owners or operators.

Subpart 4 refers the facility owner or operator to another part of the rules, part 7035.2805, which contains in subpart 8 a model of the resolution that establishes a dedicated long-term care trust fund. This rule requires that the resolution the facility owner or operator adopts duplicate this wording.

This requirement reasonably limits the kinds of resolutions facility owners and operators can use. If all facility owners and operators use the same form, then planning and financial management may proceed from the same basis at all facilities. This is another provision that avoids potential disruptions. It also ensures equitable treatment of all owners and operators.

Statements supporting the reasonableness of subparts 5, 6, 7, 8, 9, 10, 11 and 13 are supplied and noted under the similar provisions of part 7035.2705 (Trust Funds).

Subpart 14 requires that the owner or operator request and receive the Agency Commissioner's permission before the trustee may authorize any fund disbursements. The owner or operator must submit itemized bills along with the request for permission to disburse funds. This means that the fund cannot be used to provide advances for coming expenses.

Some reviewers have said this provision will make it difficult for facility owners and operators to find contractors to do the work needed. This criticism has little basis. First, contractors are not ordinarily paid in advance. Instead, they receive regular payments for orderly progress on a specified work schedule or they are paid as they complete specified major features of the project. Second, the contractors do not have to be paid directly from the trust fund. An alternative arrangement could have the owner or operator pay the contractor from another fund, established solely to provide working capital for the projects to which the fund is dedicated. Following approval from the Commissioner, the working capital fund can be replenished with disbursements from the dedicated long-term care trust fund. Facility owners and operators may incur short-term financing expenses under arrangements of this sort, but there is no prohibition against including these costs in closure, postclosure care or contingency action plans.

This requirement may increase cost estimates by an amount that represents the short-term (90-day) opportunity cost incurred while the contractor or the owner or operator waits for reimbursement. This amount will not likely grow to any large fraction of total project costs. The savings in reduced risk justify the nominal cost increases. Risks fall because the funds withheld form a powerful incentive for owners, operators and contractors to do a good job. This disincentive encourages contractors to avoid front-end loading. This happens when the contractor schedules the largest costs during the early part of the project period. Such bidding lets the contractor recoup the greatest portion, sometimes all, of project costs during the earliest phases of the project, which dilutes performance incentives during later phases.

Advance payment would also add substantial risk of fund shortfalls if any project work is so poorly done that it either incurs added cost or has to be done over. This condition would mean that the portion of the trust fund advanced would be lost. The reserve would then be underfunded. Since most costs will be incurred after site closure, the shortfall would likely be permanent.

The advantage that advance payment offers owners, operators and contractors will not likely offset the risks that an advance payment system adds to a process that must take a conservative approach to long-term care at facilities. Reserving fund resources for reimbursement is a prudent and reasonable measure.

Subpart 14 allows the Commissioner up to 90 days to approve the release of funds. This time is allowed so that the Commissioner can review the requests for reimbursement and inspect the site to make sure that work is properly done. Ninety days is needed to make sure reviews and inspections can be accomplished with due care. Although review and inspection at an individual site may not take long, the Agency has responsibility for sites throughout the State. The demand on Agency staff time could well be too great at any given point to perform needed review and inspection in less than 90 days. Any shorter period could easily do a disservice to facility users and neighbors.

When the Commissioner is satisfied that the reimbursement request is proper, the trustee is authorized to release funds. However, if the Commissioner has reason to believe that total costs will exceed the value of the dedicated long-term care trust fund, reimbursement may be withheld. This provision has been criticized by some reviewers. The reviewers said that this provision serves no useful purpose. Once the funds have been gathered and the site is closed, there will be no way a facility owner or operator can take in more revenue. The criticism assumes that the withholding provision is designed to make the facility owner or operator pay more. In fact, the provision is designed to protect the integrity of the fund. If closure or postclosure operations have begun and it becomes obvious that something has gone wrong and the work will have to start over, there is no point in using the limited resources of the fund to pay for inadequate work. That cost should be the responsibility of the owner, operator or contractor who made the error. Using the resources of the dedicated long-term care trust fund to assume normal contracting risks dilutes needed incentives. Instead, the fund's resources should be conserved for use in correcting the initial mistake. The only reasonable guide for fund management is the economic use of limited resources. The Agency has to assume a conservative approach to approve disbursements. Requests for reimbursement and the completed work associated with the expense must be carefully reviewed to make sure that expenses are appropriate and that once an expense is incurred it will not appear again.

The proper goal of the dedicated long-term care trust fund is to pay for expenses incurred for work that will make the facility a more secure site. It is not reasonable to use the fund to assume risks for contractors. If the fund were to be used for making advance payments or if there were no provision for withholding funds, then the facility owner or operator or contractor doing the work would operate under a riskless condition. There would be much less incentive to do a proper job. This provision of the rules is designed to conserve fund assets so that they are available when needed.

The rules also constrain the Commissioner's discretion in withholding funds. Facility owners and operators should not have to face losses without reason. Unit costs in engineering plans and cost estimates will provide the Commissioner with the facts needed to make the withholding decision. To withhold funds, the Commissioner must demonstrate that unit costs incurred at the site have exceeded the contingency allowances made for these costs. The units of measure will likely vary for different cost elements. For example, cover material expenses will likely be estimated as costs per acre or costs per cubic yard, while some postclosure costs will be reported in costs per well or costs per well per foot of depth. Using the unit cost criterion will ensure that any decision the Commissioner makes to withhold reimbursement will be well founded in a thorough review of the reimbursement request and the appropriate site plan. This requirement reasonably constrains the Commissioner's ability to limit trust fund disbursements.

The rule further requires that the Commissioner give the facility owner or operator written notice of the decision to withhold reimbursement. This notice must be sent within 30 days after the decision is made. The notice must contain a statement of the Commissioner's reasons for making the decision. This provision reasonably gives owners, operators and contractors timely and appropriate notice if they are to be refused reimbursement from the fund.

Subpart 15 describes the conditions under which the Commissioner must allow the dedicated long-term care trust fund to end. The first condition is satisfied when the facility owner or operator substitutes another allowable instrument for the fund. The second condition is satisfied when the Agency releases the facility owner or operator from responsibility to comply with the financial assurance rules under part 7035.2765. Both conditions describe circumstances under which the fund serves no further purpose. The fund should be dissolved when it is not needed.

7. Part 7035.2725 SURETY BOND GUARANTEEING PAYMENT INTO A TRUST FUND.

Facility owners and operators may comply with the financial assurance requirement through the use of a surety bond which guarantees that before the facility is closed the owner or operator will establish a trust fund. This option is included in lieu of the self-insurance option that some reviewers favor (See discussion in part 7035.2750 SELF-INSURANCE). Some reviewers objected to setting aside funds that would not be used until some, perhaps distant, future date. Facility owners or operators who choose this option can keep set-aside funds under their own control. The facility owners and operators can then use the funds any way they want to until it is time to close the facility. At closure, the facility owner or operator must place into trust fund the full amount of the current cost estimates. This option reasonably allows facility owners or operators to maintain control of their resources while providing facility users and the Agency with assurance that the facility will be properly closed and maintained.

A discussion of surety bonds and how they will function within the rules will be helpful here. The contract used to execute the surety agreement refers to the facility owner or operator as the principal. The agreement specifies a series of actions that the principal will perform, in this case the development of a standby trust fund. If the principal fails to perform as specified, the Commissioner can call in the bond and the surety promises to place a specified amount, the penal sum, into a standby trust established when the surety agreement is executed. The Agency can then direct that the required work be financed from the trust fund. This leaves the surety with a loss that must be recouped from the principal. Sureties charge for their assumption of risk. The cost of a surety bond generally ranges from one percent to three percent of the bond's penal sum. Sureties may also require other conditions, such as collateral, before they will execute the surety agreement.

Item A limits the facility owner's or operator's choice of sureties and establishes a compliance schedule. The limit on choice refers the facility owner or operator to a federal document, Circular 570 from the Department of the Treasury (published under Title 31, sections 9304 and 9308 of the U.S. Code). This document lists the sureties found to be acceptable bond writers for projects that involve federal funds. This list includes almost 300 companies (Reference 21) with over 30 located in Minnesota. Referring to this circular helps facility owners and operators choose a responsible firm. It also relieves the Agency of the need to develop a certification program for firms concerning whose business the Agency has little experience. This requirement takes advantage of certification work done by the federal government.

The compliance schedule in this item is identical to the schedule applicable to trust funds in part 7035.2705, item A. At a new facility, owners and operators must submit the bond to the Commissioner before taking waste into the facilities. Facility owners and operators whose existing sites have more than five years or 500,000 cubic yards of capacity must submit the bonds within 180 days of the effective date of the rules. All other facility owners and operators must submit the bonds within one year of the effective date of the rules. The rationale for these provisions is the same as that provided for the schedule in part 7035.2705.

Item B requires that the surety agreement duplicate a model provided in another part of the rules (part 7035.2805, subpart 3). This requirement reasonably limits facility owners' and operators' choices in the interest of uniformity and equity.

Item C requires that the facility owners and operators who choose to execute surety agreements must also establish standby trust funds which meet the requirements of the appropriate rules (parts 7035.2705 and 7035.2715). This requirement is included as a practical matter. State agencies cannot take in money and manage it as though it were their own. All receipts must become a part of general revenues.

16A.72 INCOME CREDITED TO GENERAL FUND; EXCEPTIONS.

All income, including fees or receipts of any nature, shall be credited to the general fund, except:

(1) federal aid;

(2) contributions, or reimbursements received for any account of any division or department for which an appropriation is made by law;

(3) income to the University of Minnesota;

(4) income to revolving funds now established in institutions under the commissioners of corrections or human services;

(5) investment earnings resulting from the master lease program, except that the amount credited to another fund or account may not exceed the amount of the additional expense incurred by that fund or account through participation in the master lease program;

(6) receipts from the operation of patients' and inmates' stores and vending machines, which shall be deposited in the

social welfare fund in each institution for the benefit of the patients and inmates;

(7) money received in payment for services of inmate labor employed in the industries carried on in the state correctional facilities which receipts shall be credited to the current expense fund of those facilities;

(8) as provided in sections 16B.57 and 85.22; or

(9) as otherwise provided by law.

Minn. Stat. § 16A.72 (1986).

None of the exceptions applies to the circumstances which concern these rules. This means that if the standby trust fund were not required, payments made by sureties to the Agency would have to be transferred to the State's general fund. There would be no guarantee that the money paid by a surety would be appropriated back to the Agency to do the work needed.

The standby trust offers a way for the surety to honor its commitment without having the Agency receive any money. If the Commissioner has to call in a bond, the trustee of the standby fund receives the bond's penal sum. The fund is then administered under part 7035.2705 or part 7035.2715. The standby trust makes the trustee the owner and manager of funds collected from a surety.

Item D specifies the actions of the owner or operator that the surety will guarantee. The surety is required to guarantee that:

- the owner or operator will assure that the standby trust has a value at least equal to the penal sum of the bond before the owner or operator begins to close the site; and
- the owner or operator will put into the standby trust an amount equal to the penal sum within 15 days after the Commissioner, the Agency or a court issues an order to close the site; or
- the owner or operator will find another means to comply with the rule within 90 days after the surety sends the owner or operator a notice of cancellation.

These conditions specify the circumstances that the owner or operator, the Agency and the surety want to occur. As long as these conditions are met, there is no need to call in the bond. The surety promises that either a trust fund will be developed or the surety will be ready to pay for the costs of closure, postclosure care and/or contingency action. These conditions provide for continuity in the coverage of the owner's and operator's obligations. This item provides the surety with a specific description of the circumstances that will lead to the surety becoming liable on the bond.

Item E notifies the surety of its liabilities under the rules. If any of the conditions described in item D are not met, the surety is liable up to the amount of the penal sum. The surety's liability is limited to the amount of the penal sum. The surety must pay into the standby trust fund an amount that will bring the value of the trust up to the level of the latest cost estimates if:

a) the facility owner or operator does not adequately fund the standby trust before the facility closes; or
b) the facility owner or operator does not adequately fund the standby trust within 15 days after receiving a closure order; or
c) the facility owner or operator does not find another way to comply with the rules within 90 days after receiving a cancellation notice.

This item amounts to a restatement in the negative of item D. It clarifies the conditions under which the surety will have to incur cost. This extra specification reasonably helps all parties understand who is responsible for what and when. Any ambiguities in these areas would likely lead to unreasonable delays and unnecessary cost.

Item F specifies the size required of the bond's penal sum. This amount must equal the sum of the current cost estimates for closure, postclosure care and contingency action. All parties' interests are protected when the surety, the facility owner or operator and the Agency know the extent of the surety's liabilities. This provision reasonably limits the surety's liability to the extent of the estimated need.

Item G covers situations in which the current cost estimates change. If the current cost estimates increase, the facility owner or operator has 60 days in which to either increase the penal sum of the bond or find alternative means to cover the difference. This allows the facility owner or operator a reasonable time to make up for a gap in the facility's coverage.

If the current cost estimates decrease, the facility owner or operator can reduce the bond's penal sum with written approval from the Commissioner. This provision reasonably allows the facility owner or operator to reduce the level of coverage if it is not needed. The interests of facility users are protected by making the reduction contingent on the Commissioner's approval.

Item H specifies the method by which the surety may cancel the bond. The surety has to notify the Commissioner and the facility owner or operator if the bond is to be cancelled. The notices must be sent by certified mail. The cancellation cannot become effective until 120 days after the Commissioner receives the notice. Return receipts from the mailed notices will provide evidence of the date on which the Commissioner received the notice.

This provision ensures that there will be no gaps in coverage caused by the surety's decision to cancel. The period between first notification and final effect allows the facility owner or operator time to find another surety or another means to comply with the rule. This period is 30 days longer than the time period set in item D, subitem (3). The extra 30 days gives the Commissioner time to call on the bond, because during this 30-day period the surety is liable under the bond's conditions.

An example will provide some help in understanding the process. Consider a case in which a facility owner or operator receives notice that the surety bond will be cancelled. If the facility owner or operator finds an acceptable alternative financial mechanism within 90 days, then the bond can be cancelled 30 days later with no effect. There will be no gap in coverage. However, if the facility owner or operator does not find an alternative mechanism, this means that within 30 days the costs of closure, postclosure care and contingency action will not be covered by any instrument. The Agency can call on the bond during this 30-day period because one condition of the bond is that the facility owner or operator will find an acceptable alternative within 90 days.

This provision gives the Agency a reasonable means to ensure that coverage will not lapse. Either the surety will guarantee that the facility owner or operator will fund the trust or the trustee will manage an adequately funded trust after the surety pays the correct amount into the fund.

Item I describes the conditions under which the facility owner or operator may cancel the bond. The only way a facility owner or operator may cancel a bond is by providing evidence that an alternative mechanism is in effect. Once the facility owner or operator sends such evidence to the Commissioner, the Commissioner's written approval will allow the facility owner or operator to cancel the bond. This is another provision which reasonably allows the owner or operator some flexibility in using an instrument of choice while providing the Agency with assurance that there are no gaps in coverage.

8. Part 7035.2735 SURETY BOND GUARANTEEING PERFORMANCE.

Facility owners and operators may choose to comply with the rules through the use of a surety bond that is somewhat different than the bond described in part 7035.2725. The surety is required under this part to guarantee that the facility owner or operator will perform facility closure, postclosure care and contingency action as specified in the appropriate plans. The bond allowed under part 7035.2725 uses balances held in trusts at specified times as the measure of the surety's liability. The bond described in this part requires performance of specified acts. Setting aside this difference, the two bonds operate in the same manner.

Item A limits the facility owner's and operator's choice of sureties and establishes a compliance schedule. The limit on choice refers the facility owner or operator to a federal document, Circular 570 from the Department of the Treasury. This document lists the sureties and acceptable bond writers for projects that involve federal funds. This list includes almost 300 companies, with over 30 located in Minnesota. Referring to this circular helps the facility owner or operator choose a responsible firm. It also relieves the Agency of the need to develop a certification program for firms with which it has little experience. This requirement takes advantage, to the benefit of facility owner or operator and the Agency, of certification work done by the federal government.

The compliance schedule in this item is identical to the schedule written in part 7035.2705, item A. That is, new owners and operators must send their bonds to the Commissioner before they first take waste into their facilities. Facility owners and operators whose existing sites have more than five years or 500,000 cubic yards of capacity must send in their bonds within 180 days of the effective date of the rules. All other facility owners and operators must send in their bonds within a year of the effective date of the rules.

Item B requires that the facility owner's or operator's surety agreement duplicate a model provided in another part of the rules (part 7035.2805, subpart 4). This requirement reasonably limits owners' and operators' choices in the interest of uniformity and equity.

Item C requires that the owners and operators who choose to execute surety agreements must also establish standby trust funds which meet the requirements of the appropriate rules (parts 7035.2705 and 7035.2715). This requirement is included as a practical matter. State agencies cannot take in money and manage it as though it were their own. All receipts must become a part of general revenues. See Minn. Stat. § 16A.72 (1986) quoted in full above.

None of the exceptions in that law applies to the circumstances which concern these rules. This means that if the standby trust fund were not required, payments made by sureties to the Agency would have to be transferred to the State's general fund. There would be no guarantee that all of the money paid by a surety would be appropriated back to the Agency so that the needed work could be done at the site.

The standby trust offers a way for the surety to honor its commitment without having the Agency receive money. If the Commissioner has to call in a bond, the trustee of the standby fund receives the payment. The fund is then administered under parts 7035.2705 or 7035.2715. The standby trust makes the trustee manager of any funds collected from a surety.

Item D specifies the actions of the facility owner or operator that the surety will guarantee. The surety is required to guarantee that:

a) the facility owner or operator will perform the specified work (closure, postclosure care, contingency action) in the manner and at the times described in the apppropriate plans and also that the facility owner or operator will satisfy all applicable facility permit conditions; and

b) the facility owner or operator will find another means to comply with the rule within 90 days after the surety sends the facility owner or operator a notice of cancellation.

These conditions specify the circumstances that the facility owner or operator, the Agency and the surety want to occur. As long as these conditions are met there is no need to call in the bond. The surety promises through its bond that all necessary work will be done on time. These conditions provide for continuity in the coverage of the facility owner's or operator's obligations. These conditions also reasonably provide the surety with a specific description of the circumstances that will lead to the surety becoming liable on the bond.

Item E notifies the surety of its liabilities under the rules. If any of the conditions described in item D are broken, the surety is liable up to the amount of the penal sum. The surety's liability is limited to the amount of the penal sum. The surety must pay into the standby trust fund an amount equal to the penal sum if:

a) the facility owner or operator does not perform closure, postclosure care or contingency action according to the appropriate plan or according to applicable permit conditions; or

b) the facility owner or operator does not find another way to comply with the rules within 90 days after receiving a cancellation notice.

This item amounts to a restatement in the negative of item D. It clarifies the conditions under which the surety will have to incur cost. This specification reasonably helps all parties understand just who is responsible for what and when. Any ambiguities in these areas would likely lead to unreasonable delays and unnecessary costs.

Item F specifies the size of the bond's penal sum. This amount must equal the sum of the current cost estimates for closure, postclosure care and contingency action. All parties' interests are protected when the surety, the facility owner or operator and the Agency know the extent of the surety's liabilities. This provision reasonably limits the surety's liability to the extent of the estimated need.

Item G covers situations in which the current cost estimates change. If the current cost estimates increase, the facility owner or operator has 60 days to increase the penal sum of the bond or find an alternative means to cover the difference. This allows the facility owner or operator a reasonable time to make up for a gap in the facility's coverage.

If the current cost estimates fall below the penal sum of the bond, the facility owner or operator can reduce the bond's penal sum with written approval from the Commissioner. This provision reasonably allows the facility owner or operator to reduce the level of coverage if it is not needed. The interests of facility users are protected by making the reduction contingent on the Commissioner's approval.

Item H specifies the conditions under which the surety may cancel the bond. The surety has to notify the Commissioner and the facility owner or operator if the bond is to be cancelled. The notices must be sent by certified mail. The cancellation cannot become effective until 120 days after the Commissioner receives the notice. Return receipts from the mailed notices will provide evidence of the date on which the Commissioner received the notice.

This provision ensures that there will be no gaps in coverage caused by the surety's decision to cancel. The period between first notification and final effect allows the facility owner or operator time to find another surety or another means to comply with the rule. This period is 30 days longer than the time period set in item D, subitem (3). The extra 30 days gives the Commissioner time to call on the bond, because during this 30-day period the surety is liable under the bond's conditions.

An example will provide some help in understanding the process. Consider a case in which a facility owner or operator receives notice that the surety bond will be cancelled. If the facility owner or operator finds an acceptable alternative financial mechanism within 90 days, then the bond can be cancelled 30 days later with no effect. There will be no gap in coverage. However, if the facility owner or operator does not find an alternative mechanism, this means that within 30 days the costs of closure, postclosure care and contingency action will not be covered by any instrument. The Agency can call on the bond during this 30-day period because one condition of the bond is that the facility owner or operator will find an acceptable alternative within 90 days. This provision gives the Agency a reasonable means to ensure that coverage will not lapse. Either the surety will guarantee that the facility owner or operator will do the required work or the trustee will manage an adequately funded trust after the surety pays the correct amount into the fund. Needed work can then be financed from trust fund balances.

Item I describes the method by which the facility owner or operator may cancel the bond. The only way a facility owner or operator may cancel a bond is by providing evidence that an alternative mechanism is effective. If the facility owner or operator submits evidence to the Commissioner, the Commissioner's written approval will allow the facility owner or operator to cancel the bond. This is another provision which reasonably lets the Agency ensure that there are no gaps in coverage.

Item J places a further limit on the surety's liability. The facility owner or operator will at some point be released from responsibility to comply with the rules. The conditions for such release are in part 7035.2775, and will be discussed below. This item provides the surety with a release from responsibility for the facility owner's or operator's actions after the Commissioner has done away with the facility owner's or operator's compliance responsibility. There is no reason to carry the surety bond agreement in full force after the Agency has determined there is no need to continue the financial assurance requirement.

9. Part 7035.2745 LETTER OF CREDIT.

Facility owners and operators may choose to comply with the financial assurance requirement through the use of an irrevocable standby letter of credit. A letter of credit extends the credit of one individual or organization (normally a bank) which is superior to that of a second individual or organization (the facility owner or operator in this case) to a third individual or organization (the Agency in this case) for the benefit of the second individual. The letter of credit will operate very much like the performance bond.

A bank issues the facility owner or operator credit equal to the sum of the current cost estimates. The letter of credit will remain in effect until the facility owner or operator is released from responsibility to comply with the rules. While the letter is in effect, the bank will honor any draft properly presented by the Commissioner. The Commissioner can present a draft only if the facility owner or operator has failed to perform a specified action (closure, postclosure care, contingency action). In addition, if the facility owner or operator presents a draft to the bank, the bank will deposit money in the amount of the draft into a standby trust fund.

A bank will recover credits extended in this manner from the facility owner or operator. Banks charge for letters of credit at rates which are comparable to rates charged for surety bonds. Banks also charge interest on outstanding balances of extended credit.

Item A limits the facility owner's and operator's choice of banks and establishes a compliance schedule. The limit on choice is that the institution must be regulated by a federal or State of Minnesota agency. This helps facility owners and operators choose a responsible firm. It also relieves the Agency of the need to develop a certification program for firms with which it has little experience. This requirement takes advantage, to the benefit of facility owners and operators and the Agency, of regulatory work routinely done by federal or State government.

The compliance schedule in this item is identical to the schedule written in part 7035.2705, item A. That is, new facility owners and operators must send their letters of credit to the Commissioner before they first take waste into their facilities. Facility owners and operators whose existing sites have more than five years or 500,000 cubic yards of capacity must send in their letters of credit within 180 days of the effective date of the rules. All other facility owners and operators must send in their letters of credit within a year of the effective date of the rules.

Item B requires that the facility owner's or operator's letter of credit agreement duplicates a model provided in another part of the rules (See part 7035.2805, subpart 5). This requirement reasonably limits facility owners' and operators' choices in the interest of uniformity and equity.

Item C requires that the facility owners and operators who choose to use letters of credit must also establish standby trust funds which meet the requirements of the appropriate rules (parts 7035.2705 and 7035.2715). This requirement is included as a practical matter. State agencies cannot take in money and manage it as though it were their own. All receipts must become a part of general revenues. See Minn. Stat. § 16A.72 (1986) quoted in full above.

None of the exceptions listed in this statute applies to the circumstances which concern these rules. This means that if the standby trust fund were not required, payments made by banks to the Agency would have to be transferred to the State's general fund. There would be no guarantee all of the money paid by a bank would be appropriated back to the Agency so that the needed work could be done.

The standby trust offers a way for the bank to honor its commitment without having the Agency receive money. If the Commissioner has to call on a letter of credit, the trustee of the standby fund receives the payment. The fund is then administered under part 7035.2705 or part 7035.2715. The standby trust makes the trustee manager of any funds collected from a bank.

Item D requires that the facility owner or operator carefully identify the institution that issues the letter of credit. This requirement is reasonable because the agreement needed to issue a letter of credit is not nearly as detailed as the instruments used to execute trusts or surety bonds. The facility owner or operator must send the Commissioner a letter that refers to:

a) the identification number of the letter of credit,
b) the name of the issuing institution,
c) the date on which the letter is issued,
d) the identification number, name and address of the facility, and
e) the amount of the current cost estimates, separately and in total.

This information provides the Commissioner with the data that reasonably will be needed to administer this system.

Item E specifies certain conditions the bank must include in the letter of credit. The credit must be irrevocable for a period of one year. This requirement reasonably gives the facility owner or operator and the Commissioner certainty about the period that is covered. The letter of credit must also be extended automatically for one year following the expiration date. This extension is not absolute. It would not be reasonable to make the bank extend credit indefinitely. Banks can cancel the letter of credit under certain conditions. The main condition is proper notification.

The bank has to notify the Commissioner and the facility owner or operator if the letter of credit is to be cancelled. The notices must be sent by certified mail. The cancellation cannot become effective until 120 days after the Commissioner receives the notice. Return receipts from the mailed notices will provide evidence of the date on which the Commissioner received the notice.

This provision ensures that there will be no gaps in coverage caused by the bank's decision to cancel. The period between first notification and final effect allows the facility owner or operator time to find another bank or another means to comply with the rule. This period is 30 days longer than the time period set in item I, below, which limits the amount of time the facility owner or operator can spend searching for a substitute mechanism. The extra 30 days gives the Commissioner time to draw on the letter of credit, because during this 30-day period the bank remains liable under the letter of credit.

An example will provide some help in understanding the process. Consider a case in which a facility owner or operator receives notice that the letter of credit will be cancelled. If the facility owner or operator finds an acceptable alternative financial mechanism within 90 days, then the letter of credit can be cancelled 30 days later with no effect. There will be no gap in coverage. However, if the facility owner or operator does not find an alternative mechanism, this means that within 30 days the costs of closure, postclosure care and contingency action will not be covered by any instrument. The Commissioner can draw on the letter of credit during this 30-day period because it remains in effect for 120 days following the Commissioner's receipt of the cancellation notice.

This provision gives the Agency a reasonable means to ensure that, once begun, coverage will not lapse. Either the bank will stand ready to extend needed credit or the trustee will manage an adequately funded trust after the bank pays the correct amount into the fund. Needed work can then be financed from trust fund balances.

Item F specifies the size required of the letter of credit. This amount must equal the sum of the current cost estimates for closure, postclosure care and contingency action. All parties' interests are protected when the bank, the facility owner or operator and the Agency know the extent of the bank's liabilities. This provision reasonably limits the bank's liability to the extent of the estimated need.

Item G covers situations in which the current cost estimates change. If the current cost estimates increase, the facility owner or operator has 60 days to either increase the amount of credit available or find alternative means to cover the difference. This allows the facility owner or operator a reasonable time to make up for a gap in the facility's coverage.

If the current cost estimates fall below the amount of credit available, the facility owner or operator can reduce the amount of credit available with the written approval of the Commissioner. This provision reasonably allows the facility owner or operator to reduce the level of coverage if it is not needed. The interests of facility users are protected by making the reduction contingent on the Commissioner's approval.

Item H specifies the conditions under which the Commissioner shall draw on the letter of credit. If the facility owner or operator does not perform closure, postclosure care or contingency action according to the appropriate plan or permit conditions, the Commissioner will draw on the credit. This provision is reasonable because it clarifies the conditions under which the bank will have to incur cost. This specification helps all parties understand who is responsible for what and when. Any ambiguities in these areas would likely lead to unreasonable delays and unnecessary costs.

Item I describes another condition under which the Commissioner shall draw on the letter of credit. This item gives the permittee 90 days after receiving a cancellation notice to find another means to comply with the rules. If the facility owner or operator does not find an alternate mechanism, the Commissioner must draw on the credit.

The Commissioner may delay this action if the bank further extends the credit. However, the Commissioner must draw on the credit during the last 30 days of any extension if the facility owner or operator has not established another financial mechanism in compliance with the rules.

These conditions provide reasonable means to make sure that coverage of closure, postclosure care and contingency action costs will not lapse. The requirements specify clearly the conditions under which the credit will be used and they give facility users the assurances they need that the covered costs will be financed.

Item J places a further limit on the bank's liability. The facility owner or operator will at some point be released from responsibility to comply with the rules. The conditions for such release are in part 7035.2775, and will be discussed below. If the facility owner or operator is released from financial assurance responsibilities, the Commissioner must return the letter of credit to the bank. This item provides the bank with a reasonable release from responsibility after the Commissioner relieves the facility owner or operator of compliance responsibility. There is no reason to carry the letter of credit in full force after the Agency has said there is no need to continue the financial assurance requirement.

10. Part 7035.2750 SELF-INSURANCE.

The Agency has received requests to include a provision allowing the facility owner's or operator's long-term care obligation to remain unsecured. The suggested option is known as "self-insurance," "financial test," "net worth test," and/or "self-assurance."

The financial assurance rules for hazardous waste facilities have self-insurance provisions. Minn. Rules pt. 7045.0504, subp. 7 (1987). Those provisions apply to private and semi-private firms. They require facility owners and operators to meet a series of specific financial tests. The tests consist of demonstrations that the facility owner or operator either has:

a) met two of the following three measures: a ratio of total liabilities to net worth less than 2.0; a ratio of the sum of net income plus depreciation, depletion, and amortization to total liabilities greater than 0.1; and a ratio of current assets to current liabilities greater than 1.5;

b) net working capital and tangible net worth each at least six times the appropriate current cost estimate;
c) tangible net worth of at least $10,000,000; and
d) assets in the United States amounting to at least 90 percent of the permittee's total assets or at least six times the appropriate current cost estimate.

OR

a) a current rating for the permittee's most recent bond issuance of AAA, AA, A or BBB as issued by Standard and Poor's or Aaa, Aa, A or Baa as issued by Moody's;
b) tangible net worth at least six times the appropriate current cost estimate;
c) tangible net worth of at least $10,000,000; and
d) assets in the United States amounting to at least 90 percent of the permittee's total assets of at least six times the appropriate current cost estimate.

If the facility owner or operator passes either of these tests, the hazardous waste rules assume the facility owner or operator will pay for all identified future costs. However, the future may not live up to that assumption. The facility owner or operator may suffer financial reverses that will cut into the ability to pay the costs of long-term care. The facility owner or operator may also prove unwilling to pay some or all of the long-term care costs.

These problems become even more imposing when some defining characteristics of the solid waste management sector are considered. Hazardous waste owners and operators in Minnesota do not earn all their revenues from waste disposal services. Rather, these owners and operators are industrial firms whose production processes yield hazardous wastes or firms that also run treatment facilities. This requires them to have permits. These firms do not rely exclusively on waste disposal services to earn revenues. They can make up revenue shortfalls after facility closure, if the firm remains viable, a fairly reasonable assumption for the normal Minnesota owner or operator.

The firms that hold solid waste facility permits, however, are quite different. These firms generally earn all their revenues from solid waste disposal services. Although some of these firms integrate both collection and disposal services, the trend among these firms is to separate these activities through incorporation, creating separate collection enterprises and land disposal enterprises. This is a reasonable and sound business management practice. Common past management practices treated the facility as an adjunct to a collection service. The disposal facility was operated on a breakeven or lose-a-little basis. Recent regulatory changes have led many facility owners and operators to change the structure of their businesses. The facility owners and operators realize that the facility could become a substantial liability as the previously unanticipated costs of long-term care occur. Many private sector facility owners and operators have, therefore, sought to protect their assets by incorporating the facility and the collection service as separate businesses. This means the facility has become a firm with a finite earning capacity, because it has a limited waste disposal capacity. Once the site is full it cannot accept waste. This also means that once the site is closed it cannot earn revenue. Therefore, the State must require that the resources needed to finance long-term care be set aside during the site's operating life. Otherwise some, or all, of the work required during long-term care will not get done because there won't be any money to pay for it.

If a self-insured solid waste land disposal facility owner or operator proves unable or unwilling to meet long-term care costs, the Agency will have to rely on courts and bankruptcy proceedings to finance long-term care. These means provide no guarantee that the owner or operator will pay any of the costs of long-term care. It is inappropriate to sanction by rule such unsecured obligations. Owners and operators should provide assurance for long-term care costs through the use of tested, conventional financial media.

Concerns for the lack of a self-insurance provision led to a series of communications with representatives of the two largest owners and operators of waste management firms in the State. <u>See</u> Appendix X. The correspondence lasted for more than one year and consisted of both written communications and personal meetings.

Agency staff took the position that conventional self-insurance should not be allowed by the rules. The waste management firms received letters stating the Agency's objections. These firms were asked to respond to the objections.

Waste Management of Minnesota, Inc. (WMI) sent the Agency a detailed response. WMI sent individual answers to each of the Agency's objections. These responses merit close attention.

The federal government has developed the basic model for self-insurance. The U.S. Environmental Protection Agency (EPA) allows self-insurance as a way to comply with the financial assurance requirements of hazardous waste facility permits granted under the Resource Conservation and Recovery Act (RCRA). The EPA conducted extensive statistical tests to determine which financial measures would be best. The study selected two samples of firms; a bankrupt sample and a nonbankrupt sample. The study then imposed selected financial measures in various combinations on the historical performance of these firms. The final test system chosen passed 95 percent of the viable firms and failed all but 0.1 percent of the bankrupt firms.

The measures chosen were sufficient for EPA's needs. The EPA concentrated on firms that generate hazardous waste. This led the EPA to stratify its samples, so that the sample universes included only firms whose products and processes are associated with hazardous wastes. A sample universe is the entire population from which a sample is drawn. This means that solid waste management firms could not possibly have been a part of the study. Therefore, the data collected cannot be applied to these firms.

The Agency's first objection to including self-insurance has to do with the correct use of statistical inference. It is not correct to use statistics drawn from one sample universe to make statements about members of another universe. For example, a statistical analysis of the height of high school boys has no statistical relevance to statements about the height of high school girls. Informal observation tells us that we can expect that the girls' average height will be less than the boys' average height, but the findings of statistical analysis of the boys' heights have no predictive value for the population of girls. Consider, for example, a further definition of sample universes in which the boys' sample is taken in Southeast Asia and the girls we are concerned with live in Scandinavia. This may seem like an absurd example, but it points out the care that is needed when making general statements based on statistics.

The Agency's correspondence with WMI stated that the EPA findings have no bearing on the tests' validity for solid waste management firms because those firms were not a part of the study's sample universe. Therefore the tests have no statistical support when used in the solid waste management sector. The financial tests may be sufficient to the need in the hazardous waste section, but they may not be adequate in the solid waste sector. There is just no way to tell with acceptable accuracy, because the only research done on the question has no proper application to the case at hand.

The Agency's analysis also indicates a characteristic which differentiates firms in the waste management sector from the firms in the EPA sample. Market and regulatory conditions indicate that waste management firms confront greater risk than the average firm considered in the EPA study. The Agency further noted that rules promulgated in Illinois tried to minimize this risk element by limiting the self-insurance option to diversified firms. Vertical integration throughout the waste management sector probably does not have the risk-reducing effects that the Illinois rules rather obviously sought.

WMI responded with the following assertions:

First - WMI argues that waste management firms were included in the EPA sample universes.
Second - WMI contends that waste management firms are not inherently riskier than other firms.
Third - WMI believes that the diversified status of a firm has no implications for the risks that the firm faces. WMI believes there is no justification for considering diversification when discussing self-insurance.

These responses indicate a profound misunderstanding of both the EPA's statistical work and the Agency's correspondence.

First, the most detailed description of EPA's statistical study is found in a technical appendix to the hazardous waste facility financial assurance rules (Reference 21). The EPA study consisted of two samples. One sample of bankrupt firms was taken from a variety of sources: a) previous research on bankruptcy forecasting, b) Moody's Industrial Manual, c) Funk and Scott's Annual Periodical Index, and d) the Wall Street Journal Index. This sample began with 95 firms. Three were dropped for data problems and others were dropped because their chief business consisted of "wholesale, retail and/or transportation service activities . . ." (pp. III-1 through III-2). The final sample used consisted of 66 firms. The other sample consisted of 190 viable firms drawn from Moody's Industrial Manual in "categories that generate and dispose of large quantities of hazardous waste on site (e.g., primary metals, petroleum refining, chemical and plastics manufacturing, textiles)" (Reference 22). Twelve firms were dropped because their businesses consisted primarily of wholesale, retail and/or transportation service activities. This left a usable sample of 178 firms.

The point to be made in response to WMI's assertion is that EPA's exclusion process prohibited waste management firms from consideration. The Agency staff pursued this question further, in the interest of precision, and contacted the principal author of the study. He confirmed the statement that there were no waste management firms in the universe from which the samples were drawn (Reference 23). Consideration was limited to firms in industrial categories known to generate hazardous wastes. A careful reading of the survey report and discussion with the report's author confirm the Agency's position.

It could be that the WMI respondents were confused about one section of the report. EPA added some special analyses in response to comments from waste management industry representatives. The study examined the financial statements of BFI and SCA Services, Inc. The study found that these two firms would have passed the financial test chosen for inclusion in the hazardous waste rules. A finding that two firms can pass the test in no way validates the test for all firms in the waste management sector. The total sector is too small and too new to have developed enough data to allow a statistically significant test of the financial measures used in the EPA rules. The fact that two firms at one point passed the test says nothing about whether the test has predictive power (validity) in the overall waste management sector.

Second, WMI contends that "waste management firms are not inherently riskier than all other businesses." The WMI response again misses the point of the initial Agency letter. WMI argues that other businesses confront risk. The firms included in the EPA study experience in common the risks they confront as hazardous waste generators. The other risks these firms confront were averaged over the entire sample. Thus, the legal risk arising from product liability judgments, cited by WMI, was accounted for in the EPA study and averaged over all firms included in the sample.

It's useful to bear in mind at this point that the A. H. Robbins case, referred to by WMI, is too recent to have influenced the results of the EPA study. Likewise, other cases (e.g., the Johns-Manville, Continental-Illinois and Texaco bankruptcies and the Union Carbide financial problems) have also occurred since the original EPA study. Experience with cases such as these, in which the firm likely would have passed the financial test until very shortly before bankruptcy was filed, would likely have had important influences on EPA's thinking.

The statement that all firms confront risk is so obvious as to be trivial. The producing firms in the EPA sample face risks in the marketplace and in the courts. Such firms also face risks induced by technological change, which can rapidly render products and production processes obsolete. These risks are generic to business activity. Again, these risks were accounted for in the EPA study. The WMI argument implies that WMI should be considered no riskier than the other firms in the EPA survey. Analyses by risk assessment specialists and insurers view waste management risks differently.

> To some extent insurance companies have adopted a "wait and see" strategy concerning EIL (environmental impairment liability) insurance until more actuarial data and additional legal clarifications emerge.
>
> For example, the 38 members of PLIA (the Pollution Liability Insurance Association) pool write their policies exclusively for chemical waste generators. They perceive fewer unanticipated risks from activities of generators than from waste site

> facilities. As they accumulate experience and confidence, they are likely to offer policies to firms more difficult to evaluate.

Reference 24.

The added data and legal changes have not emerged yet. The National Solid Waste Management Association (NSWMA) has tried to develop its own captive insurance pool to manage the risks once covered by insurance. The NSWMA has yet to interest reinsurers in taking a portion of this risk (Reference 25).

> The inherently high financial risk associated with the hazardous waste management industry stems from both investment and liability risks. The investment risk reflects the likelihood that investment funds can be lost because of unsuccessful siting attempts or uneconomical facilities. Several firms report investing over $1 million in single facilities for legal and engineering fees before being stopped from development by state or local agencies. In addition, another concern cited by potential developers is that a facility may prove to be uneconomical because of insufficient demand for services. Although most industry observers feel that demand will gradually increase over the next several years due to more strict regulation, the rate and magnitude of this predicted increase is uncertain. Unforeseen technical problems can also introduce risk into the investment decision. Start-up problems and operating problems can be a factor especially for the more sophisticated technologies. Probably even more significant than investment risk is the potential liability. Liability risk is perceived to be high because of the potential for civil or criminal suits in the event that operating problems result in damages of regulatory noncompliance.

Reference 26.

> Although handling hazardous waste may entail risks and significant capital investment, the profitability outlook for the industry is generally favorable. Potentially high profits are possible because the demand for hazardous waste management services is relatively inelastic while the supply of additional ultimate capacity may be scarce. Process changes and waste reduction may be possible for some generators but demand has not been very price sensitive. Small and medium-sized firms may not have the economies of scale to warrant major investment in disposal facilities and alternative off-site facilities may be limited in their geographic region.

Reference 27.

This evaluation contradicts the WMI argument that waste management firms are no riskier than other firms. It is reasonable to assume that the authors would not characterize a business sector as having inherently high financial risk if the risks it confronts were not rather greater than the risk confronted by other businesses. The qualification is unnecessary if waste management firms are no different from other firms.

WMI must demonstrate more than just the existence of risk and regulation to give its argument the support it needs. The Agency's letter clearly asked the WMI respondents to consider regulatory and market differences. Enforced regulations in waste management can lead to facility closures and expensive cleanup orders. Such actions would likely have significant impacts on the financial condition even of firms as large as WMI. Likewise, WMI's markets are quite different than those of the firms in the EPA sample. The sampled firms are producers who sell in national and international markets. WMI is a service firm operating in a network of localized markets. The two conditions could not be much different, given the size constraint placed on the analysis. The central point is that WMI's operating units are subject to local vagaries (regulation, accident, community opposition) to an extent that far exceeds the local influences on production firms with national markets. As noted before, the WMI response chooses to ignore the question of differences in regulations and markets. WMI simply believes that since many firms are regulated and all firms face risks, then WMI is no different than any other firm. The response is inadequate and unconvincing.

The initial Agency letter also considered the use of a model adopted by Illinois. This discussion was included because WMI operates facilities in Illinois. The Agency believes WMI might advance this modification as a means to meet the objection based on risk characteristics. Illinois' financial assurance rules require that a complying facility owner or operator earn no more than 50 percent of its gross revenues from land disposal services. These rules clearly seek to lower the risks assumed by the regulatory authority by allowing only diversified permittees to use self-insurance.

Diversification eases risks by spreading them over different operating units and markets. The presence of a parent firm in many markets allows the parent to provide individual subsidiaries with a buffer against temporary setbacks. Reverses in one market can be weathered using the resources of the corporate network. Usually, these reverses cannot be severe or long-term. Otherwise the parent firm would likely divest itself of the losing subsidiary. However, if the subsidiary shows an ability to become profitable again in the near-term, then the temporary losses can be assumed by the parent firm without jeopardizing the whole corporate structure. The subsidiary is thus insulated from some part of the risks that an independent firm must face in total.

The Agency letter notes that the waste management firms likely to qualify are diversified firms only in a very special sense. These firms have become vertically integrated. That is, they have maintained a presence in a single market, waste management services, but they have expanded their holdings into firms that serve all parts of that market - from waste collection, through processing to final disposal. This means that the firms have not diversified outside their original markets. Instead, they have permeated their original markets. The risks associated with waste management services have become interrelated among subsidiaries under the control of a single parent firm. If initial risks have diminished, this is only to the extent that a subsidiary is insulated from localized risks. There remains a real question whether the parent firm will protect a local subsidiary in trouble, when such protection weakens the resources of the corporate structure.

The WMI response makes dubious assertions about the advantages of diversification. The assertions reinforce the Agency's original point - diversification does not necessarily lower risks. The Agency notes WMI's support of the staff's original position and retains its objection that the diversified character of a waste management firm should not influence a decision on whether to allow self-insurance. WMI's confusion results because of a misreading of the Agency letter. WMI assumes the letter concluded that firms which aren't diversified should not be allowed to self-insure. There is no conclusion stated in the Agency letter on the question of diversification and self-insurance. Instead, the letter notes that the Illinois rule writers probably did not intend Illinois' financial assurance rule to extend a benefit to firms that have diversified through vertical integration.

The first Agency letter asked WMI to consider whether adding risks to a corporate structure might not impact the parent firm's financial condition in ways that conventional accounting cannot report. Instead of considering this question, WMI discussed probability.

Before considering WMI's statistical analysis, a related issue should be adressed. The WMI response includes discussion of the way in which net worth measures are used in the financial test applied in the usual self-insurance case. Under Minnesota's hazardous waste facility rules, a self-insuring permittee must report the combined closure, postclosure care and response action costs associated with all self-insured facilities that the parent firm owns. This total interstate self-insurance cost is added to the estimated costs anticipated at the Minnesota site. The sum of the costs for the Minnesota site and all other sites is then used as the measure against which the parent firm's net worth is compared. If the site is to be self-insured, the parent firm's net worth must be at least $10 million and it must also be six times greater than the combined costs calculated for all sites.

For example, if the LMN company wants a permit for a site in Minnesota, it must first estimate the costs of closure and postclosure care. Assume this value is $1.5 million. LMN must then report on all other self-insured sites. Assume LMN has four other self-insured sites in other states and the combined estimated costs for closure, postclosure care and response actions at these sites are $13.5 million. If the parent firm wants to self-insure the Minnesota site, it must have and maintain a net worth of at least $90 million (six times $15 million). Every dollar added to the self-insurance bill must be matched by six dollars of net worth.

WMI presents this provision as a response to the Agency argument that fixed financial statistics will not properly reflect the cumulative impact of multiple self-insured sites. Since the test value changes as new sites are added to the self-insured list, it must not be fixed. This presentation again misses the central point of the Agency's objections. The Agency must rely on financial statements for its evidence that the permittee meets the self-insurance tests. These statements are fixed, as far as the Agency can tell, for the normal financial reporting period (one year).

Consider the case, advocated by WMI, in which a single parent firm has many self-insured sites in many states. Again, from Minnesota's point of view, financial values fixed for one year determine whether the local facility owner or operator qualifies for self-insurance. (Bear in mind throughout this example that the Agency has no independent source to use for verification of the values reported from sites in other states.) Events may occur in other states which would change the status of the local facility owner or operator with respect to financial assurance. Between the time that the Agency approves the facility owner's or operator's self-insurance demonstration, the parent firm could add more sites in other states and experience substantial losses from other sites. Both cases could change the result of the local site's self-insurance test, but the Agency would have no way to know that the changes had occurred until the time for annual review of the self-insurance test arrives.

Consider again the LMN example. Assume that the firm has a demonstrated net worth of $100 million. This would qualify the local site for self-insurance, since the total net worth needed was calculated at $90 million. Once the Agency approves self-insurance for the local site, the Agency's information does not change for a year. The financial values are fixed, even though the facility owner's or operator's condition can change quite a bit in a year. If, for example, LMN added two more self-insured sites (at, say, $10 million) in two other states and incurred a $5 million loss at a site in a third state, this would change the picture. The required net worth to qualify the local site would increase to $150 million while the firm's reported net worth, assuming no other changes, would fall to $95 million. The site would not qualify at its annual review. The conditions causing this disqualification could occur well before the annual review takes place. The strict interpretation of EPA's statistical findings would hold that a greater-than-acceptable risk exists for the period between the time financial conditions worsen and the time of the next annual review.

The more important question raised by the WMI response is whether the risk associated with many self-insured land disposal facilities is an additive function, as the Agency maintains, or a multiplicative function, as WMI maintains. WMI's argument considers only the unlikely condition in which contingent events occur simultaneously at many, or even all, sites. (This discussion assumes that since WMI uses the modifier contingent, the firm is considering only response and remediation costs, not closure and routine postclosure care.) WMI correctly maintains that the probability that a number of independent events will occur simultaneously is the product of their individual probabilities. WMI then goes on to argue that the best way to minimize risks is to add as many sites as possible to the list of self-insured sites. This argument results from a fundamental misunderstanding of the laws of probability. It is an attempt to rationalize a problem away, and ignore the realities of time and place. WMI's focus on simultaneity leads to a fundamental error. WMI is correct in its belief that the probability of occurrence of a set of independent events is the product of their individual probabilities. (This analysis apparently assumes that the dependent and conditional probabilities associated with individual sites form a composite that represents the whole site.)

Consider the problem as one of rolling dice. The probability of getting a one on a single die is 1/6 = 0.167. The probability of getting two ones when rolling two dice is (1/6)(1/6) = 0.028. Extending the example to three ones from three dice, the probability becomes (1/6)(1/6)(1/6) = 0.005. This describes the result assumed by WMI; the three independent events occur simultaneously. If this were a correct representation of the case, then the conclusion would be correct.

However, the inference is incorrect. Overall risk does not decrease, as inferred. WMI states that, "As the number of facilities (covered by self-insurance) increases . . . the likelihood that events will occur at <u>all</u> sites decreases."

The proper way to view the problem considers the case in two stages. First, think of a "planning" stage in which no events have occurred. Next, consider what happens to the probability calculations after an event occurs. In the first stage, the correct approach is to determine the likelihood that the events in question will form a "union." "The union of two events A and B is the event that occurs if either A or B both occur on a single performance of the experiment." Reference 28. Considering the events in question as unions takes account of the more realistic possibility that either one or two or more events may occur. This is the realistic case which WMI and the Agency confront.

Consider again the three-dice toss. The likelihood that either one or two or three ones will result is:

$$(1/6 + 1/6 + 1/6) - [(1/6)(1/6)(1/6)] = 0.5 - 0.005 = 0.495$$

This is a substantial difference from the minute result hinted at in the WMI response.

So, at the start of the analytical process, both parties confront a level of aggregate risk larger than the risk levels WMI assumes. The next stage in the analysis focusses on the impact of actual occurrences on the security that self-insurance offers. Assume that one event occurs. This event then drops out of the probability analysis. The event isn't probable anymore; it's real. It places a real financial burden on the corporate resources that are being promised as security for other sites. This is the central question of concern to the Agency. It should also concern other states' environmental agencies when they are invited to join the WMI network of risk.

Consider again the three dice (self-insured sites) and name them A, B and C. Locate site A in Minnesota and sites B and C in other states. If a problem arises at site B, then the LMN Corporation becomes responsible for paying whatever costs are involved. The costs to be incurred at B become realized liabilities which diminish LMN's net worth and working capital. This means that the risks associated with sites A and C remain, while LMN's financial capacity is diminished by costs incurred at B.

This assumed case describes the main concern presented by the Agency which WMI ignored in its response. The Agency letter asked WMI to "consider the implications of widespread use of (self-insurance)." What happens as WMI adds sites to its self-insured list and approaches "full subscription." That is, all sites in all states are self-insured. The dice toss can once again provide an illustration. Consider adding dice to the experiment as the analogue to adding sites to the self-insurance list:

Number of dice	Probability of a one	Probability of a union
3	0.167	0.495
4	0.167	0.666
5	0.167	0.833
6	0.167	0.999

(The dice example becomes less meaningful because the probabilities are limited. In practice, the likelihoods for separate events will vary and there could very well be more than six sites. The example is presented to illustrate the fact that adding sites increases, not decreases, aggregate risk.)

WMI and the Agency must also consider that some of these events can mean site closure. If closure is needed the permittee would incur costs at a site from which it gains no revenue. This would leave the facility owner or operator with a diminished capacity to insure the remaining risks. The overall risk may well not have fallen in direct proportion to the loss associated with the event that occurred.

The WMI response presents no risk estimate. We can assume from WMI correspondence and from discussions with WMI representatives that risks are finite and the associated costs are substantial. Given no data on which to evaluate WMI's claims, the Agency must take the conservative position that assumes risk and cost will be high. Therefore, reliance on a risk pool consisting of WMI-managed sites, a risk pool whose assets are managed by WMI, becomes a tenuous proposition. The Agency has no regulatory control over sites in other states. Regulations differ between states. This means other states' regulations may not be as protective of ground water resources. This makes it more likely that the events considered here will occur in other states. A further implication is that the corporate resources pledged to secure the Minnesota site will likely be used (possibly used up) in other states. Comparisons of states' environmental regulations add credibility to this concern. Minnesota is generally found to be one of the states with the most stringent environmental controls. Reference 29.

This leaves the Agency with a curious choice, assuming conventional self-insurance is allowed. Adopting conservative rules and standards along with vigorous enforcement may reduce the likelihood that the firm's corporate financial resources will not be needed for remedial action at the Minnesota site. The resources will likely then be used at sites in states that have less stringent rules. The Agency's alternative is to ease standards and not enforce them very rigorously. The Agency can then emphasize ground water monitoring efforts. This will maximize the chances of Minnesota getting its piece of the net worth before other states drain it away. The proper and reasonable solution is to reject these alternatives and rely on tested, conventional financial intermediation to provide the financial security for land disposal sites.

The initial Agency position was that the information used in the self-insurance financial tests can be too old to be useful, under conventional arrangements in solid and hazardous waste regulations. The financial statements customarily used in support of the financial tests are compiled annually. This system imposes information lags that other financial media avoid. Financial reverses can occur very quickly, so it is preferable to avoid reliance on old data.

The WMI response accepts the Agency statement that financial statements may be more than a year old when the Agency receives them. WMI also maintains that the majority of the data in financial statements will be less than a year old. This remark apparently considers financial data as separate bits of information gathered in over a year-long reporting period. WMI also suggests that since many financial companies base their decisions on annual financial statements, this information should be good enough for the Agency. Finally, WMI suggests that the Agency require more frequent financial reporting to solve this problem.

The assertion that most data in a financial statement are less than a year old refers to the fact that business activity is continuous, not discrete. The financial condition of a firm changes daily. The WMI statement assumes that data are useful simply because they exist. In practical terms, data are useful only if they are available in a consistent format that allows comparability between periods.

The financial tests used in most self-insurance programs rely on data compiled in balance sheets and income statements. These statements have their main value as measures of dynamic change, although current hazardous waste rules are accepting of static data. The tests are meant to provide regulators with early warning of imminent bankruptcy. Chosen indicators moving beyond acceptable limits are construed as signs that the firm is becoming less viable. The regulator then requires the facility owner or operator to either close or find another way to comply with the rules.

Regardless of the time at which a regulator gets a piece of information, its usefulness is tied directly to the reporting period. For example, although an action (e.g., an asset sale) may take place six months after one report is submitted, this information will not get to the regulator until the next published report is sent six months later. The information does not become usable until a year after the previous report. The age of the data does not matter as much as the reporting period.

WMI correctly points out that these problems could be solved in part with additional reporting requirements. If conventional self-insurance were to be included in the rules, quarterly reporting would likely be required. However, WMI has not successfully answered the other objections to self-insurance, so there is little need to pursue this issue further.

The Agency's original position was that only differences in administrative service costs matter when this issue is discussed. The question of opportunity costs thus narrows to consideration over which compliance method is cheapest. (An opportunity cost measures lost chances. For example, a person may hold savings as cash stuffed in a mattress or deposit the cash in a bank savings account. The foregone interest earnings from the savings account are an opportunity cost that is incurred if the person decides to stuff the mattress with money.) The opportunity costs associated with dedicating reserves for long-term care do not enter into the question, because such diversions would be required under any method. WMI completely misstates the problem when it asserts that the Agency position considered opportunity costs "irrelevant as the purpose of financial assurance regulations is to protect the environment rather than waste management firms."

The original Agency statement assumed a firm would optimize its choice of financial intermediaries. This means the firm need not rely on a trust fund to comply with the rules. Using a trust fund would indeed deprive a firm of the use of its funds. Instead, the likeliest case would have the firm purchasing a bond or a letter of credit. Both of these choices would allow the firm to retain control of its capital. The firm thus incurs minimal opportunity cost.

WMI asserts in its response that "self-insurance is a valid way of providing financial assurance for the protection of the environment." The word "valid," in common usage, means:

1. having legal force; properly executed and binding under the law; or
2. sound; well-grounded on principles or evidence; able to withstand criticism or objection, as an argument.

Reference 30.

WMI presumably relies here on the second understanding of the word, because the first definition makes no sense in this case. Considering the second definition, previous discussion has demonstrated that conventional self-insurance for solid waste management facilities is not sound or based on sound principles. The only evident principle in WMI's response is that of self-interest. Minnesota has no significant experience with conventional self-insurance that could be used as evidence. The limited national evidence available on conventional self-insurance raises important questions about the propriety of conventional self-insurance. A survey of EPA's experience with self-insured hazardous waste facilities found enough failures in the system to call for a new investigation of the financial tests (Reference 31).

WMI also asserts that it is unnecessary and unfair to exclude conventional self-insurance from the compliance options allowed. This phrase occurs in a logical construction that argues: conventional self-insurance is a valid financial assurance mechanism, so forcing WMI to use another mechanism is unnecessary and unfair.

WMI offers no evidence that conventional self-insurance is indeed a valid mechanism. The statement rests on a simple assertion of validity. The Agency's objections, challenging the validity of conventional self-insurance, are presented in detail above. It is necessary to exclude from the rules financial mechanisms that are invalid; that is, unsuited to the basic purpose of the rules.

The question of fairness caused the Agency staff to once again refer to a dictionary. The source cited above defines unfair as:

1. not just or impartial; biased; inequitable; or

2. dishonest, dishonorable or unethical in business dealings involving relations with employees, customers or competitors.

Assume that WMI uses the word unfair in the first sense. The Agency has been scrupulously impartial in its consideration of this matter. Facility owners and operators with an interest in this question have had well over a year to discuss issues of concern and suggest changes. (The Agency's first detailed correspondence with WMI began in September 1985. WMI's response arrived over a year later, in October 1986.) The Agency staff has investigated available background materials, looking for independent evaluations of conventional self-insurance programs. The Agency has maintained throughout the rulemaking process that all interests must be represented in consideration of the rules. This includes the interests of facility users and nearby property owners along with the interests of solid waste management firms.

WMI's response presents no evidence that the Agency has shown bias in its considerations. There is a consistent conservative bias built into the rules which is well-justified by the uncertainty that surrounds many of the processes involved. However, this conservative bias impacts all facility owners and operators with equal force.

The question of equity in resource allocation issues has become a matter of increasing interest in the last twenty years. Generally, resource analysts find that the most equitable (fairest) distributions are achieved through user fees. That is, resource users pay for the costs imposed on others by their use of the resource in question. An important consideration also is that the total cost to a user should vary according to the extent of use. This means that the person whose activities cause $X of damage should pay less than the person who causes $2X of damage, and so on.

Historic patterns in solid waste management have imposed substantial inequities. This happens as facility users avoid the costs of ground water contamination. These costs are shifted to those who have to rely on the contaminated ground water. The proposed financial assurance rules can be viewed as a means to require current resource users to pay for their use of a resource whose value is diminished (contaminated) by the facility. The WMI proposal to include conventional self-insurance would spread a risk premium throughout a national network of waste disposal sites. This means facility rates in Minnesota would not necessarily incorporate the risks incurred through site operations. Instead, rates at the Minnesota site could be raised or lowered by WMI's activities in other states and in enterprises other than solid waste disposal (hazardous waste management and nuclear waste management). This could unfairly impose risks on Minnesota facility users that properly belong to WMI's customers in other states.

Facility users also have some equity concerns in this matter. Although WMI's response indicates the firm would pass on any cost savings to its customers, there is no guarantee that this would happen if conventional self-insurance provisions were included in the rules. The cost savings involved, if they are as great as WMI represents them to be, would amount to a tempting and easily gained windfall profit. Prudence suggests that the Agency should remove this temptation from the waste manager's path.

If WMI does not pass on cost savings to its customers, the response letter says the firm wants to invest the cost savings that conventional self-insurance offers. The investment opportunity is research and development (R&D). The firm wants to be able to control resources that should be dedicated to long-term care at a local landfill site and use those resources to develop new technologies.

This assertion provides a clear argument for exclusion of conventional self-insurance. R&D investments are the riskiest class of investments that business makes. This is why R&D budgets are usually a very small part of business expenditures. This sort of activity is contrary to the goal of the financial assurance rules. This goal is the preservation of financial resources that will be needed in the future for ordinary facility maintenance or remedial action.

WMI wants to use these resources, instead, to underwrite risky ventures.

Such ventures, if successful, will improve WMI's market position. If the ventures are unsuccessful, then the price of failure will have to be borne by WMI's customers and neighbors, since the firm will have used up its reserves on bad R&D projects. The more likely and safer course for WMI is to use the withheld resources to make direct purchases that will increase its share of local markets.

The WMI proposal is to allow waste management firms to retain managerial control of reserves developed for long-term care at facilities. The conventional self-insurance provisions written into similar rules for hazardous waste facilities would meet WMI's goals. Such provisions would contradict the goals of the Agency's solid waste rules. Conventional self-insurance provides no control over the facility owner's or operator's use of financial reserves until those reserves are needed for work at the land disposal site. The normal self-insurance rule does not even require the facility owner or operator to report on how the withheld funds are developed or used. Instead, the cost-savings incurred through conventional self-insurance can be used to: a) reap windfall profits, b) expand market share through direct purchase of competitors' assets, or c) lower the risks of R&D expenditures. It is not reasonable to structure administrative rules so that they present competitive advantages to one segment of the regulated community and shift risks from a facility owner or operator to the State.

Conventional self-insurance is an unnecessary addition to the proposed rules. Other financial media allowed within the rules make it possible for facility owners and operators to keep control of their assets (bonds, letters of credit). There is a cost associated with these media, but this cost is minor in comparison with the size of the reserves required to meet long-term obligations. WMI makes no objection to this cost. Instead, the firm's objections refer strictly to the opportunity costs incurred if contingency action reserves must be placed in trust funds. The objections indicate WMI has not read correctly the proposed rules. WMI's goals can be met through the use of bonds or letters of credit.

Other reviewers have argued that the rules should include conventional self-insurance provisions for public sector facility owners and operators. In Minnesota, about 60 percent of the mixed municipal solid waste (MMSW) land disposal facility permits are held by local governments. Those making this suggestion believe that since local governments cannot escape from their responsibilities, the need for financial guarantees is less strong. Local governments are unlikely to become bankrupt, they cannot run away. Moreover, local governments have tax powers which enable them to meet the costs of long-term care as they are incurred.

This suggestion considers the issue from an ideal perspective and ignores some troublesome realities. Local governments' tax powers are not unlimited. Assessment limits, levy limits, State and federal revenue sharing programs and, ultimately, the political attitude of the taxpayers constrain local governments' revenue-earning potential. Although the budget and revenue constraints local governments face differ in nature from private firms' constraints, cost and income concerns still place strong limits on what local governments can do. This means that a local government facility owner or operator could also prove unable or unwilling to finance the costs of long-term care.

Most comments on this issue have been presented in staff meetings with local government officials. The officials argue that they do not believe a state agency will manage long-term care reserves in the interests of the local governments. They believe the Agency will take funds developed locally and use them for work at other landfills around the State. A corollary to this argument is that the rules imply an insulting mistrust of local government officials.

The financial instruments included in the rules are structured to satisfy these objections. These instruments will be described in detail below, but it is worth considering their general terms in this context. Much of the disagreement with local government officials arises because they believe the trust fund requirements will force local governments to pool their resources in a statewide fund.

> "The PCA has recommended that closure and post-closure money should be invested in the state trust fund," County Administrator Jim Tersteeg pointed out.
>
> "The county's position is we are responsible for the landfill and should control money set aside for it," he added.
>
> County Attorney Tom Simmons pointed out to the commissioners that no other state agency seeks to control local funds. Renville County, he continued, is only the second county to be approached in the PCA effort.
>
> There is no certainty that PCA will be able to secure a better return on the investment in the state trust fund, he told board members. Commissioners agreed that local investment of the money was also of greater value to the county's economy.
>
> The board decided to present the issue at a district meeting of the Association of Minnesota Counties to be held in Montevideo

Aug. 8, seeking support of other counties in resisting the PCA move.

Reference 32.

The proposed rules allow facility owners and operators to pool their resources if they want to (see part 7035.2715). However, the proposed rules clearly do not require facility owners and operators to pool their resources in a statewide trust fund. Instead, facility owners and operators may choose any trustee from among those financial institutions in the State that are qualified to administer trusts.

If local government officials prefer to retain control of reserved funds, they can choose from the surety bond or letter of credit options. The local government could thus set up a sinking fund in its budget that would remain under full local control. These media offer facility owners and operators a reasonable alternative to trust funds.

A somewhat related argument from local officials is opposition to a provision of the trust agreement included in the rules.

> Counties strongly oppose provisions of the draft rule that name PCA as legal beneficiary of local solid waste financial assurance trust funds. This is an infringement upon local control of locally collected revenues. Counties must retain the right to negotiate the types and costs of remedial actions needed to achieve the desired environmental standard.

Reference 33.

Again, the dispute focusses on the issue of local control of funds set aside for long-term care at land disposal facilities. The complaint results from an incomplete reading of the proposed rules. Surety bonds and letters of credit would offer local governments all of the control they want.

There is a chance that local governments could lose control of their funds under surety bond or letter of credit arrangements. This could happen if the local government facility owner or operator refused to perform the work specified in the appropriate engineering plans. For example, assume that a local government facility owner or operator does not properly close its site and that the facility owner or operator had executed a surety bond or letter of credit in compliance with the rules. The Commissioner would then draw on the instrument. The surety or bank would be required to make specified deposits into a standby trust fund. The Agency would use the trust fund to finance proper closure and long-term care at the site. The surety or the bank would then recover the amounts deposited from the facility owner or operator. The local government facility owner or operator would lose control of its funds under these circumstances, but only after it had made an explicit choice to not meet its responsibilities. Given such a refusal, it is unreasonable to allow such a facility owner or operator to keep control of set-aside funds when they are needed to care for the site.

The statement cited above discusses negotiations as though they are a matter of secure right. The argument cites no source for the origin of this claimed right. If the Agency were to recognize this claim and regularize it in the financial assurance rules, it would reduce the on-site engineering studies to the status of bargaining chips. The argument for negotiating rights assumes, in advance, that the engineering studies are wrong. This is a most unreasonable solution to the problem of providing long-term care at land disposal facilities. If the findings of on-site engineering and hydrogeologic investigations cannot be trusted, then there is no point in planning facility development. The future becomes unknown and unknowable. The only course open to operators and the Agency then is to cover current costs and hope that the future will take care of itself.

A more reasonable approach, embodied in the proposed rules, sets up a system under which:

a) all parties agree on the engineering cost estimates developed in compliance with the proposed rules;
b) periodic reviews inform changes in the cost estimates; and
c) the cost estimates constrain the use of the reserved funds.

This arrangement equally informs all parties of developments at the site from the current period until the end of the facility owner's and operator's postclosure responsibilities. The proposed rules put in place an orderly and systematic development plan. This system will ease the transition from daily facility operations to postclosure care. It will also help bring more order to the process of implementing remediation at facilities.

This orderly management system is much preferred and more reasonable than the process implied in which all matters are always negotiable. County governments do not lose chances to negotiate under the proposed rules. Rather, information sharing and planning will confine negotiations to their proper place, which is during the planning period. The suggestion that local governments must retain some absolute negotiating right indicates that county governments want to be able to intervene when plans are being implemented. Intervention would disrupt operations and prove costly. Orderly planning and implementation under the proposed rules are expected to conserve many scarce resources - natural, financial and human.

The self-insurance arguments various reviewers have made remain unconvincing. It is not reasonable to allow future obligations to remain unsecured. However, the request to allow self-insurance was strong enough that the Agency has developed a modification of customary self-insurance provisions. The modification consists of a security requirement that is added to the financial tests. Facility owners or operators who want to self-insure must first pass the financial test and then send securities to the Agency that will be held as collateral.

This provision does not diminish the arguments against conventional self-insurance. The financial test fashioned on the EPA hazardous waste facility model remains invalid in the solid waste management sector. It cannot be used in the solid waste management sector with the same confidence that it is used for hazardous waste facilities. However, the information provided in the tests will prove useful and necessary to the Agency in the analysis of securities' market values. The EPA model provides a further advantage, since its form and administration are familiar to both the Agency and the private sector firms that are likely to qualify for self-insurance.

Security is the essential difference between the facility owners' and operators' suggestions and the Agency's proposed self-insurance alternative. Facility owners and operators suggest that they should be allowed to comply with the rules through the use of an unsecured I.O.U. The Agency's proposed self-insurance option requires facility owners or operators to provide security for the I.O.U. Compliance costs under the agency proposal will be slightly higher than under the facility owners' and operators' proposals. This is because firms and municipalities will incur some costs if they issue bonds. There will also be nominal charges incurred for the establishment of standby trust funds. Still, the Agency's self-insurance option will very likely cost less than the other financial assurance mechanisms.

Self-insurance will also allow facility owners and operators to control their financial reserves. They will only lose control if they mismanage funds or choose not to comply with the rules. Self-insurance is described and discussed below in detail.

Item A allows facility owners and operators to comply with the rules through the use of self-insurance. This provision places two requirements on land disposal facility owners and operators. First, facility owners and operators must demonstrate that they pass a specified series of financial tests, set out in item B. The measures that comprise the tests indicate the facility owner's or operator's current financial strength and short-term prospects for continued financial stability. The financial tests will help the Agency assess the market value of the securities required in the second part of this item.

The second part of this item requires facility owners and operators to send the Agency securities (bonds or warrants) that can be used as collateral for long-term care obligations. Since the securities must serve as collateral, they must have a value that is independent of the relationship between the Agency and the facility owners and operators. So, the kind of bond that makes a limited promise to discharge specified obligations cannot be used. This kind of bond is allowed under Illinois' financial assurance rules, for example. Owners and operators in Illinois can self-insure if they pass some financial tests and sign either an "Operator's Bond Without Surety" or an "Operator's Bond With Parent Surety." Both bonds have value only to the state agency. They cannot be traded or sold because they name the Illinois Department of Environmental Protection as the only possible recipient of payments under the bond. These bonds provide no added security to the state agency because they have no value to anyone other than the state agency.

The bonds required under the proposed rules provide added security, at minimal added cost, because they have independent market value. They have value because the issuer's obligation is to either the bearer of the bond or the registered bond holder. The bond can be transferred and, because of transferability, there is an active secondary market for bonds in which their value depends on both their specific terms and general economic conditions. The process of market valuation will be discussed more fully below.

The warrants allowed under the proposed rules provide security because they are municipal obligations to pay specified sums. A warrant is different from a bond because it is not negotiable. Only the person named as payee can be paid by the municipal treasurer. A properly executed warrant is authorized by appropriate local fiscal and political officials and must be honored by local treasurers.

The security requirement imposes on facility owners and operators a reasonable performance incentive that is lacking in conventional self-insurance forms. The security requirement also gives the Agency reasonable assurance that there will be a way to pay for long-term care at facilities, even if facility owners and operators refuse to do the work.

Item B describes the elements of the financial test. The proper goal of a private sector firm is profit. Financial reporting in the private sector is thus oriented toward providing information on profitability and returns on investment. The proper goal of a public sector facility is service. Public sector financial reporting has little to do with profit, since public bodies are seldom managed for profit. Instead, public sector accounting provides information about the sources and uses of funds. Minnesota has a mixture of private and public facility owners and operators. This means that different sorts of tests must be applied under different types of ownership status.

Subitem (1) contains the elements of one of the financial tests for private sector facility owners and operators. These elements are taken directly from EPA rules covering financial assurance for hazardous waste facilities. The specific elements of the test are:

(a) two of the following three ratios: a ratio of total liabilities to net worth less than 2.0; a ratio of the sum of net income plus depreciation, depletion and amortization (also known as cash flow) to total liabilities greater than 0.1; or a ratio of current assets to current liabilities greater than 1.5; and

(b) Net working capital and tangible net worth each at least six times the current cost estimates for all owned or operated facilities; and

(c) Tangible net worth of at least $10 million; and

(d) Assets in the United States amounting to at least 90 percent of the owner's or operator's total assets and at least six times the current cost estimates for all owned or operated facilities.

The test elements can best be considered as three subsets (Reference 34). Unit (a) contains the first subset, the financial ratios, which are most commonly used in financial analysis for their predictive value. They provide measures of a firm's likely future that are normally valid, at least in the short term. Financial analysts have developed many ratio measures designed to provide different sorts of information. The ratios are needed because the basic financial statements do not, by themselves, provide enough information to make informed decisions. A business firm is a dynamic system and no single measure or value can provide a sufficient indication of the firm's health. As with all dynamic systems, the critical measures are not the dimensions of important variables. The more important information has to do with the relationships of these variables to each other and how these relationships compare with other systems. For example, the fact that a firm has millions of dollars in liabilities does not mean it has problems as long as its asset base is large enough to support the debt and finance continued operations.

The second subset of tests, found in unit (b), consists of multiples of financial measures. These are the requirements that net working capital, tangible net worth and total assets be at least six times the amount of the current cost estimates for all owned or operated facilities. The multiples are included in the test to prevent situations in which the size of the estimated costs involved overwhelms the business firm. A firm can have very good financial ratios and also have a very small asset base. A large cost estimate would very likely prove too expensive for the firm in such a case.

Units (c) and (d) contain the third subset, which requires that net worth be at least $10 million and that assets held in the United States be either 90 percent of total assets or 6 times the estimated costs. Net worth is the difference between total assets and total liabilities. It can be considered the same as owners' equity. This test is included as a bankruptcy protection measure. Smaller firms fail more often than larger firms. Size does not afford an absolute protection, but it has proven over time to matter quite a lot when it comes to private sector performance.

The asset holding requirement is another bankruptcy protection measure. In bankruptcy proceedings, assets held in other countries are less accessible than assets held in the United States. This requirement minimizes the potential damage that could be caused by a private firm's liquidation or reorganization. The measure requires that substantial assets be maintained in the United States, where they will be more readily available to pay for needed work if a liquidation or reorganization occurs.

The EPA performed extensive analyses to develop the final form of this financial test. The analyses evaluated over 300 candidate financial tests, which were comprised of various financial ratios and multiples. Each test was evaluated on its performance as measured from historical data. The EPA evaluated these tests according to two criteria:

a) the percentage of eligible, nonbankrupt firms that pass the test; and
b) the number of firms per 10,000 which pass the test and later become bankrupt.

The EPA then evaluated a small group of the most effective tests; those tests which passed the greatest percentage of eligible firms and passed the fewest number of firms which later became bankrupt. This time implementation cost was the single evaluative criterion. The test finally put into the rules proved to be the least costly of the effective tests.

The selected test passed over 95 percent of eligible firms and also passed firms that later became bankrupt at a rate of nearly 10 per 10,000. Earlier discussion explained why these statistical findings have no validity in the solid waste management sector. However, this financial test can provide some very important information that the Agency will need to administer the self-insurance rule. The bonds that provide the security that makes self-insurance possible will have market values that change from period to period. The financial strength and prospects of the issuer are important influences in setting market values. The financial information obtained through the test will give the Agency a reasonable way to verify the market valuation of the bonds. Furthermore, the financial test will also provide the Agency with reasonable notice of any deterioration of a facility owner's or operator's financial condition. The details of market valuation will be discussed in an appropriate later section.

Subitem (2) contains the elements of an alternative financial test for private sector facility owners and operators. This alternative test is also taken directly from EPA rules covering financial assurance for hazardous waste facilities. The specific elements of the test are:

(a) a current rating for the facility owner's or operator's most recent bond issue of either AAA, AA, A, or BBB from Standard and Poor's or Aaa, Aa, A, or Baa from Moody's; and
(b) tangible net worth at least six times the current cost estimates for all owned or operated facilities; and
(c) tangible net worth of at least $10 million; and
(d) assets in the United States that amount to at least 90 percent of the sum of the current cost estimates for all owned or operated facilities.

Unit (a) requires that corporate bonds be rated at least "investment grade." The EPA confronted a problem in developing financial assurance rules for hazardous waste facilities. Some public utilities are regulated by these rules. Local public utility regulations often have a limiting effect on public utilities' liquidity positions, which figure importantly in the ratio values included in the private sector financial test. The EPA chose to rely, in part, on bond ratings set by firms with long experience in this area: Standard and Poor's and Moody's. These firms rate bond issues with respect to their security as investments. Both rating systems use alphabetical codes.

KEY TO MOODY'S BOND RATINGS

Aaa - Bonds which are rated Aaa are judged to be of the best quality. They carry the smallest degree of investment risk and are generally referred to as "gilt edge." Interest payments are protected by a large or by an exceptionally stable margin and principal is secure. While the various protective elements are likely to change, such changes as can be visualized are most unlikely to impair the fundamentally strong position of such issues.

Aa - Bonds which are rated Aa are judged to be of high quality by all standards. Together with the Aaa group they comprise what are generally known as high grade bonds. They are rated lower than the best bonds because margins of protection may not be as large as in Aaa securities or fluctuation or protective elements may be of greater amplitude or there may be other elements present which make the long term risks appear somewhat larger than in Aaa securities.

A - Bonds which are rated A possess many favorable investment attributes and are to be considered as upper medium grade obligations. Factors giving security to principal and interest are considered adequate but elements may be present which suggest a susceptibility to impairment sometime in the future.

Baa - Bonds which are rated Baa are considered as medium grade obligations, i.e., they are neither highly protected nor poorly secured. Interest payments and principal security appear adequate for the present but certain protective elements may be lacking or may be characteristically unreliable over any great length of time. Such bonds lack outstanding investment characteristics and in fact have speculative characteristics as well.

Ba - Bonds which are rated Ba are judged to have speculative elements; their future cannot be considered as well assured. Often the protection of interest and principal payments may be very moderate and thereby not well safeguarded during both good and bad times over the future. Uncertainty of position characterizes bonds in this class.

B - Bonds which are rated B generally lack characteristics of the desirable investment. Assurance of interest and principal payments or of maintenance of other terms of the contract over any long period of time may be small.

Caa - Bonds which are rated Caa are of poor standing. Such issues may be in default or there may be present elements of danger with respect to principal or interest.

Ca - Bonds which are rated Ca represent obligations which are speculative in a high degree. Such issues are often in default or have other marked shortcomings.

C - Bonds which are rated C are the lowest rated class of bonds and issues so rated can be regarded as having extremely poor prospects of ever attaining any real investment standing.

STANDARD & POOR'S CORPORATE RATING DEFINITIONS

A Standard & Poor's corporate or municipal bond rating is a current assessment of the creditworthiness of an obligor with respect to a specific debt obligation. This assessment may take into consideration obligors such as guarantors, insurers, or lessees.

The bond rating is not a recommendation to purchase, sell, or hold a security inasmuch as it does not comment as to market price or suitability for a particular investor.

The ratings are based on current information furnished by the issuer or obtained by Standard & Poor's from other sources we consider reliable. We do not perform an audit in connection with any rating and may, on occasion, rely on unaudited financial information. The ratings may be changed, suspended, or withdrawn as a result of the changes in, or unavailability of, such information, or for other reasons.

The ratings are based, in varying degrees, on the following considerations:

I. Likelihood of default - capacity and willingness of the obligor as to the timely payment of interest and repayment of principal in accordance with the terms of the obligation.

II. Nature of and provisions of the obligation.

III. Protection afforded by, and relative position of, the obligation in the event of bankruptcy, reorganization, or other arrangements under the laws of bankruptcy and other laws affecting creditor's rights.

AAA - Bonds rated AAA have the highest rating assigned by Standard & Poor's to a debt obligation. Capacity to pay interest and repay principal is extremely strong.

AA - Bonds rated AA have a very strong capacity to pay interest and repay principal and differ from the highest-rated issues only in a small degree.

A - Bonds rated A have a strong capacity to pay interest and repay principal, although they are somewhat more susceptible to the adverse effects of changes in circumstances and economic conditions than bonds in higher-rated categories.

BBB - Bonds rated BBB are regarded as having an adequate capacity to pay interest and repay principal. Although they normally exhibit adequate protection parameters, adverse economic conditions or changing circumstances are more likely to lead to a weakened capacity to pay interest and repay principal for bonds in this category than for bonds in higher-rated categories.

BB - Bonds rated BB, B, CCC, and CC are regarded, on balance, as predominantly

speculative with respect to capacity to pay interest and repay principal in
B - accordance with the terms of the obligation. BB indicates the lowest degree
of speculation and CC the highest degree of speculation. While such bonds
CCC - will likely have some quality and protective characteristics, these are
outweighed by the large uncertainties or major risk exposures to adverse
CC - conditions.

C - The rating C is reserved for income bonds on which no interest is being paid.

D - Bonds rated D are in default, and payment of interest and/or repayment of principal is in arrears.

Bond Investment Quality Standards: Under present commercial bank regulations issues by the Comptroller of the Currency, bonds rated in the top four categories (AAA, AA, A, BBB, commonly known as "investment grade" ratings) are generally regarded as eligible for bank investment. In addition, the legal investment laws of various states impose certain ratings or other standards for obligations eligible for investment by savings banks, trust companies, insurance companies, and fiduciaries generally.

Reference 35.

A former president of Standard and Poor's provided more details on the factors that inform the ratings:

1. Issuing documents: . . . In determining a rating, the indenture is far less important than the company's earning power, financial resources, and property protection. This is not to say, however, that the indenture does not have a great bearing on the bond rating. . . .

2. Earnings: the past record and foreseeable potential are, in most cases, the single most important factor in credit rating. High levels of earnings frequently preclude liquidity problems because access to short-term cash needs can be readily accommodated. Remembering that bond ratings turn on timely repayment of principal and interest, strong cash flows generated by high and continued earnings, combined with an adequate depreciation, depletion, and amortization policy where applicable, contribute to a healthy plus factor to the determination of a bond rating. . . .

3. Asset protection: Asset protection generally is more important as a long-term consideration than as one influencing immediate liquidity. The analysis here is primarily statistical and, hence, highly objective.

> Of primary interest are the ratio of its working capital to its debt; the ratio of its debt to its equity; and the ratio of its total net tangible assets to its debt. The relative importance of these major ratios depends on the type of industry the company is in. . . .
>
> 4. Management: Evaluating management is one of the most difficult chores a rating agency faces. But management is one of the most important facets of a successful operation. It is my opinion that the single most important reason for the failure of the Penn Central was the inability of its management to deal with its problems. . . .
>
> 5. Financial resources are, of course, the largest single area in which liquidity has a direct impact on long-term debt rating. In looking at the financial resources of a company, we are concerned not only with a company's cash position but also with its ability to obtain cash. This area of financial resources, which constitutes one of the five fundamental areas of investigation to determine long-term debt rating is the test of liquidity. . . . Briefly stated, the financial resources we consider are those alternative sources of borrowing that a firm may use to raise cash for either long- or short-term debt repayment. They include the amount of cash reserves on hand including salable receivables; the short-term borrowing potential, particularly bank lines; the ability of the company to tap the long-term debt market, particularly at the time of <u>its</u> choosing; the ease with which the company could <u>sell</u> stock; and the potential sale of assets -- obviously the weakest alternative.

Reference 36.

Liquidity is an important factor in the financial test presented in subitem (1). That test makes use of cash flow, working capital and current asset values which are all liquidity measures. They provide an indication of a firm's ability to discharge short-term liabilities. These liquidity measures are in the test because they add to the test's efficacy under statistical analysis. That is, EPA found that liquidity measures add to the predictive power of the overall financial test.

However, the test is somewhat rigid in its emphasis on liquidity. Conditions may arise in which a financially sound firm may not meet the liquidity criteria of the financial test in subitem (1). In these circumstances, a regulator or obligor may find that ready access to cash may substitute for actual cash in hand. (The Brenton Harris statement cited above makes this point in the second and fifth paragraphs.) Since bond ratings take access to cash into account, the bond ratings required under unit (a) will serve as a reasonable substitute for the liquidity criteria in the first financial test.

Units (b), (c) and (d) retain the multiples and bankruptcy protection measures in subitem (1). It is reasonable to allow the alternative financial test because the alternative offers comparable security and may be needed by firms that cannot meet specified liquidity criteria.

Subitem (3) contains the elements of the financial test for public sector facility owners or operators. Earlier discussion explained why public sector accounting practices do not allow the use of conventional private sector financial analyses. Fortunately, public sector financial reporting and statutory constraints provide alternative measures of financial performance. The specific elements of the financial test are:

(a) a current rating for the facility owner's or operator's most recent bond issue of either AAA, AA, A, or BBB from Standard and Poor's or Aaa, Aa, A, or Baa from Moody's; and
(b) a surplus of the net debt limit imposed by Minn. Stat. § 475.53 over existing debt that exceeds the sum of the current cost estimates; and
(c) current tax levies that do not exceed the levy limits imposed by Minn. Stat. § 275.51; and
(d) a certification that foreseeable conditions in the coming year will not cause the facility owner or operator to not meet any of the first three criteria.

Unit (a) describes bond rating criteria that are the same as the criteria in unit (a) of subitem (s). The EPA introduced the bond rating standards to provide a test that financially-strong utilities could pass. This test element can serve just as well for municipalities, which operate under even more constrained conditions because they do not compete in markets for profit. Rating firms analyze municipal bond issues with a care equal to that which they give corporate issues. The bond rating measures thus provide a reasonable means to verify market valuations.

Unit (b) requires that facility owners and operators maintain an excess of net debt limit over incurred debt that equals or exceeds the estimated costs of closure, postclosure care and contingency action.

Minn. Stat. ch. 475 places limits on the amount of debt municipalities can incur. Municipal net debt cannot exceed 7 1/3 percent of total assessed value. The statutory definition of net debt (Minn. Stat. § 475.51, subd. 4) excludes from net debt the bonds that will be presented as security for self-insurance. However, this measure of the municipality's capacity to incur long-term debt still serves as a reasonable indication of the value of the security. If a municipality is at or near its debt limits, it could prove difficult for the county board or city council to approve the bond issues and enact the tax levies that will be needed to repay the debt incurred through the collateral bond or warrant. Excessive debt conditions would lower the market value of the bonds.

Unit (c) requires that levy limits be observed. Minn. Stat. § 275.51 limits the amount of taxes a municipality can levy. Taxes levied to pay for facility long-term care costs may be exempted from these limits. This measure is included as an indication of the municipality's ability to pay facility ownership costs. The reasoning is much the same as rationale presented for the net debt test. A municipality operating beyond statutory levy limits will likely have trouble refunding and paying for the new debt if the Agency has to sell bonds or present a warrant to pay for long-term care. It is not reasonable to let a municipality in this position self-insure. The requirement provides a safeguard that the Agency will not be placed in a position in which it must allow self-insurance for a municipality that cannot afford to self-insure.

Unit (d) requires a certification by an official of the elected body that holds the permit. Municipal governments have to make budget and revenue projections to manage their resources with the proper care. The proposed rules require facility owners and operators to demonstrate, through these projections, that short-term changes will not cause the owners and operators to fail the financial test. These demonstrations will have to be certified as accurate by an appropriate local official. This requirement serves two purposes. First, it provides the Agency with further information on the facility owner's and operator's financial condition and prospects. Second, it reminds local officials that their responsibilities are current and cannot be abandoned once they have Agency approval for their initial self-insurance demonstrations. The exercise of long-term care at facilities will continue for many years. The Agency and facility owners and operators must develop stable patterns of sharing information in the interest of efficient long-term management.

Item C specifies how facility owners and operators must demonstrate that they qualify for self-insurance. The demonstration consists of a series of written certifications.

Subitem (1) requires a certification of reports. The first certification is a letter from an appropriate authority which reports that the facility owner or operator meets the criteria in the financial test. The exact form of the letter is specified in another part of the rules. A letter from a private sector facility owner or operator must be signed by the firm's chief financial officer. A letter from a public sector facility owner or operator must be signed by the head of the public body that holds the permit. This provision makes an appropriate authority responsible for a very important action - that of reporting to a State agency that the financial data presented qualify the permittee to self-insure. The Agency must be assured that the data which inform its self-insurance decisions are accurate and reliable.

Providing a standard form for the self-insurance demonstration minimizes the administrative burden of the rules for both permittees and the Agency. Facility owners and operators will not have to spend time devising their own letters and the Agency will not have to spend time reviewing idiosyncratic submissions of many facility owners and operators.

Subitem (2) requires that the self-insurance demonstration letter be accompanied by an analysis from an independent certified public accountant (CPA). The CPA's analysis must report on examination of the facility owner's and operator's latest financial statements. The report must certify that the financial statements were developed in accordance with generally accepted accounting principles (GAAP) and that they are a fair representation of the facility owner's and operator's financial condition.

This requirement gives the Agency needed confidence in the data that inform an important decision. The burden of this certification is placed on a third party, the independent CPA, who has no interest in the outcome of the Agency's decision. The CPA's sole interest is in the credibility of the analysis. The requirement also relieves the Agency of the need to review unaudited materials.

Subitem (3) requires two special reports from the CPA.

Unit (a) describes the requirements of the first report. The first special report must find that the data in the demonstration letter are derived from the independently audited, year-end financial statements and that there is no reason to adjust the data in the letter. This finding gives the Agency reasonable assurance of the quality of information used to demonstrate qualification for self-insurance. Some of the information provided in the letter usually is not reported separately in financial statements. This is true for the cash flow measure, for example.

Unit (b) describes the requirements of the second report, which is a finding on the market value of the bonds presented as security. Bonds do not maintain their face value in secondary markets. This is because economic conditions have an effect on the worth of an issuer's promise to pay a specified amount on a specified date:

In understanding the bond market there are three main elements to consider: The price of the bond itself, the interest rate (or coupon rate) it pays; and your actual return on investment (yield).

A bond is issued at a specific face value, generally $1,000, and a specific interest rate. An 8 percent rate means that you're entitled to 8 percent of $1,000, or $80 a year. Traditionally, bonds carried a page of coupons, each one entitling the owner to an interest payment; when payment date arrived, you clipped the coupon and exchanged it for cash at a bank. Nowadays, companies will mail your interest checks automatically, but the term coupon rate still survives.

The general level of interest rates in the financial markets does not stay the same for the life of the bond. When business picks up, demand for credit rises, and the inflation rate increases, bond interest rates also increase. When business slows, credit-demand eases, and inflation falls, bond rates decrease. In today's business climate, a company may be able to attract investors by offering bonds at 8 percent, but tomorrow the going rate may be 8 1/2 percent, or 7 1/2 percent. Changes in interest rates affect the market value of the bonds you already own.

Assume, for example, that you own a $1,000 bond at 8 percent, which means an interest payment of $80 a year. If long-term interest rates move up, the next bonds the company sells may come out at a coupon rate of 8 1/2 percent, or $85 a year. What does this do to the older bond?

Its value will fall, from the $1,000 you paid for it to perhaps $960 on a thirty-year bond. The interest payment is still $80 a year, but $80 on a $960 investment gives a return of close to 8 1/2 percent, which is the going market rate. The interest payment, as a percentage of the bond's current value, is called the current yield.

If you sold your $1,000 bond for $960, you'd take a $40 loss. The person who bought it for $960, held it to maturity, and turned it in for $1,000 would have a $40 gain. The value of that gain is figured into the bond's market price. The total return to an investor -

counting interest rate and gain (or loss) in price - is called the yield to maturity.

The rule, then, is that when interest rates rise, bond prices fall. But this is relevant only if you have to sell the bond before maturity. As long as you hold it to maturity, you'll get your full investment back.

Assume, now, that you own a $1,000 bond paying 8 percent, or $80, and long-term rates fall. The next bonds that the company sells come out at a coupon rate of 7 1/2 percent, or $75 a year. What happens to the older bond? The value moves up - to around $1,035, because an $80 interest payment on $1,035 is close to 7 1/2 percent, the current level of market rates.

If you sold your $1,000 bond for $1,035, you'd have a $35 gain. The person who bought it at that price and held it to maturity would get only $1,000 when the bond was redeemed, a $35 loss. That loss is figured into the market price in calculating competitive yield to maturity.

The other part of the rule, then, is that when interest rates fall, bond prices rise. When a bond is selling at more than $1,000, it's said to be at a premium. When it's selling for less, it's at a discount. Anyone who holds his bond to maturity will be able to turn it in for face value. But if you sell before maturity, you may get more or less than you paid for the bond, depending on what has happened to interest rates since you first bought.

Reference 37.

Unit (c) addresses the market value of the bonds. The proposed rule requires that the CPA's report must find that the total market value of the bonds equals or exceeds the sum of the cost estimates. The Agency must know whether the security it holds is sufficient. An independent CPA should develop the report because this protects the interests of both the facility owners and operators and the Agency. The CPA is a neutral person whose sole interest lies in making a credible, authoritative report. In most cases, neither the facility owners and operators nor the Agency should find cause to dispute the CPA's findings.

Subitem (4) addresses self-insurance approval. Once self-insurance has been approved, the facility owner or operator is required annually to make revised self-insurance demonstrations. None of the conditions reported in the demonstration letter will remain the same. Both the Agency and the facility owner or operator must know how changing conditions have changed the value of a self-insurance demonstration. The Agency expects the annual self-insurance revisions to coincide with the annual cost revisions required under part 7035.2685.

Subitem (5) establishes denial criteria. The Commissioner is required to disallow self-insurance under a specified set of circumstances all of which relate to the CPA's reports. Those circumstances are:

- an adverse opinion or a disclaimer of opinion;
- a qualified opinion; or
- an opinion that the owner or operator fails to pass the financial test.

The American Institute of Certified Public Accountants has set standards as to what qualified opinions, adverse opinions, and disclaimers of opinion should say and when they should be issued.

1. Qualified Opinion.

A qualified opinion states that "except for" or "subject to" the effects of the matter to which the qualification related, the financial statements present fairly financial position, results of operations, and changes in financial position in conformity with generally accepted accounting principles consistently applied. Such an opinion is expressed when a lack of sufficient competent evidential matter or restrictions on the scope of the auditor's examination have led him to conclude that (he) cannot express an unqualified opinion, or when the auditor believes, on the basis of his examination, that:

a. the financial statements contain a departure from generally accepted accounting principles, the effect of which is material;

b. there has been a material change between periods in accounting principles or in the method of their application; or

c. there are significant uncertainties affecting the financial statements, and he has decided not to express an adverse opinion or to disclaim an opinion.

2. Adverse Opinion.

An adverse opinion states that financial statements do not present fairly the financial position, results of operations, or changes in financial position in conformity with generally accepted accounting principles. Such an opinion is expressed when, in the auditor's judgment, the financial statements taken as a whole are not presented fairly in conformity with generally accepted accounting principles.

3. Disclaimer of Opinion.

A disclaimer of opinion states that the auditor does not express an opinion on the financial statements. When the auditor disclaims an opinion, he should state in a separate paragraph(s) of his report all of his substantive reasons for doing so, and also should disclose any other reservations he has regarding fair presentation in conformity with generally accepted accounting principles or the consistency of their application. The disclaimer of opinion is appropriate when the auditor has not performed an examination sufficient in scope to enable him to form an opinion on the financial statements. A disclaimer of opinion should not be expressed because the auditor believes, on the basis of his examination, that there are material departures from generally accepted accounting principles.

Reference 38.

A facility owner or operator should not self-insure if a CPA's examination of financial statements indicates that the facility owner or operator either does not qualify for self-insurance or has submitted incorrect or insufficient data in support of the self-insurance demonstration.

Subitem (6) allows the use of a corporate guarantee by parent corporations. The proposed rules allow a parent corporation to make the self-insurance demonstration on behalf of a subsidiary firm. Part 7035.0300 defines a parent corporation as a corporation that has at least half the voting stock of the owner's or operator's firm. This requirement allows facility owners and operators to take advantage of a parent firm's size and financial strength.

This subitem requires that the parent firm be the issuer of the bonds if the facility owner or operator chooses to use the corporate guarantee to make the financial assurance demonstration. This requirement expressly disallows cases in which parent firms meet the financial test and subsidiary firms issue bonds.

If the facility owner or operator chooses this option, all evidence and judgments will relate to the parent firm and its financial position. If the parent firm and the issuer are different, then none of the data submitted in support of self-insurance will matter in the determination of bond market values. Bond market values depend critically on assessments of the issuer's financial condition. The firm demonstrating financial strength should issue the bonds.

Guarantors must send the Commissioner a corporate guarantee in a form provided in another rule. The Agency must have valid proof of the guarantee and standard forms save all parties time and money. The terms of the guarantee are discussed in detail below.

Unit (a) defines the essential elements of the guarantee. The guarantor must set up a trust fund, as specified in part 7035.2705, if the facility owner or operator fails to perform work described in the closure, postclosure care or contingency action plan. The guarantor makes a pledge very much like the pledge made by an independent surety, as specified in parts 7035.2725 and 7035.2735. This requirement effectively commits the guarantor, who takes on the self-insurance burden of proof, to the completion of required work at a facility even though the guarantor does not hold the facility permit. The guarantor, in effect, takes on the financial responsibilities associated with the facility owner's or operator's permit obligations.

Unit (b) provides for cancellation of the guarantee. The guarantor may cancel the guarantee. However, both the Commissioner and the facility owner or operator must receive notice of cancellation by certified mail. The cancellation may not become effective until 120 days after the Commissioner receives the cancellation notice. This requirement enables a guarantor to cancel the guarantee agreement under specified conditions. The conditions protect the Agency's and the facility owner's or operator's interests. The advance notice gives the facility owner or operator time to establish a substitute financial assurance instrument. The notice lets the Agency know in advance that the facility owner or operator will be switching financial instruments.

Unit (c) provides a safeguard to make sure that cancellation of the guarantee will not lead to any gaps in financial assurance coverage. The guarantor must promise that, if the guarantor sends a notice of cancellation, the facility owner or operator will establish a substitute financial assurance instrument within 90 days after the Commissioner receives the cancellation notice. If the facility owner or operator does not meet this obligation, the guarantor promises to provide the alternate financial assurance instrument. If the facility owner or operator reneges on this responsibility, the guarantor remains liable for 30 days, under the terms of the guarantee, to discharge the facility owner's or operator's responsibility. This requirement prevents coverage gaps as a result of guarantee cancellation.

Item D presents necessary conditions associated with the bonds submitted as security for self-insurance. The first condition is that the bonds must be marketable. This feature was discussed in detail above. Marketability gives the bonds a current cash value that can be measured and compared with cost estimates. The marketable bonds can be converted readily into cash and used to pay for facility work that facility owners or operators do not perform. This gives the Agency the security needed to approve self-insurance.

Another condition is that the total value of the bonds must at least be equal to the total value of the cost estimates. Bonds are issued in specific denominations, usually $1,000 or $5,000. This means that the total value of the bonds will only seldom equal the total value of the cost estimates. The requirement gives the Agency assurance that the security provided will be at least adequate to cover the estimated costs, should the need arise.

Another condition requires the Commissioner to give facility owners and operators receipts for bonds received. The facility owners and operators and the Agency need to have good evidence of who has the bonds at any given date.

Another condition requires the Commissioner to give the bonds to the State Treasurer for safekeeping. The Commissioner will deposit securities received with the State Treasurer, who will hold the securities until the Agency asks for them to be returned. The State Treasurer should hold the bonds because that office is equipped and empowered to perform this function. The Agency has neither the facilities nor the authority to hold valuable commercial paper. The securities will not be sold or submitted for payment unless a facility owner or operator proves unable or unwilling to pay for specified long-term care activities.

Another condition requires private sector facility owners and operators to send bonds that are called unsubordinated debentures. A bond is a legal debt. It is the issuer's promise to pay the bond holder a fixed sum, with specified interest, on a specified date. The usual case involves a sale for the face amount of the bond, annual or semi-annual installment payments of interest, and full repayment of the face amount when the bond matures on a specified date. Debentures are bonds that are not secured by specific physical assets. The Agency will require debentures, rather than secured bonds, because this places less strain on a firm's credit position. If the Agency were to require that bonds be secured, the private firm would not be able to borrow against the portion of asset value committed to the repayment of the bonds.

The Agency requires that the bonds be unsubordinated because this places them in a position superior to subordinated debt.

> The term "subordinate" means below or inferior. Thus, subordinated debt has claims on assets after unsubordinated debt in the event of liquidation. Debentures may be subordinated to designated notes payable - usually bank loans - or to any or all other debt. In the event of liquidation or reorganization, the debentures cannot be paid until senior debt as named in the indenture has been paid. Senior debt typically does not include trade accounts payable.

Reference 39.

The requirement that bonds be unsubordinated adds security to the facility owner's and operator's self-insurance demonstration but it does not add to the cost of compliance.

The rules place no further restriction on the types of bonds private sector facility owners and operators present as security. Facility owners and operators may set interest rates and repayment schedules, subject only to the requirement that the total market value of the bonds must exceed the sum of the current cost estimates.

Another condition requires public sector facility owners and operators to send registered municipal bonds that meet the requirements of Minn. Stat. chs. 400 and 475. This requirement limits facility owners' and operators' options according to the statutory constraints that apply to local governments' assumption of debt.

Another condition relates to the terms of the bonds submitted. Recall that a bond is a promise to repay according to a specified schedule. A bond is said to mature when it comes time for repayment. Bonds can have different maturities. The bonds used as security for closure costs must mature two years after the scheduled closure date. The bonds used as security for postclosure care and corrective action must mature two years after the scheduled end of the postclosure care period. These dates are found in the plans required under parts 7035.2625 and 7035.2645. The proposed rules require this because it will take time to inspect sites and approve closure and long-term care operations. The maturity date requirements ensure that the bonds will be marketable until the specified dates. This means that the bonds will be available for sale in case anything goes wrong with closure or long-term care operations. The security is needed not just currently, but for some time after owners and operators complete the actions described in closure and long-term care plans.

A final condition relates to bonds submitted by local governments. Minn. Stat. ch. 475 limits the maturities of municipal bonds to 30 years. A scheduled postclosure care period for a public sector facility owner or operator could exceed 30 years. A public sector facility owner or operator in such circumstances could not comply with the rules. Subitem (3) makes a special provision for such cases. Public sector facility owners and operators who cannot issue bonds that will cover the required period(s) can send the Agency 30-year bonds as an initial compliance measure. They must then make an annual substitution of new 30-year bonds until the maturities of the bonds are the same as the maturities required under subitems (1) and (2).

An example will help illustrate how this provision works. Assume that a public sector owner or operator has a facility that is scheduled to close in 15 years. This means that the facility's postclosure period will extend 35 years into the future (15 years of operations + 20 years of postclosure care). The facility owner or operator can comply with subitem (1) by sending the Agency 17-year maturity bonds as security for closure costs. But the facility owner or operator cannot comply with subitem (2) because State law limits municipal bond issues to 30 years. The facility owner or operator must send 30-year bonds as security for postclosure care and contingency action costs. The facility owner or operator must then, in the following year, send substitute 30-year bonds. The bonds sent in the previous year will be returned to the facility owner or operator and security for the specified costs will be maintained at appropriate levels. This substitution must occur each year until the maturities of the bonds sent to the Agency comply with subitem (2). This means seven years of substitutions in the assumed case. State law limits the maturities of bonds that municipalities issue. This provision gives public sector owners and operators a way to comply with the rules within the constraints imposed by Minn. Stat. ch. 475.

Item E presents the conditions necessary for warrants submitted under item A. Warrants differ from bonds. A warrant is a promise to pay a specified amount to a person designated as the payee of the instrument. However, a warrant is not a negotiable instrument. It cannot be sold in secondary markets, so it has value only to the payee. A warrant has no maturity date, so there is no need to write requirements for the terms of the warrant. This makes the conditions for warrants simpler than the conditions that apply to bonds.

The first condition is that warrants sent to the Agency under these rules must comply with applicable statutes. The laws that apply to warrants are written in individual sections, depending on the type of governmental unit that writes the warrant. Statutes on warrants written by counties are found in Minn. Stat. chs. 383, 384 and 385. Statutes on warrants written by cities are found in chapter 427. Statutes on warrants written by towns are found in chapters 366 and 367. This requirement specifies the statutory constraints that apply to the instruments public sector facility owners and operators may use as security for specified costs.

The other conditions on warrants are the same as the conditions placed on bonds. The warrants must equal or exceed in value the sum of the cost estimates. The Commissioner must give owners and operators receipts for warrants received. The Commissioner must send warrants to the State Treasurer for safekeeping until it is time to either return the warrants to the facility owners and operators or submit the warrants to a local treasurer for payment. The rationale for these conditions is the same as for bond conditions described above.

Item F requires that facility owners and operators who choose to self-insure must establish standby trust funds. The Agency imposes this requirement for the same reason that standby trusts are required of facility owners and operators who use letters of credit or surety bonds to comply with the rules. Briefly stated, the standby trust is needed to protect the interests of facility users and owners and operators. Any funds the Agency receives must be transferred to the State's general fund. There is no guarantee that the Agency will receive an appropriation for the same amount of money so that it can proceed to pay for operations that the facility owner or operator has not completed. The standby trust provides a reasonable means to handle money if it ever becomes necessary to sell bonds or submit warrants for payment.

Item G describes the actions facility owners and operators must take if cost estimates change. Changes can be caused by physical events at the facility or by inflation. Facility owners and operators must make sure that the bonds or warrants they send the Agency continue to provide security that fully covers specified costs.

Facility owners and operators have 60 days to make up the difference if cost estimates exceed the value of warrants or the market value of bonds. Facility owners and operators may choose to send bonds or warrants. They may also choose to use another allowable instrument to make up for any deficiencies in their financial assurance coverage. If facility owners and operators choose to send bonds, they must also send a CPA's report that the new bonds have a market value large enough to make up for the deficiency.

Changes in cost estimates will occur. Facility owners and operators and the Agency must have ways available to adapt to changes.

Item H describes the conditions under which bonds or warrants may be substituted. The rules must make provision for substitutions because, as discussed under Item D above, State law limits the maturities of municipal bonds.

The rule requires that the new bonds or warrants have values equal to the bonds or warrants for which they are exchanged. A CPA's opinion on the market value of exchanged bonds must accompany the substitution request. These requirements ensure that substitution will not lessen the security provided with the self-insurance demonstration.

The rule requires the Commissioner to make the exchange when the facility owner or operator submits the request and the CPA's report. The rule also requires the Commissioner and the facility owner or operator to exchange appropriate receipts. The facility owners or operators and the Agency need to have good evidence of who has the bonds on any given date.

Item I describes what facility owners and operators must do if the value of the cost estimates falls below the value of the security offered. Facility owners and operators who encounter these conditions and have sent the Agency bonds must request that the Commissioner send them any bonds that provide security in excess of the cost estimates. Facility owners and operators who encounter these conditions and have sent the Agency a warrant must send the Agency a substitute warrant of a value equal to the revised cost estimates. Facility owners and operators seeking either action must provide documentary evidence in support of their requests.

The Agency does not need security in excess of current cost estimates. This provision gives facility owners and operators and the Agency an orderly means to adjust financial assurance arrangements.

Item J describes what facility owners and operators must do if they substitute another allowed financial assurance method for self-insurance. Facility owners and operators in these circumstances must provide the Commissioner with evidence that they have other authorized financial assurance mechanisms and that coverage by the substitute mechanisms is effective. These demonstrations must accompany the facility owners' and operators' written requests for return of bonds or warrants sent to the Agency as security for self-insurance. These requirements ensure there are no coverage lapses if owners and operators switch from self-insurance to another mechanism.

Item K describes the actions the Agency must take if facility owners and operators request that bonds or warrants be returned as provided in items I and J. The Commissioner must act on these requests within 60 days. This requirement gives the Commissioner's staff a reasonable amount of time to review the requests and supporting documents.

Facility owners and operators must give the Commissioner receipts for all bonds or warrants returned. The Commissioner must have evidence that the facility owners' and operators' requests have received proper action.

Requests submitted under items I and J can involve a number of circumstances. A set of subitems makes provision for these different circumstances.

Subitem (1) applies to cases in which facility owners or operators request security returns because cost estimates have decreased. If the facility owner or operator has sent the Agency a warrant, the adjustment will involve substituting an appropriate warrant for the one held by the State Treasurer. The Commissioner must return the earlier warrant in exchange for the substitute warrant. If the facility owner or operator has sent the Agency bonds, the Commissioner is limited in the number of bonds that can be returned. Recall that bonds are usually issued in fixed denominations of $1,000 or $5,000. The Commissioner must take care that returning bonds does not cause a coverage gap in the security provided. This could happen if, for example, the facility owner or operator asks for bonds to be returned because cost estimates have dropped by $27,000 and the bonds sent as security were issued in $5,000 denominations. (Assume for the sake of this example that the market value of the bonds equals their face value.) The Commissioner could not send back bonds with a total value of $27,000. The proposed rules limit the size of the return to amounts that are no greater than the difference for which the facility owner or operator seeks adjustment.

Subitem (2) applies to cases in which the facility owner or operator makes a partial substitution of another financial assurance mechanism for self-insurance. If the facility owner or operator has sent the Agency a warrant, the adjustment will involve substituting an appropriate warrant for the one held by the State Treasurer. The Commissioner must return the earlier warrant in exchange for the substitute warrant. If the facility owner or operator has sent the Agency bonds, the Commissioner is, again, limited in the number of bonds that can be returned. In order to make sure that there are no coverage gaps, the Commissioner must only return bonds whose total market value is less than the coverage provided by the substitute financial assurance mechanism(s).

Subitem (3) applies to cases in which the facility owner or operator makes a complete substitution of another financial assurance mechanism for self-insurance. In cases of this sort, the Commissioner must return all warrants or bonds once it is determined that the substitute financial assurance mechanisms have become effective.

Provisions for the various types of adjustment and substitution are made separately because the conditions that will require action are distinct enough that no general provision will serve. The Agency should not hold more security than is needed. However, the Agency must take care to make sure that no coverage gaps result from adjustments or substitutions.

Item L addresses conditions under which the Commissioner must either sell bonds or submit warrants for payment. This provision is made to cover the circumstances which make security requirements necessary. The Agency must have a way to finish needed work if, for example, an owner or operator proves unable or unwilling to close a site and maintain it for 20 years after closure. This provision makes the security requirements of this rule effective.

The Commissioner must have authorization from the Agency Board to sell bonds or to submit warrants for payment. The Commissioner can take this action only after issuing proper orders to a facility owner or operator and determining that the guarantor or the facility owner or operator has failed or refused to comply with the orders. This requirement gives guarantors and facility owners and operators administrative procedures that protect them from improper use of the Commissioner's authority. Guarantors and facility owners and operators who believe that conditions do not justify the sale of bonds or the payment of warrants can present their arguments to the Agency Board. Guarantors and facility owners and operators who appear before the Board may also present their arguments for contested case hearings. This administrative step provides guarantors and facility owners and operators a reasonable means to protect their interests.

The Commissioner must also seek authorization to sell bonds or submit warrants for payment if a self-insured facility owner or operator or a guarantor fails to pass the appropriate financial test and, within 90 days of failing, does not establish an alternative financial assurance mechanism. Ninety days is a reasonable amount of time to allow facility owners and operators and guarantors in their effort to comply with the rules. They will have the experience of other facility owners and operators and guarantors to draw on if they need to find financial intermediaries. The search for an alternative compliance mechanism cannot be allowed to extend indefinitely because this increases the risk that an accident or premature closure may occur while the security is inadequate for closure and long-term care.

The Commissioner must have the proceeds of bond sales or payments made under warrants deposited in the standby trust fund. This fund is required because all Agency receipts must be transferred to the State's general fund, with no guarantee of an offsetting appropriation. The Agency will use any activated standby trusts as the means to manage funds dedicated to long-term care at facilities. This solves a money management problem because it protects the interests of all parties. Funds held in trust are owned by the trustee, not the beneficiary or the grantor. The terms of the proposed trust agreement call for any surplus funds to be returned to the grantor.

Item M requires the Commissioner to return any bonds or warrants held after a facility owner or operator is released from financial assurance responsibilities under other parts of the rules. The Agency has no need to keep the securities after a facility owner or operator has properly discharged financial assurance responsibilities.

11. Part 7035.2755 USE OF MULTIPLE FINANCIAL ASSURANCE MECHANISMS.

This part allows the facility owner or operator to comply with the rules by using more than one financial mechanism. Facility owners and operators can use any combination of trust funds, letters of credit, self-insurance, or surety bonds that guarantee payment into trust funds. The instruments must conform to applicable sections of the rules. This provision is included as a means to help facility owners and operators manage changing circumstances. For example, if a facility owner or operator has a bond or a letter of credit and a short-term condition arises which changes a cost estimate the surety or bank may not want to extend the terms of its agreement on short notice. The facility owner or operator may use this provision to find another instrument or alter an existing instrument so that the total of the financial mechanisms once again complies with the rules. This provision gives needed flexibility to the facility owners and operators without compromising the goals of the rules.

The list of available instruments excludes the surety bond that guarantees performance. If there is a case of default, combining a performance bond with funds derived from other instruments would become extremely complex. Other instruments are available to allow facility owners and operators the range of choice they will need.

If the facility owner or operator chooses to use more than one financial instrument, the combined value of these instruments must equal the sum of the current cost estimates. The Agency must make sure that the instruments afford complete coverage of the costs involved.

If a trust fund is used in combination with other instruments, it can serve as the standby trust for the bond or letter of credit. A single standby trust can be used for two or more instruments. This provision helps the facility owners and operators hold down the costs of compliance.

The Commissioner is not restricted in the use of financial instruments to accomplish closure, postclosure care or contingency action. Any other arrangement would require setting an order of priority among the various instruments. Given such a priority ranking, disputes could cause needless delays while conditions at the site get worse. This provision allows the Commissioner to act quickly to correct emergency conditions. The Commissioner should then have the widest possible range of choices for action.

12. Part 7035.2765 USE OF A FINANCIAL MECHANISM FOR MULTIPLE FACILITIES.

This part allows owners and operators who have more than one facility to use a single financial instrument to cover all sites. The face value of that instrument must equal the total value that would result if all sites had been covered by individual instruments. For example, if an owner or operator has three sites and the sum of the current cost estimates is $500,000 at each site, then a single letter of credit for $1.5 million can be used to cover all three sites.

Owners and operators who choose this option must identify the facilities covered and the extent of coverage for each facility. This is to let the Commissioner know the limits to which the instrument can be used for each site. The Commissioner must know these limits because the rules constrain the use of the instrument to only the amounts specified for coverage at each site. Referring again to the previous example, the rules would allow the Commissioner to draw on credit of $500,000 at each site. This precaution will help avoid situations in which the users of one site get billed for costs incurred at another site.

13. Part 7035.2775 RELEASE OF OWNER OR OPERATOR FROM FINANCIAL REQUIREMENTS.

As noted in earlier discussion, there will come a time when there will be no need for financial assurance at the facility. The facility owner or operator should be released from financial assurance responsibilities at this time. This part sets the conditions for such a release. The releases come in three parts.

Subpart 1. Release from closure requirements. This subpart deals with the facility owner's or operator's release from financial responsibility for closure costs. Owners and operators must certify that the facility has been closed in accordance with the closure plan. An engineer registered in Minnesota must also make the same certification. These certifications must be sent to the Agency. This provision commits the facility owner or operator and the engineering consultant to a statement that the facility has been closed in accordance with the applicable rules and permit conditions. The certification clearly establishes responsibilities for the work done. Without such certification, responsibilities would become ambiguous, a condition which could, in turn, lead to unnecessary and costly delays.

The Agency has 90 days in which to send the facility owner or operator a written release from the financial assurance responsibility for closure. This 90-day period has the same function as the 90-day review period allowed for reimbursement approvals under trust fund arrangements. The Agency staff needs this time to inspect the site and make sure that the certifications are accurate. This requirement provides the Agency the time needed to make sure that the site has been properly closed.

The rules do not require that the Agency release the facility owner or operator from financial assurance responsibilities. If the Agency has reason to believe that the site has not been closed in accordance with the closure plan, the Agency can continue to require that the facility owner or operator provide financial assurance for closure. Closure work improperly done will have to be done over. Responsibility for mistakes correctly lies with the facility owner or operator and the project contractor. This requirement provides an incentive to complete closure properly the first time.

Subpart 2. Release from postclosure requirements. This subpart establishes conditions for the release of facility owners or operators from financial responsibility for postclosure care. When a facility owner or operator has completed all postclosure care requirements, the facility owner or operator must send the Agency a written request for release from financial assurance requirements for postclosure care.

The Agency has a 90-day period in which to review the request. If the Agency determines that the facility owner's or operator's postclosure care activities have been in accordance with the postclosure care plan, then the Agency will send the facility owner or operator a written release from the financial assurance requirement. The Agency does not have to authorize release if there is reason to believe that the work has not been done according to the postclosure care plan. The rationale for this provision is the same as that provided for subpart 1.

Subpart 3. Release from corrrective action requirements. This subpart establishes conditions for the release of a facility owner or operator from financial responsibility for contingency action. The 90-day review period in this subpart relates to either the end of the postclosure care period or the end of a contingency action project. The Agency must, within this time period, release a facility owner or operator from contingency action financial assurance requirements, if the Agency determines that all work has been done in accordance with the contingency action plan. The Agency does not have to grant the release if the work does not accord with the contingency action plan. The rationale for these provisions is the same as that provided for subpart 1 above.

14. Part 7035.2785 USE OF A SINGLE MECHANISM FOR FINANCIAL ASSURANCE OF CONTINGENCY ACTION, CLOSURE AND POSTCLOSURE CARE.

This part allows facility owners and operators to use a single mechanism as financial assurance for all applicable costs. The instrument and its administration have to conform to all applicable rules. The funds available through the single mechanism must equal the sum that would be available if the facility owner or operator were to use separate instruments. This provision allows facility owners and operators to save administrative costs. A single instrument intended for multiple use will cost less than three separate instruments intended for specific uses.

15. Part 7035.2795 INCAPACITY OF OWNERS OR OPERATORS, GUARANTORS, OR FINANCIAL INSTITUTIONS.

This part describes the facility owner's or operator's obligations if bankruptcy occurs. The Agency, as regulator and, in some cases, as beneficiary of financial instruments, will have important interests to maintain if either the facility owner or operator or one of its financial intermediaries fails.

Bankruptcies occur because business firms cannot pay their debts. Bankruptcy proceedings are usually referred to according to the chapter of the federal Bankruptcy Code under which they are initiated. Chapter 7 proceedings involve complete liquidation of a firm's assets. Creditors in these cases are reimbursed from the distribution of the bankrupt's property. Chapter 11 proceedings involve debt reorganization, in which the bankrupt presents creditors and the Court with a plan that will allow repayment of some or all of the debt out of future earnings.

The standing of State environmental agencies in bankruptcy proceedings is uncertain (References 40 and 41). The Bankruptcy Code is designed to give debtors a fresh start, while at the same time protecting the interests of creditors. This goal can conflict strongly with environmental protection goals. If a facility owner or operator begins bankruptcy proceedings, the Agency should be notified so that the Agency can take an active part. The Agency's interests in such cases will be substantial, since the outcome may determine whether needed work will be done at the site.

Subpart 1. Notification of bankruptcy. The facility owner or operator must notify the Commissioner within ten days after bankruptcy proceedings have begun in which the facility owner or operator is the bankrupt. The notice has to be sent by certified mail. This provides the Agency with reasonable notice of a legal proceeding that will have an important impact on the facility.

Subpart 2. Incapacity of financial institutions. If the financial intermediary chosen by the facility owner or operator becomes bankrupt or loses authority to conduct business, the facility owner or operator is considered to be without financial assurance. The facility owner or operator in such cases will have 60 days to find another intermediary and execute acceptable financial instrument. This provision reasonably ensures that coverage at the site will not lapse.

16. Part 7035.2805 LANGUAGE REQUIRED FOR FINANCIAL INSTRUMENTS.

This rule provides facility owners and operators with the exact language they must use to execute financial instruments which are acceptable to the Agency. The rationale for this provision has been considered before, but it bears repeating here. Requiring standard language in financial media extends equitable treatment to all facility owners and operators. Each facility owner or operator will know the other owners' or operators' choices. No one facility owner or operator will be able to craft an agreement that provides an advantage over competitors.

The use of standard language will also help minimize the costs of compliance. The Agency will spend less time reviewing standard documents than it would spend analyzing nonstandard documents. Facility owners and operators will also benefit since they will not have to spend time composing language for financial instruments. Financial intermediaries will also benefit from consistent language that conforms to standard practice. The language in each document is consistent with standard business practices in the State of Minnesota.

This rule promotes equitable treatment of all facility owners and operators and minimizes some compliance costs.

Subpart 1. Trust agreement. This subpart gives facility owners and operators the language they must use if they choose to develop trust funds or if they establish a standby trust in connection with other instruments. The rule instructs facility owners and operators to include appropriate language for descriptive terms (names, titles, etc.) that are written between brackets in the model. This provision tells facility owners and operators how to adapt the instrument to their individual needs.

The introductory section of the trust agreement provides basic information that is needed to make the contract enforceable. The instrument is dated and all parties to the contract are named and described. The facility owner or operator who will make deposits into the fund is referred to as the grantor; the facility owner's and operator's chosen trustee is referred to as simply the trustee.

The introductory section also describes the conditions that have caused the grantor and the trustee to enter into the contract. These conditions are:

a) the Agency's adoption of rules requiring the owner or operator to demonstrate the ability to meet specified costs;
b) the owner's and operator's choice of a trust fund as the means to comply with the referenced rules;
c) the owner's and operator's choice of trustee; and
d) the trustee's willingness to enter into the contract.

After the introduction, named sections describe the specific conditions of the contract.

Section 1. Definitions. This section describes the parties to the contract in the words they are referred to in the body of the agreement. The facility owner or operator is defined as grantor, the trustee is defined as trustee and the Agency is defined as beneficiary.

These three parties must be identified if a trust is to be enforceable. The last definition is one that has caused some concern among local government officials. The Association of Minnesota Counties (AMC) stated this concern in its 1987 legislative platform.

> Counties strongly oppose provisions of the draft rule that name the PCA as legal beneficiary of local solid waste financial assurance trust funds. This is an infringement upon local control of locally collected revenues. Counties must retain the right to negotiate the types and costs of remedial actions needed to achieve the desired environmental standard.

Reference 42.

The parties named in a trust must be distinct. That is, a grantor cannot serve also as trustee and grantors and trustees cannot be beneficiaries. The grantor must receive surplus funds when the trust dissolves. This is a provision of the rules. However, the grantor cannot benefit from the trust while the trust is active.

The Agency's status as beneficiary has very specific constraints. The Agency's control of funds extends only to releasing the funds for reimbursement. Normally, proper expenses incurred at the site will be reimbursed from the trust fund after the facility owner or operator satisfies the Commissioner that work at the site was done properly and the expenses were appropriate. The Agency will never receive any money from the trust.

The Agency's beneficiary status and, indeed, the trust fund mechanism itself are needed because facility owners and operators may prove unable or unwilling to pay for required work at a site. This has happened with both private sector and public sector facility owners and operators. It is worth noting here that only one private sector facility owner or operator has objected to the Agency's beneficiary status. The designation of the Agency as beneficiary enables the Agency to have a way to accomplish needed work at sites if facility owners and operators prove uncooperative. The means chosen to accomplish this end do not infringe on local government control, since the decision to rely on the trust is voluntary. Facility owners and operators who object to the Agency's status and control may choose one of the other financial media, which leaves them in full control of funds.

The negotiating rights defended in the AMC statement are more claimed than real. There is little doubt that local governments may want to intervene in any stage of a remediation project. The question is whether allowing this intervention is proper or sensible. The appropriate time to negotiate is during the development of the engineering plans and cost estimates. Once the plans are approved by all interested parties (owners, operators and the Agency), there is no further need for negotiation unless new technology is developed. Site development and financial management can proceed in an orderly fashion, with everyone sharing the information needed to make cost evaluations. When specified actions are needed, the appropriate plans can guide both the facility owner or operator and the Agency through every foreseeable contingency.

A more pragmatic concern is whether the exercise of the claimed negotiating rights makes financial sense. Delays in project implementation can prove very costly. Administrative processes can be stopped but physical events will not wait because a facility owner or operator wants to investigate a cheaper alternative treatment process. Administrative charges can also mount up if the site qualifies for superfund action. Cases of this sort incur negotiating costs not only from charges billed by the facility owner's and operator's representative, but also from the Agency. The Agency has to recover its administrative costs from responsible parties.

Given the general inappropriateness of negotiating late in remedial action and the costs implicit in such delays, it is reasonable to expedite the process and confine negotiations to the plan development stage.

Section 2. Identification of Facilities and Cost Estimates. This section further defines the scope of the trust agreement. Detailed specification serves all interests because it clarifies the rights and duties of all parties. An attachment (Schedule A) required by this section will describe in detail the facility or facilities covered by the agreement and the amount of long-term care costs to be covered under the agreement.

Section 3. Establishment of Fund. This section describes how the trust fund is to be set up and developed.

The facility owner or operator and the trustee agree that they do not want any third party to have access to the fund except as specified in the contract. This provision is written to provide protection for the fund in the event that either the facility owner or operator or the trustee fails. This statement of intent secures the fund's assets against creditors' claims under bankruptcy proceedings. The Government Accounting Office (GAO) has researched the question of bankruptcy and environmental regulation. Reference 31. The GAO found that bankruptcy has given responsible parties an escape route by which to avoid compliance with environmental regulations. State authorities seeking to compel remedial action have had little success in securing the assets of a bankrupt to pay for cleanup actions. These cases demonstrate both the need for and reasonableness of provisions designed to protect funds reserved for long-term care at facilities.

The wording of the grantor's and trustee's intent also provides facility owners and operators with some of the protection that they indicate are needed. This phrase in the contract can be considered as a binding limitation on the Agency's use of reserved funds. Later parts of the contract specify the Agency's role in this agreement. The language on intent prohibits the Agency from using reserved funds unless the situation conforms to circumstances described in the contract.

An attachment required by this section (Schedule B) will describe in detail the initial financing and scheduled development of the trust fund. The fund is described as consisting of any initial deposits plus future deposits plus earnings and interest on earnings less any payments or distributions made by the trustee. This provision makes it clear to all parties how the fund's balances will be determined.

A final provision specifically relieves the trustee of duties which are properly exercised by the Agency. These duties consist of following the facility owner's or operator's compliance with the rules, e.g., checking to see that fund balances are adequate to meet future needs and that payment rates are correct. These duties properly belong with the Agency, which has the data and experience needed to accomplish the tasks. It would be unreasonable to require trustees to do work that the Agency can and should do.

Section 4. Payment for Contingency Action, Closure and Postclosure Care. This section describes the conditions under which the trustee can release funds for use at the site. The trustee will only release funds in response to a written order from the Commissioner. The uses of these released funds are written order from the Commissioner. The uses of these released funds are limited to payment for contingency action, closure or postclosure care expenses incurred at the facilities described in the agreement. This language provides owners, operators and the Agency with assurance that the funds will not be spent for purposes other than those specified in the site's engineering plans.

The Commissioner is required to specify who is to receive reimbursement. It may be the grantor. It may also be a contractor who has conducted work at the site. Contractors may become involved if a facility owner or operator refuses to do the required work. This provision gives the trustee the ability needed to perform required duties under these circumstances.

The agreement also allows the trustee to make refunds to the grantor. This need could occur if fund balances become greater than needed. Changed conditions could cause requirements to decrease. If the fund is larger than needed, there is no reason to retain the excess. Any surplus should be returned to the grantor.

Section 5. Payments Comprising the Fund. This section restricts payments into the fund to the forms the trustee is willing to accept. Cash is acceptable. Trustees may not want to accept all kinds of securities. The trustee's fiduciary responsibilities bias investment strategies toward conservation. Many types of securities are too risky to be considered as qualifying payment into the trust. They could lose value once they become part of the fund, causing a disruption in the orderly development of the fund. Trustees can assess the risk of investments, so the contract reasonably allows trustees to refuse securities they consider risky.

Section 6. Trustee Management. The introduction to this section describes legal constraints usually referred to as the prudent man rule. This provision limits the investment strategies that trustees may use. The limitations favor conservative investments. Such constraints are proper and reasonable because neither growth nor income is an appropriate goal for these trust funds. Instead, the trustee's goal should derive from the facility owner's and operator's need to make sure that all the funds set aside for long-term care will be available when they are needed. This means the trustee should not invest funds held in trust on risky ventures. Conservative investments and management are more likely to maintain the integrity of reserved funds.

Specific prohibitions and authorizations are added to encourage fund conservation.

a. The trustee is not allowed to accept securities or notes from the grantor as payments into the fund. This would amount to accepting a liability rather than an asset. The fund would then have a promise from the grantor to pay the value of the note or security.

b. Trustees are allowed to place funds in checking accounts (demand deposits) and savings accounts (time deposits). Trustees may need to do this from time to time so that they can make business transactions. However, these deposits are limited to the amount insured by the Federal Deposit Insurance Corporation (FDIC). The FDIC insures deposits from a single depositer in a single bank up to $100,000. This limit is consistent with other conservative restrictions placed on the trustee's management of funds.

c. Trustees are allowed to hold cash from the fund for short periods of time, if they need to do this to make investments or disbursements. Trustees are not liable for interest earnings in these circumstances. This provision is written to give trustees enough discretion to carry out routine transactions with ease.

Section 7. Commingling and Investment. This section allows trustees to add assets developed by the grantor to assets from other trusts to form larger, collective trusts. Section 6 constrains the extent of activities within the limits of the prudent man rule. This section enables trustees to take advantage of scale economies in investment. Brokerage fees on investment transactions vary with the size of the transaction. Large purchases or sales incur smaller fees, not in total, but on a unit basis. These savings can reduce administrative charges, which will allow more earnings to be retained in the trust funds. There are enough trustees in the region to make it reasonably certain that no single trustee will be able to pocket such savings as windfall profits. Trustees can get other advantages from increasing their scale of operations. Larger trust funds enable trust managers to diversify investments in ways that minimize risk and maximize returns. The results of this optimization process improve as the size of the fund invested grows.

This section thus reasonably gives trustees the ability to better manage trust funds. The flexibility granted to trustees under this section helps to lower administrative costs, decrease risk and increase returns.

Section 8. Express Powers of the Trustee. This section provides further specification of the actions and judgments conferred on the trustee. This section does not limit any of the other provisions of the agreement. Rather, it provides all parties to the agreement with a more detailed description of the trustee's normal management activities and responsibilities. The provisions of this section empower the trustee to make normal market transactions with the properties held in trust. This section also releases the grantor from any obligation to oversee the daily operations of the trust. This provision reasonably defines the responsibilities of the trustee with respect to routine financial management.

Section 9. Taxes and Expenses. This section makes provision for the ordinary expenses incurred through the formation and operation of the trust. Taxes assessed to the trust are to be paid from the fund. The question of taxation has come up several times during discussion of the proposed rules. The Agency staff has sought an opinion from both the Internal Revenue Service and the Minnesota Department of Revenue. Neither Agency has yet given an opinion on the question of whether trust fund earnings should be taxed. If the taxing agencies decide that trust fund earnings are taxable, the fund will pay these taxes.

This provision also makes it clear that the trustee should recover all reasonable administrative costs from the fund, if not paid by the grantor. The Agency expects that trustees will be paid directly from the fund. The expenses described are properly assessed against the fund, since it is the fund that incurs the expense.

Section 10. Annual Evaluation. This provision requires the trustee to make annual reports on the financial condition of the trust fund. The trustee will send these reports to the facility owner or operator and the Commissioner, who will both need to know how the fund is doing to see whether it will be large enough to meet the estimated costs. The trustee is required to use current market data in evaluating securities. This provision ensures that decisions made by the Agency and the facility owner or operator will be based on reasonably current data.

The grantor is given 90 days in which to contest the trustee's valuations. If the grantor does not send a written objection to the trustee within 90 days, it is understood that the trustee agrees with the evaluation. This provision makes the process of fund evaluation more manageable for both the facility owner or operator and the trustee. Both parties know what they must do and when they must do it.

Section 11. Advice of Counsel. This provision makes it clear that the trustee has an option to seek independent legal advice. This provision is made more for the information of the grantor than to protect any right of the trustee. The grantor is made aware that the trustee may seek outside advice on interpretations of the duties and responsibilities defined in the agreement.

If the trustee acts on independent legal advice, the trustee is protected to the fullest extent allowed under the law. This provision makes the trustee's legal rights explicit within the agreement.

Section 12. Trustee Compensation. This provision informs facility owners and operators that the trustee is entitled to payment for service. It also places a limit of reasonableness on compensation. This is another provision that makes explicit ordinary rights and duties. It helps to make sure that all parties know their commitment when entering into the agreement.

Section 13. Successor Trustee. This section describes how one trustee resigns in favor of another trustee. The process set up is deliberate and orderly. No transfer may occur until a successor trustee accepts the appointment. Transfers are required to include all currently-held funds and assets.

There may be occasions in which a facility owner or operator will take no action when a trustee presents a resignation notice. The agreement makes explicit provision for such cases. The trustee is allowed under these circumstances to request that a court either assign a successor trustee or provide the current trustee with other instructions. This provision gives all parties reasonable assurance that this situation can be resolved and that funds will continue to be available for long-term care even if the current trustee wants to be released from the contract.

The Commissioner, the facility owner or operator and the current trustee will receive certified notice of the date on which the successor trustee will assume responsibility for the trust. The successor trustee must send these notices at least ten days before the effective date. This provision ensures that there will be no gap in the coverage that the trust funds provide for qualified expenses.

A final provision specifies that the fund will pay for transaction costs incurred in transfers from one trustee to another. This provision is included to make sure that all parties understand that transfer costs are considered as ordinary costs reimbursable in the same way as taxes and other expenses.

Section 14. Instructions to the Trustee. This section limits the trustee's duties and responsibilities to those written either in the trust agreement or transmitted by the appropriate authority. This provision gives the trustee protection from expectations that the trustee respond to informal or unspecified instructions. The trustee's main responsibilities will be financial management and disbursement. These responsibilities are important enough that there should be little or no room for error in the intepretation of instructions. This eliminates the errors that may arise in following verbal instructions.

Section 15. Notice of Nonpayment. This provision requires the trustee to notify the Commissioner if a facility owner or operator misses a scheduled payment. The Commissioner will need this notice to determine whether facility owners or operators are complying with the rule. If a facility owner or operator misses a payment, enforcement measures in accordance with part 7035.2705, item K begin. Discussions with trust company officials indicate that they believe this is a reasonable requirement and will not impose a burden on trustees.

Section 16. Amendment of Agreement. This section makes provision for changes to be made in the agreement. All the affected parties must agree before changes can be made. This requirement reasonably protects the interests of all parties.

Section 17. Irrevocability and Termination. This provision requires that all affected parties must agree before the trust can be ended. There is a further provision that any surplus funds be distributed to the facility owner or operator or any successors or heirs of the facility owner or operator. This requirement reasonably protects the interests of all parties.

Section 18. Immunity and Indemnification. This section protects the trustee from liability arising from non-negligent acts. This is further notice that the trustee's responsibilities do not extend beyond financial management and reporting. This gives protection to the trustee, whose proper role is limited to holding and protecting financial assets. This provision does not exempt the trustee from liability for negligent acts.

Section 19. Choice of Law. This provision requires that the trust agreement must be interpreted according to Minnesota law. The requirement reasonably provides all parties with a specific legal reference when needed to understand and manage the trust.

Section 20. Interpretation. This section places limits on the understanding of the language of the agreement. Singular and plural words included in the agreement include each other. This means, for example, that if there are two grantors to the trust, the provisions of the trust apply equally to both even though the agreement refers consistently to the grantor. This provision also makes it clear that section headings are not to be understood as substantive elements of the agreement. This section clarifies linguistic matters that could lead to confusion in the interpretation of the agreement.

Summary language and provision for appropriate signatures follow section 20 of the agreement. A reference to this rule is required as well as an attestation of signatures.

Subpart 2. Certification of acknowledgment. This subpart provides the language required in the certification of acknowledgment that must accompany the copy of the trust agreement which the facility owner or operator sends to the Commissioner. The need and reasonableness for this certification was presented above (See p. 208).

Subpart 3. Surety bond guaranteeing payment into a trust fund. This subpart provides the language required in a surety bond that guarantees the owner or operator will develop an approvable trust fund by the time the owner or operator closes the site. The language is consistent with standard business practices in the State of Minnesota. The first section of the bond is devoted to basic data.

1. The date the bond is executed by the grantor and the surety.
2. The date on which the terms of the bond become effective.
3. The name of the principal. This will be the owner, in the usual case.
4. A descriptive name for the facility owner's or operator's organization (e.g., individual, or corporation, or partnership).
5. The state in which a corporation is incorporated.
6. The name and business address of the surety.
7. Names and identification numbers for all facilities covered and each individual facility's estimated costs for closure, postclosure care and contingency action.
8. The total amount to be covered by the bond, known as the penal sum.

The data provided concisely set the basic parameters of the agreement. The contract would not be enforceable without them.

The first full paragraph defines the extent of the surety's commitment to the Agency. The statements in this paragraph set the surety's liability equal to the penal sum. If there are joint sureties, the liability is joint and several but limited to actions arising from the activities described. This requirement reasonably provides the surety and the facility owner or operator with notice of the extent of the surety's liability.

The next two paragraphs describe the conditions which have caused the facility owner or operator and the surety to enter into the agreement, namely, the facility owner's or operator's need to have a permit and the financial assurance requirement associated with that permit.

The next paragraph describes the facility owner's and operator's intention to establish a standby trust fund. This requirement comes from part 7035.2725, item C.

The next five paragraphs describe the conditions that the surety will guarantee. If these conditions do not occur, the surety will be required to deposit the penal sum of the bond in the standby trust fund. The conditions guaranteed are:

a) that the facility owner or operator will develop a trust fund equal to the estimated cost(s) of closure, postclosure care and/or contingency action (the types of activities covered are left to the facility owner's or operator's choice);

b) that the fund will be fully developed either before the site closes or within 15 days after the facility owner or operator receives a proper order to begin one of the specified activities; or

c) that the facility owner or operator will provide an approvable alternate financial assurance instrument if the bond is cancelled.

The next paragraph is a positive statement of the conditions under which the surety will become liable on the bond obligation, namely, the failure of the principal to fulfill one of the conditions described above. There is also a positive statement of the surety's responsibility to make deposits into the standby trust following proper notice from the Commissioner.

The next paragraph further specifies the limits of the surety's liability. This liability is not ended until the sum of payments into a standby trust equals the amount of the penal sum. A further statement explicitly limits the surety's liability to the amount of the penal sum.

The next paragraph makes provision for the surety to cancel the bond. The surety must notify the facility owner or operator and the Commissioner of the intent to cancel. The actual cancellation may not take effect until 120 days after the Commissioner receives the notice.

The next paragraph makes provision for the facility owner or operator to cancel the bond. This cancellation may occur only if the Commissioner sends the surety a written authorization to end the bond.

The next paragraph is optional and may be included if the surety and the facility owner or operator want it. This paragraph makes provision for annual adjustments in the penal sum of the bond. The provision limits the increase to 20 percent. There is also a requirement that the penal sum may not be decreased without the Commissioner's written permission.

The final two paragraphs certify the date of signing and the signatures of the surety and the principal.

Subpart 4. Surety bond guaranteeing performance. This subpart provides the language required in a surety bond that guarantees the facility owner or operator will perform specified activities. The provisions of this bond are the same as the provisions in the financial guarantee bond except that different conditions apply in determining the surety's liability. The form is consistent with standard business practices in the State of Minnesota. If the facility owner or operator chooses to comply with the rule through the use of a performance bond, then the surety must guarantee that the facility owner or operator will perform closure, postclosure care and needed contingency action according to the plans submitted and Agency directives. If the facility owner or operator does not perform the needed activities as specified, then the surety becomes liable on the bond obligation.

Subpart 5. Letter of credit. This subpart provides the facility owner or operator with the language needed in the financial instrument if the facility owner or operator chooses to comply with the rules by using a letter of credit. The letter appears very much like a normal business letter. Many of the identification requirements of other instruments are omitted from the letter of credit. These identification requirements are to be met by the owner or operator.

The first paragraph of the letter identifies the instrument and states that credit is extended in favor of the Agency on behalf of the facility owner or operator. This paragraph also identifies the amount of credit extended. This amount is analogous to the penal sum of the surety bonds. The credit becomes available when the Commissioner presents a sight draft to the bank which: refers to the letter's identification number and certifies that conditions defined in the solid waste rules have occurred which call for the Commissioner to draw on the credit extended.

The next paragraph provides the effective date of the letter and requires that its term be at least one year. The letter must extend automatically for another year beyond the expiration date and on each successive expiration date. The letter can be cancelled under specified conditions, namely: that the bank send the facility owner or operator and the Commissioner notice of its intent to cancel and that this notice be sent 120 days before any current expiration date.

The next paragraph states the bank's intention to honor any properly presented drafts. When the bank honors a draft, it will deposit the amounts required into a specified standby trust fund.

There is a final certification that the language of the letter is the same as the language required under the rules. This is followed by appropriate signatures and a reference to the Uniform Commercial Code to which the letter is subject. The form of this letter is consistent with standard business practices in the State of Minnesota.

Subpart 6. Letter from the chief financial officer of a private firm. This subpart gives private sector facility owners and operators the language they must use in a demonstration letter if they choose to self-insure. The rule instructs facility owners and operators to include appropriate language for descriptive terms (names, titles, etc.) that are written between brackets in the model. This provision tells facility owners and operators how to adapt the letter to their individual needs.

The first paragraph of the letter identifies the firm that is making the self-insurance demonstration and its chief financial officer (CFO). This paragraph also presents the letter's intent, which is to comply with the self-insurance provisions of the financial assurance rules. The paragraph also identifies the sites for which the self-insurance demonstration is made and the cost estimates covered by the demonstration. This language identifies the person responsible for the self-insurance demonstration and clearly states that person's intentions. The self-insurance demonstration letter must make these identifications if it is to be enforceable.

The letter continues with a series of information submittals. The first submittal applies to cases in which the facility owner or operator makes the self-insurance demonstration. The CFO identifies the facilities for which the demonstration is made. The CFO also supplies cost estimates for closure, postclosure care and corrective action at each covered facility.

The next submittal applies to cases in which a parent corporation makes a corporate guarantee on behalf of the facility owner or operator. The CFO identifies the facilities for which the corporate guarantee is made. The CFO also supplies cost estimates for closure, postclosure care and corrective action at each covered facility.

The third submittal applies to all cases. The CFO identifies all facilities outside Minnesota for which the firm makes either self-insurance demonstrations or corporate guarantees. This submittal includes appropriate cost estimates.

The final submittal applies in all cases. The CFO identifies all waste facilities the firm owns, operates or controls through subsidiaries for which no financial assurance is made. This submittal includes appropriate cost estimates.

This information is required to make operational several criteria in the financial tests. Some criteria are "multiples." These criteria require, depending on the alternative chosen, that the facility owner or operator or its guarantor show that specified financial measures (net working capital, tangible net worth and, conditionally, total assets held in the United States) are at least six times greater than the costs estimated for closure, postclosure care and contingency action at all owned, operated or controlled sites. The information presented in the letter summarizes the information required under part 7035.2750.

The next paragraph of the letter reports whether the firm makes certain reports to the Securities and Exchange Commission (SEC). These reports are referred to as "10Ks" because they are submitted on a SEC form that is designated as 10K. The 10K reports contain a full set of financial statements. They are public records that serve as valuable independent checks on self-insurance demonstrations. This information notifies the Commissioner of a valuable information source and imposes no cost on facility owners or operators.

The next paragraph describes the reporting bases for the information presented in the self-insurance demonstration. Business firms may choose the basis for their fiscal reporting. The first statement reports the end date of the firm's fiscal year. Next, the CFO designates specified data as derived from the firm's independently audited financial statements. The self-insurance demonstration requires a CPA's statement that specified information is derived from independently audited financial statements. The notice required in this paragraph makes the CFO responsible for needed information and imposes no costs on the facility owner or operator.

The next paragraph of the letter states that the bonds submitted as security are sent along with the demonstration letter. This language reasonably commits the firm and its chief financial officer to both actions required by the rules: demonstrating that the firm meets the self-insurance criteria and submitting bonds as collateral. It is a formal action that recognizes the permittee's enforceable responsibilities.

The next part of the letter consists of the information that comprises the first alternative financial test. The first alternative test requires self-insuring private sector facility owners and operators to report:

a) the total of all current cost estimates for all owned or operated facilities;
b) the maturity dates, face values and market values for the bonds submitted as collateral; and
c) the self-insuring firm's total liabilities, tangible net worth, net worth, current assets, current liabilities, net working capital, cash flow, and asset holdings in the United States.

The final portion of the first alternative test is a set of questions which determine whether the firm meets the self-insurance criteria. This portion of the letter organizes information from the facility owner or operator to be compared easily with the self-insurance criteria.

The next part of the letter consists of the information that comprises the second alternative financial test. The second alternative financial test requires self-insuring private sector facility owners and operators to report:

a) the total of all current cost estimates for all owned or operated facilities;
b) the maturity dates, face values and market values of the bonds

submitted as collateral;

c) the rating of the firm's most recent bond issue, the name of the rating service and the bonds' issuance and maturity dates; and

d) the firm's tangible net worth and asset holdings in the United States.

The final portion of the second alternative test is a set of questions which determine whether the firm meets the self-insurance criteria. This portion of the letter organizes information from the facility owner or operator to be compared easily with the self-insurance criteria.

The final element of the letter is the chief financial officer's certification that the letter is identical to the model provided in this subpart. This statement is followed by the chief financial officer's signature, name, title and date of signing. These requirements assure that the person who signs the letter is responsible for the firm's financial policies and is authorized to commit the firm's resources to long-term care at solid waste management facilities.

Subpart 7. Corporate guarantee for contingency action, closure or postclosure care. This subpart gives the corporate parents of private sector facility owners or operators the language they need to make corporate guarantees for their subsidiaries. This subpart instructs guarantors to include appropriate language for descriptive terms (names, titles, etc.) that are written between brackets in the model. This provision tells guarantors how to adapt the guarantee to their individual needs.

The first paragraph of the guarantee:

a) dates the instrument,

b) identifies and designates the guarantor,

c) identifies the Agency as the obligee, and

d) identifies the facility owner or operator as the person on whose behalf the guarantee is made.

These identifications are routine. This information specifies the relationships of all the interested parties. These specifications make the guarantee effective.

Recitals follow which specify the conditions of the guarantee. These conditions are made specific so that all parties understand the guarantee's scope and limits. The recitals define and protect all parties' interests and commit all parties to actions defined by specified conditions.

The first recital states that the guarantor qualifies to make the corporate guarantee under the terms of part 7035.2750. The guarantor also promises to comply with all the terms of part 7035.2750.

The second recital identifies the facilities and the types of cost covered by the guarantee.

The third recital specifies the meaning of terms that might be considered too general. Cost estimates are related directly to plans developed according to part 7035. These plans define for all interested parties the financial limits of the guarantee.

The fourth recital defines the basic condition of the guarantee. The guarantor promises to either do required work or establish a trust under part 7035.2705 if the facility owner or operator does not complete work specified in appropriate plans or permit conditions. The statement commits the guarantor to the completion of proper closure and long-term care at the covered facilities.

The fifth recital has the guarantor's promise to establish alternate financial assurance if the guarantor fails to meet the terms of the financial test. The promise includes two reporting dates: first, the guarantor promises to notify the Commissioner and the facility owner or operator, within 90 days, when the firm does not meet test criteria; second, the guarantor promises to provide an alternative to the self-insurance demonstration, within 120 days, when the firm does not meet the test criteria.

The sixth recital has the guarantor's promise to send notice on bankruptcy filings. The Agency and the facility owner or operator are to receive notice within ten days after the beginning of voluntary or involuntary bankruptcy proceedings which name the guarantor as debtor.

The seventh recital provides for alternate financial assurance if the Commissioner notifies the guarantor that the guarantor no longer meets the self-insurance criteria. The guarantor promises to establish the alternate financial assurance within 30 days of receiving such notice.

The eighth recital binds the guarantor to the terms of the guarantee and cites specific conditions which do not change this commitment. Those conditions are:

a) permit amendment,
b) changes in closure, postclosure care or contingency action schedules; and
c) other changes imposed under relevant rules.

The ninth recital allows the guarantee to be cancelled under specified conditions. If a guarantor wants to cancel a guarantee, the guarantor must notify the Commissioner and the facility owner or operator of this decision.

The cancellation cannot become effective until 120 days after the Commissioner receives the notice.

The tenth recital places a further condition on a guarantor's ability to cancel a guarantee. The guarantor promises to provide alternate financial assurance if the facility owner or operator does not provide alternate financial assurance within 90 days after the Commissioner receives a notice of cancellation. This condition assures that there will be no financial assurance coverage gaps resulting from cancellation of guarantees.

The eleventh recital contains two waivers which apply to notification. The waivers mean that the guarantor does not have to be notified of:

a) the Agency's or the facility owner's or operator's acceptance of the guarantee, and
b) changes in relevant plans and facility permit conditions.

The final element of the letter is the CFO's certification that the wording of the guarantee is the same as the wording required in the rules. This certification is reasonable because it commits the CFO and the firm to compliance with the relevant rules.

Subpart 8. Letter from the head of an elected or publicly-appointed body. This subpart provides for public sector facility owners and operators the language they must use in a demonstration letter if they choose to self-insure. The rule instructs facility owners and operators to include appropriate language for descriptive terms (names, titles, etc.) that are written between brackets in the model. This provision tells facility owners and operators how to adapt the letter to their individual needs.

The first paragraph of the letter identifies the public body that is making the self-insurance demonstration and its elected or appointed head. This paragraph also presents the letter's intent, which is to comply with the self-insurance provisions of the financial assurance rules. This paragraph also identifies the sites for which the self-insurance demonstration is made and the cost estimates covered by the demonstration. This language identifies the person responsible for the self-insurance demonstration and clearly states that person's intentions. The self-insurance demonstration letter must make these identifications if it is to be enforceable.

The second paragraph of the letter states that the bonds submitted as security are sent along with the demonstration letter. This language reasonably commits the public body and its elected or appointed head to both actions required by the rules - demonstrating that the public body meets the self-insurance criteria and submitting bonds or warrants as collateral. It is a formal action that recognizes the facility owner's and operator's enforceable responsibilities.

The largest part of the letter consists of the data that comprise the financial test. Self-insuring public sector facility owners and operators must report:

a) the total of all current cost estimates for self-insured sites;
b) the maturity dates, face values and market values for the bonds submitted as collateral;
c) the issuance date, maturity date and rating of the public body's most recent bond issue;
d) the total assessed value of the public body, current total debt and statutory limits on net debt; and
e) the total taxes currently levied and the statutory limits on taxation.

The final portion of the demonstration, lines 14 through 17, is a set of questions which ask whether the public body meets the individual self-insurance criteria found in part 7035.2750. This portion of the letter organizes information from the facility owner or operator to compare it easily with the self-insurance criteria.

The final element of the letter is the elected or appointed head's certification that the wording in the letter is identical to the wording specified in Minn. Rules pt. 7035.2305, subp. 8. This is followed by the elected or appointed head's signature, name, title and date of signing. These requirements enable the Agency to be sure that the person who signs the letter is responsible for the public body's financial policies and is authorized to commit the public body's resources to long-term care at sites.

Subpart 9. Resolution establishing a dedicated long-term care trust fund. This subpart provides the language required in a resolution establishing a dedicated long-term care trust fund. The model resolution is written in a form that has general utility throughout local government. It begins with statements of the conditions that cause the municipality to make the resolution. The statements that follow describe the actions the municipality has decided to take in response to the stated conditions. The resolution concludes with appropriate authorizing and certifying signatures. The form of the model resolution follows generally accepted forms for resolutions by government.

The conditional statements first identify the municipality as owner or operator of the facility for which the financial assurance demonstration is made. The statement also identifies the statute (Minn. Stat. § 116.07, subd. 4h) and the part of the proposed rules (Minn. Rules pt. 7035.2695) that require the municipality to establish and demonstrate financial responsibility for the facility site. The last conditional statement recognizes the Agency's authority to require the financial responsibility demonstration. The conditional statements clearly identify the reasons the municipality establishes a dedicated long-term care trust fund.

The resolution next describes the actions taken in response to the identified conditions. The municipality commits itself to take the following actions:

1. creation of the dedicated long-term care trust fund;

2. maintenance of this fund, which is reserved for use only under specified conditions;

3. fund development as prescribed in the proposed rules (part 7035.2720);

4. payment of any administrative or legal expenses the Agency incurs if it must take legal action to compel the municipality to close the facility site, perform routine postclosure care and maintenance or undertake corrective action at the site;

5. making any payments for Agency administrative or legal expenses from funds other than the dedicated long-term care trust fund; and

6. naming a fund trustee who assumes fiduciary and reporting responsibilities.

Earlier parts of this document provided the reasons for actions 1, 2, 3, and 6. Actions 4 and 5 were not discussed earlier. These provisions are not included in part 7035.2720 because that rule specifically names the purposes for which the dedicated long-term care trust fund may be used. Those purposes do not include reimbursing the Agency for administrative and legal expenses. These provisions are included in the model resolution at the suggestion of representatives of local governments. These provisions are intended to discourage frivolous delays and legal actions. Local governments will sometimes stonewall State agencies, hoping that the cost of enforcement action will be so high the Agency will decrease or drop its demands. Actions 4 and 5 of the resolution impose delay costs on the municipality, not the Agency. These costs should properly be incurred by the party responsible for the delay. This measure will encourage timely action by municipal facility permit holders.

The resolution ends with appropriate authorizing and certifying signatures that give legal force to local government resolutions.

J. Reasonableness of Parts 7035.2815 to 7035.2875 SOLID WASTE MANAGEMENT FACILITY SPECIFIC TECHNICAL REQUIREMENTS.

The following discussion addresses the reasonableness of the proposed rules that establish design, construction, and operation requirements for specific solid waste management facilities. Each facility type has unique requirements for managing solid waste in a manner that does not harm human health and the environment. To establish one set of criteria for all solid waste management facilities would be impractical. The criteria would require so many exemptions for particular facilities from certain standards that the rule would be cumbersome to read and interpret. To clarify the applicability of standards, the Agency has chosen to separate the requirements based on facility type. The separation does result in some duplication of language but is much easier for each affected person to read than one combined set of criteria. The Agency believes it is reasonable to establish separate rules for facilities to assist the facility owners or operators in determining their responsibilities.

Before discussing the technical requirements for each facility, the Agency believes it is necessary to explain the policy behind the standards established in the rules. The Agency has attempted to draft a set of rules flexible enough to allow facility owners and operators to design management facilities that meet their needs and wants while stringent enough to minimize the potential for harm to human health and the environment. To accomplish this goal, the Agency has formulated a combination of performance and design standards.

The Agency considered three options for the regulatory structure of the technical standards. They include: uniform design standards, performance standards, and a combination of design and performance standards. Uniform design standards imply that all facilities are located in poor geologic areas, have the identical type and amount of incoming waste, and operations are identical. A comprehensive set of design standards strict enough to protect human health and the environment based on the worst case scenario would be imposed on all facility owners and operators. Using this approach, a variance would be granted if the facility owner or operator demonstrates that equivalent protection would be provided by an alternative design. This option provides a high assurance of protection of human health and the environment but may result in the overregulation of some facilities. The time needed to address the variance request would be unproductive.

The performance standard approach establishes goals that require site-specific analyses to determine appropriate controls to meet the standard. This approach allows the greatest flexibility. A rule based on performance standards decreases the possibility of overregulation, but by its nature, is resource-intensive, results in increased uncertainty for the regulated community and may result in inconsistent application. The performance standard is most difficult to enforce because no specific set of criteria is established. Rather, decisions are based on rule interpretation.

A combination of design and performance standards allows for the establishment of controls based on site-specific conditions while establishing some minimum standard for design of the facility. The rule also provides for modification to some design standards without the use of a structured variance procedure based on information received from the facility owner or operator. A key advantage to this process is the establishment of a uniform process for matching requirements to potential problems. The Agency believes this approach provides protection without overregulation.

Overregulation leads to the installation of unnecessary or redundant protective devices and design features because there is no basis for requiring these items at all facilities. Design standards alone are developed on the assumption that only one set of conditions exist independent of where the site is located. In reality, uniform conditions do not exist and the requirement that only one design is acceptable would be overregulated.

To address every potential problem with examinations of site-specific characteristics and development of appropriate requirements would require a complex scheme. The Agency believes that a reasonable system of regulation has been achieved through the blending of performance and design standards. Certain facility design and operational requirements are needed no matter the site conditions while others must remain flexible to site-specific conditions. For instance, liners are needed whenever leachate is generated whether it be at a compost facility or a disposal facility, while ground water monitoring and specific numbers of wells are not required at all facilities nor in the same density at all disposal facilities.

Because of the difficulty with enforcement of performance standards and with providing consistent review between facility designs, the Agency believes the use of performance standards does not provide the facility owners or operators with sufficient guidance on their responsibilities. The Agency believes strict design standards do not provide sufficient flexibility in designing facilities based on site conditions and changing technology. Therefore, the Agency believes incorporation of both performance and design standards is appropriate to ensure protection of human health and the environment.

The specific requirements for each facility type are discussed in the following section. The Agency will provide its reasons for including either design or performance standards in each part.

1. Part 7035.2815 MIXED MUNICIPAL SOLID WASTE LAND DISPOSAL FACILITIES.

This part discusses the specific design, construction, and operation requirements for mixed municipal solid waste land disposal facilities. A review of the historical record of ground water quality around these facilities shows ground water is polluted. This evidence, along with operation and construction violations, indicates that the existing solid waste rules are not adequate to reduce environmental impacts from these facilities. Therefore, the Agency has developed new standards based on current technology.

Subpart 1. Scope. This subpart establishes the responsibility of all landowners and facility owners or operators of mixed municipal solid waste land disposal facilities to comply with the requirements of this part. Including this provision in the rules informs facility owners and operators of their responsibilities under the rules.

Subpart 2. Location. This subpart contains requirements limiting the locations where land disposal facilities may be sited. These facilities are also subject to the location standards for all solid waste management facilities in part 7035.2555.

The location requirements of subpart 2 are needed to protect water quality and human health and safety. This is consistent with the Agency's statutory authorities. Subpart 2 does not control facility siting based on aesthetic and nuisance conditions, such as proximity to residential development or highways. Aesthetic and nuisance restrictions are under the jurisdiction of local governmental zoning ordinances.

Location standards are needed so that, if a land disposal facility fails to adequately contain leachate, the site's natural conditions can protect ground water and surface water and control the migration of decomposition gases. The location standards also make it feasible to monitor and correct pollution that occurs in spite of the natural protection of the site.

Although the facility design and operation provisions in part 7035.2815 require land disposal facilities to contain leachate and gas migration, these engineering precautions do not guarantee total containment. These releases can occur due to human errors in facility operation. Corrective actions to contain and recover pollutants are not assured of complete success either. In summary, it would be unwise to rely solely on engineered solutions for protection; the natural setting must provide a second line of protection.

Thus it is necessary to limit land disposal facilities to locations where the natural conditions minimize the adverse effects of leachate and gas releases. Item A establishes four conditions that a potential land disposal site must meet. Under the first of these, subitem (1), the facility must be located only in an area where the topography, geology, and ground water conditions allow the facility to be designed, constructed, operated, and maintained in a manner that minimizes environmental impacts.

Subitem (1) is needed to prevent siting in locations where natural conditions interfere with the ability to contain leachate or gas within the facility and to contain any release in a limited area. Siting efforts in Minnesota have provided many illustrations of such undesirable sites. Examples include sites in watersheds that route surface water directly through the facility; sites with shallow water tables or perched ground water that preclude proper liner installation, threaten subsequent liner performance, or direct gas flow back into the operating area; and sites on the edge of steep slopes subject to erosion and landsliding. Another condition common to Minnesota that could jeopardize facility engineering is unstable foundation soil such as peat, some clays, bentonite horizons in bedrock, and some soils under artesian pressures.

Environmental protection has often been the secondary goal of siting efforts. Historically, the focus was to find inexpensive, available land that could not be put to more productive uses. Unfortunately, the same natural conditions that make these sites inexpensive, available, and unproductive often make them unsuitable for constructing and operating a successful solid waste land disposal facility. Subitem (1) prevents sites from being located in areas where such conditions interfere with successful leachate and gas containment.

Subitem (2) requires that a facility be located only in an area where ground water flow paths and variations in soil or bedrock conditions are known in sufficient detail to enable reliable tracking of pollutant movement. This condition prevents siting in areas where the geology is so complex or unpredictable that a hydrogeologic investigation cannot adequately define ground water flowpaths. At such a site, there is little chance for success in tracking leachate movement if it escapes the engineered containment system. As will be described more fully under subpart 3, some of Minnesota's soil and bedrock conditions fit this description. A common example is the glacial terminal moraine, which frequently consists of a complex mixture of varying tills laced with deposits of more permeable ice-contact and water-deposited soils. The more permeable deposits are often irregularly sized and shaped. This precludes correlation between soil borings. The discontinuities can consist of isolated sand lenses or sinuous, continuous pathways for ground water movement. A second example is fractured bedrock. The fractures often can be difficult to define and provide rapid and unpredictable pathways for pollutant movement. Subitem (2) allows the Agency to reject a site where ground water and pollutant movement cannot be adequately defined.

Subitem (3) requires that the facility be located only in an area where it is feasible to construct a monitoring system with sufficient monitoring points to assure that pollutants can be detected and tracked. This provision is related to subitem (2), but focuses more on the technical and economic feasibility of providing a monitoring system, regardless of whether hydrogeologic conditions can be defined. Some settings where hydrogeologic conditions can be well-defined may present formidable obstacles to monitoring. For example, at sites where ground water is very deep, the increased cost of monitoring wells may make effective monitoring infeasible. Although the water table comes within 50 feet of the land surface over much of Minnesota, a deeper water table is also common, and some locations may have 200 feet or more of permeable unsaturated zone. Secondly, the cost of monitoring may be prohibitive at sites that have either very thick aquifers or considerable vertical ground water movement within and between aquifers. At these sites a monitoring system would have to include many more monitoring points to sample at different depths. In each of these examples, it may be feasible to install an initial monitoring system, but not feasible to expand the monitoring system to adequately define and track pollutant movement. It is not prudent and not protective of the environment to locate a facility in these areas. Subitem (3) allows the Agency to prohibit a facility from being located where the feasibility of monitoring cannot be demonstrated.

Subitem (4) requires that the facility be located only in an area where, if there were a release from the facility, pollutants can be contained and corrective actions taken to prevent adverse effects on water supplies and to return the facility to compliance with ground water and surface water quality standards. This provision ensures that facilities are not located in areas where their impacts are irreversible. Corrective action must be both technically and economically feasible. For example, ground water movement must not be so rapid and multidirectional that a polluted zone would quickly expand beyond manageable proportions. Again, a site with the potential for impacts to migrate to great depths may be unacceptable under subitem (4) because of the higher costs of any actions taken at greater depths. Subitem (4) reasonably provides that if corrective action is unlikely to be successful, the site cannot be used as a land disposal facility.

Two observations should be made about item A, and about subpart 2 in general. First, the location requirements are not quantitative and provide latitude for discretion and interpretation. Other approaches were considered but rejected. For example, an early attempt was made to list a series of specific hydrogeologic conditions that should be prohibited through the location requirements. For each of these conditions, however, there were often circumstances under which the prohibitions did not seem justified or were inconsistent with other requirements. Downward ground water movement was one of these undesirable conditions. Sites with downward ground water movement pose a threat to deeper ground water resources, and they are difficult to monitor because the angle of descent cannot be predicted reliably. But downward ground water movement is very common in low-permeability soils, which are normally preferred over highly permeable soils. Thus a provision discouraging sites with downward ground water movement conflicts with the effort to discourage siting in vulnerable areas underlain by high-permeability soils.

A few commentors also wondered whether the location standards should require minimum distance offsets between the facility and surface water bodies. This approach was rejected because any distance chosen seemed arbitrary and overprotective for some settings and underprotective for others. It became clear that siting involves trade-offs and requires flexibility to compare the advantages and disadvantages of a particular site against alternative sites. Prohibiting specified hydrogeologic conditions can eliminate sites that, on balance, are better than other available alternatives. The objectives-oriented requirements of item A focus directly on the results a site must achieve, rather than on arbitrary specifications that may not always lead to the intended result.

Second, the location requirements apply to existing and new facilities. Existing facilities that are poorly sited will have to be evaluated under the provisions of subpart 2 as their permits come up for review. If an existing facility clearly cannot meet the location standards there are three options. The owners or operators of the site can close it, apply for a variance from subpart 2, or construct an engineered secondary containment system if item B is applicable. The Agency will consider unique site circumstances in deciding whether to grant the variance. Relevant circumstances include the availability and desirability of alternatives, the availability of revenues to provide for proper closure and postclosure, the degree of risk to human health and the environment associated with facility operations, and the measures that will be taken to minimize that risk. In some cases, the Agency may find that continued operation under a restrictive permit and variance is preferable to the available alternatives.

Item B requires that, unless the facility owner or operator provides an engineered secondary containment system, a facility cannot be located in an area where the hydrogeologic or topographic conditions would allow rapid or unpredictable pollutant migration, impair the long-term integrity of the leachate containment system, or preclude reliable monitoring. The listed site conditions do not afford adequate secondary protection to ground water if the primary containment system fails. If the natural conditions are not adequately protective, secondary containment should be required. Alternatively, the rule could have simply prohibited new and existing facilities in these areas by deleting item B. This alternative was rejected because it appeared to preclude land disposal altogether in some regions of Minnesota and would have forced existing facilities to close even if there were no reasonable alternatives. Instead, item B reasonably allows facilities to be sited in these areas if the investment in secondary containment is made. Because of the added risk posed by sites with these conditions, in-place and functional secondary containment is required rather than accumulating financial assurance set-asides.

Under subitems (1), (2), and (3), the additional engineering required by item B must consist of one of the following: a second liner with a collection system between the two liners; an in-place, operational ground water containment and treatment or disposal system that can be activated immediately if ground water pollution is detected; or another method of secondary containment backing up the liner and providing additional protection equivalent to the other two options. These measures are commonly employed in other states.

Two-liner systems with leachate collection above each liner are standard designs for hazardous waste land disposal facilities, and are becoming increasingly common for mixed municipal solid waste in vulnerable areas of the eastern seaboard states. In the two-liner system, leachate escaping the upper liner is intercepted by the second liner. Ground water containment systems provide an option that may be preferable to the second liner at some sites. Various approaches to ground water containment, including pump-out systems and subsurface barrier curtains or walls, are commonly used to limit pollutant migration. Either option provides the additional protection to ground water needed because of the shortcomings of the natural site conditions.

Item C identifies areas where land disposal sites are prohibited. Subitem (1) prohibits land disposal facilities from being located on a site where there are karst features, such as sinkholes, solution channels, disappearing streams, and caves. Karst may cause failures of the leachate management system or prevent effective monitoring or containment of pollutants. Karst areas formed on soluble bedrock pose a special risk to ground water. The karst areas of southeastern Minnesota are extremely vulnerable to ground water pollution, and they threaten to undermine structures, including liners, through collapse (References 43, 44, 45, 46). Subitem (1) reasonably prohibits facility construction on sites characterized by visible karst features.

Some commentors wondered why the prohibition of subitem (1) is limited to areas with visible karst features only. They raised concerns over the more extensive areas containing subsurface voids and openings formed by dissolution and collapse. The Agency believes that outright prohibition is only reasonable when visible karst features are found at a site because subsurface voids and dissolution channels at some sites are far below the surface, where they present little risk to the structural integrity of the facility and do not interfere with ground water monitoring. The automatic prohibition of areas with visible karst features is proposed in the rules because of the potential for rapid and unpredictable ground water movement through the surface openings. An outright prohibition is not proposed for sites with only deeper soluble bedrock because the hydrogeologic evaluation will develop sufficient data on the stability and suitability of these sites. Additionally, if a ban on areas with deeper karst features was made automatic, the entire southeast region of Minnesota may be considered unsuitable for locating a land disposal facility. This would be an unreasonable burden to place upon the residents of this region as they would incur considerable expense in transporting their solid waste.

Subitem (2) prohibits sites where there are other unstable soil or bedrock conditions that may cause failures of the leachate management system. The rationale is the same as for subitem (1); it would be unreasonable to allow disposal on a site where the liner and leachate management system are at risk from unstable foundation conditions. As mentioned in the discussion of subitem (1) of item A, foundation materials such as peat and low-strength clays would not adequately support a liner and other facility features.

Subitem (3) is protective of human health and safety rather than the environment, and is directed at minimizing bird hazards to aircraft. It provides that a fill area must not be located on a site where an airport runway used or scheduled for use by turbojet aircraft is located within 10,000 feet of the waste boundary, or an airport runway used or scheduled for use by piston-type aircraft only is located within 5,000 feet of the waste boundary, unless approval is obtained from the Federal Aviation Administration (FAA). This requirement is based on federal solid waste regulations (Reference 47). The federal regulations require that a facility, within the stated distances of runways, disposing of putrescible wastes "shall not pose a bird hazard to aircraft." 40 CFR 257.3-8. The determination of whether a given fill area poses a bird hazard to aircraft is outside the expertise of the Agency. Thus, subitem (3) requires approval by the FAA to operate a fill area in the vicinity of an airport. Through conscientious efforts to cover waste frequently, a land disposal facility should be able to avoid attracting the gulls and other scavengers that concern the FAA.

The discussion of subpart 2 has repeatedly highlighted Minnesota's highly variable hydrogeologic conditions. This variable, often complex, hydrogeology also influences the requirements for hydrogeologic evaluations in subpart 3. Before discussing subpart 3, a brief overview of Minnesota's hydrogeology will help clarify the basis for some of the provisions. Most of the following discussion is directly from Reference 43; see also References 48 and 49.

The soils and bedrock of Minnesota can be grouped into three categories. The basement rocks, usually igneous or metamorphic crystalline rocks, are the oldest and hardest layer of rocks. They underlie the more porous and permeable bedrock formations of sandstone, dolomite, limestone and shale. Above the bedrock, unconsolidated sand, gravel, and clays occur in varying thicknesses, forming the visible land surface over much of Minnesota.

The basement rocks generally are not prominent aquifers. They are dense and hard, and seldom have open spaces capable of holding water, except in cracks and crevices created by differential earth movements. They occur at or very near the land surface over much of northeastern and southwestern parts of Minnesota. There, and in a few other areas of the State where the overlying materials yield little ground water, fractured basement rocks are the only aquifers available and are locally important. Fractures and cracks may be interconnected, but only in a few known sites do they contain enough storage space to have significant water yields over large areas. As with the ground water flow, any potential pollutant migration is through the fractures. The fractures are difficult to locate, and they lead to complicated, unpredictable flow patterns. Thus, it can be very difficult to develop a reliable ground water monitoring system. If basement rocks are shallow enough to be of interest at a land disposal site, the hydrogeologic investigation must identify any fractures, determine how they are interconnected, delineate how ground water moves through them, and figure out how to monitor them.

Bedrock formations are found on top of the basement rock in most parts of the State. Much of the southwestern and western parts of the State contain scattered remnants of sedimentary bedrock of Cretaceous age. These consist of mixtures of loose sand, sandstone, siltstone, and shale ranging up to 500 feet thick. Most often they are low yielding water sources, but are important locally.

The most important bedrock source of ground water in Minnesota, though, is the porous and permeable sedimentary bedrock of the southeastern quarter of the State. This consists of one to five major water-yielding sandstone and limestone aquifers. The Twin Cities are located within this geologic setting. These layers of sandstone, dolomite and limestone are separated by relatively impermeable layers of shale and siltstone that confine the ground water under artesian conditions. In areas adjacent to river valleys, however, they are unconfined. Not all units are present in all locations due to uneven deposition and subsequent weathering and erosion.

Ground water flow is through the pore spaces between sand grains in the sandstones. Fracture flow occurs in all the formations and is the predominant mode of flow in the carbonate aquifers, the dolomites and limestones. Thus fracture flow can present the same problems for prediction and monitoring as in the basement rocks. In the karst area of far southeastern Minnesota, fractures and openings in the upper bedrock carbonates have been enlarged by dissolution, erosion, and collapse. As discussed in subpart 2, the problems of contamination potential, flow prediction, and monitoring are intensified in this setting.

Finally, unconsolidated layers and lenses of sand, gravel, silt, clay and boulders cover the bedrock or basement rock over practically all of the State, except where the basement rocks or porous bedrock are exposed at the land surface. The unconsolidated soils range in thickness up to 600 feet or more. They provide ground water to most of the households served by domestic wells in the State. They also supply most irrigation wells and most municipal wells in western Minnesota.

Most of the unconsolidated materials are the result of glaciation. Minnesota was overridden by numerous glacial advances which deposited complex sequences of glacial soils of differing permeability and mineral composition. References 50 and 51. Glaciation shaped Minnesota into some 27 physiographic provinces, each with its own internal complexities of soil types and variability. Reference 52. Glacial deposits generally are much more heterogeneous than the basement or bedrock. A particular site may contain a variety of deposits. These deposits may be irregularly, unpredictably shaped, and they may contain a broad range of soil permeabilities. A site may contain one or more distinct tills (an unsorted clay- to boulder-sized mix of material deposited directly by the glacier), various more permeable ice-contact and meltwater sand and gravel deposits, lake deposits, and all gradations between these material types. Low-permeability tills commonly contain highly permeable sand lenses and stream deposits, which may be of limited extent or may provide continuous pathways for contaminant movement. Clayey lake deposits often contain coarser, more permeable beach ridges and near-shore deposits.

Nonglacial unconsolidated materials also may be highly heterogeneous. Also common in Minnesota, these nonglacial materials include alluvium (stream deposits), colluvium (slope deposits), and residuum (residues from weathering of bedrock or basement rocks).

In summary, hydrogeologic conditions vary widely from place to place within Minnesota, and even within individual sites. The water table is virtually at the ground surface in some areas and more than 200 feet deep in other areas. Each site presents a unique hydrogeologic condition, with different challenges for siting, hydrogeologic evaluation, and monitoring. This variability demands that the proposed rules incorporate flexible standards for both facility locations and hydrogeologic evaluations. Accordingly, subparts 2 and 3 and other portions of the proposed rules emphasize site-specific conditions and allow options based on site conditions.

Subpart 3. Hydrogeologic evaluation. This subpart requires the facility owner or operator to complete a hydrogeologic evaluation of land disposal sites. This evaluation consists of field, laboratory, and literature investigations. The purposes of the hydrogeologic evaluation are:

1. to define the conditions that would control or influence pollutant migration from the facility, and to estimate the directions and rates of subsurface pollutant movement;
2. to define soil and ground water conditions that may affect the performance of the facility, so that these conditions are taken into account in locating the facility within the site and in the facility design, operation, and contingency planning;
3. to provide the hydrogeologic information needed to determine whether the facility is located in compliance with subpart 2; and
4. to provide the information needed to design effective systems to monitor ground water, surface water, and gas.

All mixed municipal solid waste and disposal facilities, both new and existing, are required to develop this information. Under the terms of amended permits issued since 1982, existing facilities have been required to conduct hydrogeologic evaluations. The hydrogeologic evaluation provides an understanding of subsurface conditions that influence facility performance. Without this evaluation, an unreasonable condition would exist: the facility could not be sited, designed, or monitored; and the types of corrective action that may be needed, and the anticipated success of each, would remain unknown. The public would be ill-served without such an evaluation. The almost universal existing condition of adverse ground water impacts from existing Minnesota mixed municipal solid waste land disposal facilities clearly demonstrates that the hydrogeologic evaluation is needed and reasonable for these facilities.

A thorough hydrogeologic evaluation has become standard practice for siting land disposal facilities nationwide. The amount and extent of information needed to conduct a hydrogeologic evaluation is not new. The Agency's "Guidelines for a Hydrogeologic Investigation of a Solid Waste Landfill," first issued in February 1985, describes a similar approach. See Exhibit XIX.

Because many existing facility owners and operators have undertaken hydrogeologic evaluations since 1981, they have already fulfilled many of the requirements of subpart 3. This is also the case for facility owners and operators conducting remedial investigations to determine what corrective actions may be needed to address ground water pollution. These facilities may already be subject to requirements equivalent to, or more stringent than, subpart 3. As permits are renewed for facilities that have completed hydrogeologic studies, the Agency will determine case by case whether any additional work must be done to comply with subpart 3.

Subpart 3 consists of items A to D, which contain general requirements applicable to all parts of the hydrogeologic evaluation, and items E to I, which prescribe four main phases of the hydrogeologic evaluation.

Item A requires the facility owner or operator to investigate and define the hydrogeologic conditions at the facility. Item A further requires that the hydrogeologic evaluation is a condition required for obtaining or retaining a permit, and must be included in the permit application required for proposed new or expanded facilities. For existing facilities, the Agency amends the facility permit to include a timetable for completion of the various phases of the hydrogeologic evaluation. Failure to comply with permit conditions may result in Agency administrative or legal actions to compel compliance. Item A also requires updates and revisions to the hydrogeologic evaluation as needed to clarify renewed uncertainties about the hydrogeologic conditions or to define changes in those conditions. This provision ensures that the understanding of subsurface conditions remains reliable and current. Updates may be required after review of the permit every five years, or during the term of the permit if there is good cause. Causes for updates may include indications from the monitoring data that pollutant migration is different than predicted, or that high-capacity ground water withdrawals are inducing new ground water flow patterns.

Item A allows the facility owner or operator to use previous work that is reliable, well-documented, and equal in information content to fulfill the requirements of subpart 3. This provision avoids needless redoing of previous site investigation. The provision was suggested by commentors who wanted it clarified that the Agency could not arbitrarily dismiss previously-generated information.

Item B requires that the hydrogeologic evaluation be conducted in phases. The work done under each item F to I builds on the information developed in earlier phases of the hydrogeologic evaluation. Such phasing is recommended in the Agency's existing hydrogeologic investigation guidelines. See Exhibit XX. It has been incorporated into many of the amended permits. The four main phases identified in subpart 3 are: the preliminary investigation (item E), in which already-available information is compiled to inform and guide the subsequent investigations; the detailed site investigation (items F and G), in which field, laboratory, and interpretive work are done to define subsurface conditions and anticipated pollutant migration; design and installation of a water monitoring system (item H); and water quality monitoring (item I).

The requirement for a phased hydrogeologic evaluation is needed to ensure that the Agency has regular opportunities to provide input to the facility owner or operator during the investigation. Without this regular input, it has been the Agency's experience that large amounts of work must be redone or supplemented because the methods used do not meet acceptable standards, or because the investigation is not adequately directed toward particular aspects of the subsurface conditions that could have been identified at an earlier stage. The Agency provides comments that allow the facility owner or operator to focus on conditions that may affect the permitting, placement, or design of the facility. In some cases this allows an early determination that a site may be unpermittable or permittable only with extreme design measures. The facility owner or operator can then save the expense of a complete hydrogeologic evaluation and redirect efforts toward a more suitable site. All parties can avoid the increased pressure to proceed with a bad site that inevitably results as the investment in the site grows. The requirement for phased investigation is a widely accepted practice. Most facility owners and operators and consultants now recognize that it is to their advantage to obtain Agency comments regularly in order to be cost effective.

Subitem (1) requires that before entering a new phase of the hydrogeologic evaluation, the facility owner or operator must submit for the Commissioner's approval a detailed description of the work proposed for that phase, and a report of the findings from the preceding phase, accompanied by supporting data. This requirement provides the Agency with ordered presentations of the findings and proposed work. The Agency must review this information to support comments on the proposed work. The facility owner or operator should submit this information to the Agency, since hydrogeologic investigations require careful planning. The final report must present all findings in an organized manner with appropriate documentation. Despite some commentors' concerns about delays caused by this process, the Agency believes Agency approval is appropriate before proceeding with a new phase. The Agency is cognizant of the impact of delays. The Agency now strives to shorten review time for investigations in progress. A short delay is warranted, given the benefits of the Agency review. The actual number of reports and work plans includes three work plans, coming between the four major phases. This results in very minor time losses in the entire scope of the hydrogeologic investigation. Review points in the investigation are typically used as times to prepare for the coming phase.

Subitem (1) authorizes the Commissioner to require additional work plans to enable additional reviews between successive stages of investigations. This provision is for investigations that involve major decision points on how to proceed or generate large amounts of data requiring extended review times. Consultants typically organize the detailed site investigation into a series of successive rounds of drilling or testing, with each round of work used to more efficiently focus the next round. Consultants and facility owners or operators often want the reassurance of frequent submittals and meetings with the Agency during the course of the hydrogeologic evaluation. The Agency requires additional submittals judiciously, and can often accomplish intermediate reviews in meetings or by telephone, without any extensive exchange of paperwork.

Subitem (2) requires that soil and rock samples be retained for at least 90 days after submitting the report. This requirement allows the Agency the opportunity to inspect the samples, and, if necessary, require additional classification or testing. Inspections of samples enable the Agency to evaluate the validity of the consultants' soils correlations, test results, and interpretations. Ninety days allows the Agency to establish whether there is a need for inspection or further work. At a site where there is a greater potential for pollution, many consultants now retain samples for the life of the project.

Item C requires the facility owner or operator to define the hydrogeologic conditions within the areas specified in subitems (1) to (5). It is necessary and reasonable to define the target area because questions usually arise on the areal extent and depth of drilling required. The facility owner or operator normally does not want to do more work than necessary, and it would be unreasonable to require them to do so.

Item C limits the target area according to the objectives that must be met and the subsurface conditions. This approach is preferable to rigid standards that would arbitrarily specify distances or depths applicable to all sites. Soils and ground water conditions vary from one site to another. Distances and depths arbitrarily specified for all hydrogeologic investigations would be under protective for some sites and gross overkill for others. The approach in item C better ties the investigation requirements to the needs at the particular site. A secondary result is that the facility owner or operator might be rewarded with some savings in hydrogeologic evaluation costs by choosing a site where the soils and ground water conditions are more suitable to prevent pollutant movement.

Subitem (1) requires facility owners and operators to define hydrogeologic conditions beneath the waste fill area and leachate management system. The soils and ground water directly beneath these areas would be the first affected by leachate migration from the facility. This provision can be waived under filled areas at existing facilities where drilling through refuse might create pathways for pollutant migration. Regardless of technologies available to reseal drillholes, the risks might outweigh the benefits at existing sites. The Agency can normally use the information obtained from areas surrounding the actual fill area. Under the proposed rules, the Agency will require drilling within existing fill areas only where essential hydrogeologic information cannot be obtained by other methods and the additional risk is warranted.

Subitem (2) requires definition of hydrogeologic conditions beyond the waste fill area and leachate management system based on the directions and rates of ground water flow. Studies completed under this subitem will define the conditions that control pollutant migration. It is necessary to define the conditions controlling pollutant movement for the reasons already given in the general discussion on subpart 3. The language of subitem (2) leaves room for discretion; some persons might be more comfortable if the rule specified a fixed distance from the facility within which conditions must be defined. However, this approach would ignore the fact that ground water flow is very different among sites. The rate of ground water movement can vary depending on soil permeabilities and the hydraulic gradient. For example, at sites where ground water flow is rapid it will be necessary to define hydrogeologic conditions farther from the actual fill area.

An approach that may have promise, either to assist in applying subitem (2) or to incorporate into some future rules revision, is the time-of-travel criterion. This approach is currently being developed in federal regulations and guidance. The distance it would take pollutants to migrate over some specified time period (e.g., 10 years, 100 years) is calculated. This distance is then used in one of several ways, for example, as a measure of ground water vulnerability, a criterion for monitoring well placement, or some other type of decision criterion. Until there has been some experience with the time-of-travel approach, the approach in subitem (2) will be used to identify potential impacts.

Subitem (3) requires definition of hydrogeologic conditions within areas where corrective actions would be taken to contain, recover, or treat leachate or polluted ground water. This provision ensures that corrective actions are planned, financed, and carried out based on a sound understanding of the hydrogeologic conditions. This provision is not a fixed standard because the locations where corrective measures can be placed vary from site to site, and alternative procedures to make the requirement more specific are not available.

Subitem (4) addresses the vertical extent of the hydrogeologic evaluation. It lists five conditions defining the required vertical coverage. The last paragraph of item C provides an exception to these requirements.

Units (a) and (b) require definition of conditions in the unsaturated zone and in any perched saturated zone. Conditions in the unsaturated zone control the movement of pollutants. Conditions such as low permeability, high adsorption, and high cation exchange capacity may restrict pollutant migration. In contrast, high permeabilities, low attenuative capacity, and fracturing are examples of conditions that may allow rapid pollutant migration. Perched saturated zones, i.e., thin zones of ground water perched by low permeability units above the zone of continuous saturation, are common in Minnesota's glacial soils and in several of the bedrock formations. Perched zones can cause pollutants to travel laterally. They may also interfere with liners and leachate collection by supplying unanticipated quantities of water to these systems. Such conditions can be identified through common soil sampling and testing methods.

Units (c), (d), and (e) describe the vertical extent of the hydrogeologic evaluation in the saturated zone. The saturated zone contains the ground water that these rules are intended to protect. Proper siting, design, monitoring, and contingency action planning depend on knowledge of the soil and ground water conditions in the saturated zone.

Unit (c) requires the hydrogeologic evaluation to define conditions within the zone of continuous saturation, from the water table, (the uppermost limit of the saturated zone) through the uppermost aquifer, the next aquifer below it, and any intervening units. Depending on individual site conditions, this represents from two to four units: two units if the water table occurs in the uppermost aquifer and the next underlying aquifer is directly in contact with this water table aquifer; three units if a saturated low permeability unit, or aquitard, overlies one of the two uppermost aquifers; or four units if aquitards overlie both of the two uppermost aquifers.

This condition recognizes the movement and interconnection of ground water. It is not protective to permit a land disposal facility knowing only the conditions in the first aquifer or aquitard. It is more prudent to determine in advance deeper aquifers that may be affected by pollutant migration, so that contingency action plans and financial assurance can address any threat to deeper ground water. It is less prudent to wait for the first aquifer to become polluted and only then investigate the deeper ground water resources, particularly since deeper ground water is often used as a drinking water source in Minnesota.

Some commentors have questioned whether unit (c) is reasonable in practice when applied to sites with very thick hydrologic units or a very deep water table. At these sites, they fear, the costs of the hydrogeologic evaluation could become prohibitive due to the costs of deep drilling.

Three considerations indicate that unit (c) is reasonable. First, under the last paragraph in item C, the Commissioner may approve a depth shallower than required in subitem (4) if there is little likelihood that pollutants will migrate below this depth. If the deeper ground water is not at risk, due to ground water flow directions, impermeable protective confining units, fail-safe provisions for containment and recovery of pollutants, or other factors, the Commissioner may allow the facility owner or operator to limit the hydrogeologic evaluation to a lesser depth. The Agency anticipates the need to make this judgment in some cases. Second, hydrogeologic conditions at greater depths generally can be defined without extending every drillhole or piezometer to these depths. Ground water flow directions and rates usually become less variable with greater depth below the water table and can be predicted with fewer direct measurements. In many sections of Minnesota, the geology may also become less complicated with depth. Finally, if the cost of the hydrogeologic evaluation remains prohibitive despite the preceding conditions, then the site is probably deficient. If deep ground water is potentially threatened, then corrective action may also be cost-prohibitive, and the site may be unsuitable for a land disposal facility.

Unit (d) requires where facilities that have affected ground water quality to a depth greater than given in unit (c), the hydrogeologic evaluation must be extended through at least the lowest affected aquifer. This condition assures that pollutant impacts are defined, regardless of where these impacts occur.

Unit (e) requires the hydrogeologic evaluation to cover any deeper aquifers used locally as major sources of water supply. A major source means that the aquifer supplies drinking water for a significant number of people or large quantities of water for other purposes. This provision is necessary and reasonable for the protection of public health and valued resources. If the aquifer is a major source of water supply, then considerable information on subsurface conditions will be available from governmental agencies and from well logs, and the amount of on-site work needed will be reduced correspondingly.

The last paragraph of item C, which allows the Commissioner to approve a minimum depth shallower than required in subitem (4), has already been described and illustrated in the discussion of subitem (4), unit (c). Hydrogeologic investigations at great depths are costly and should not be undertaken if it can be shown that there is little likelihood of pollution migrating to these depths.

Item D provides flexibility in applying the requirements in the remainder of subpart 3. Specifically, it provides a mechanism whereby the facility owner or operator may propose, and the Commissioner may approve, alternatives to the procedures required in items E to I. This approach allows items E to I to be specific without the danger of inflexibly dictating procedures that might not be appropriate in every case. The alternatives to this approach would be either to be specific, inflexible and possibly wrong about the best methods of investigation, and to require variances when the specified methods are inappropriate, or to have non-specific requirements flexible enough to cover any situation. Item D supplies a prudent middle ground, which combines specificity and flexibility when changes are justified. Requests for alternative procedures can be incorporated into the work plans required under item B.

Item D represents a flexible rule administration. The Commissioner may approve or require changes from the requirements in items E to I only for good cause, including the specific cases given in subitems (1) to (4). Subitem (1) addresses situations where subsurface conditions are shown to be uniform, or the requirements prove to be unnecessary or excessive for site conditions. Uniform soils and other circumstances can render certain requirements of items E to I unnecessary. For example, the requirements of item F for minimum numbers of borings in subitem (3) and for a 5-foot soil interval between soil samples in subitem (5) are generally appropriate, but they may be unnecessary for a facility located in a uniform lake plain, sand plain, or other setting in which the subsurface materials do not vary across the site.

Subitem (2) is the case where a requirement is infeasible for a particular site or hydrogeologic condition. For example, the methods for securing undisturbed soil samples specified in item F, subitem (5), have broad application, but in some soils they may prove impossible. Again, the Agency needs the option to develop a reasonable alternative.

Under subitem (3), alternative procedures are authorized when they produce more or better information or when they reduce the chance of interconnecting aquifers. It may sometimes be possible to substitute geophysical or other noninvasive methods in place of drilling, if there is cause for concern about opening up new holes that might inadvertently provide pathways for movement of pollutants. Geophysical methods generally are less accurate and may be subject to multiple interpretations, and drillholes can be carefully resealed, but situations may arise where the risks of drilling outweigh the benefits.

Finally, subitem (4) allows for exceptions when the required procedures are not sufficient to produce the hydrogeologic information needed for the report in item G. The Commissioner may approve or require changes. The facility owner or operator must develop an understanding of the soil and ground water conditions; if procedures specified in items E to I do not provide that understanding, they are not needed or reasonable.

A further constraint on the use of alternative procedures is the final paragraph of item D. It states that in all cases, alternative procedures are acceptable only if the subsurface conditions are thoroughly defined and the alternative procedures do not add to uncertainty in monitoring and corrective action. This condition clarifies that alternative procedures proposed for economy and convenience are not acceptable if they result in incomplete knowledge of the conditions controlling pollutant migration or less reliable monitoring and corrective action. Additional measures will be required to provide information on subsurface conditions to ensure pollutants can be monitored.

Item E contains requirements for the first phase of the hydrogeologic evaluation. The first phase includes a preliminary evaluation of available published and unpublished information about the site and surrounding area. It is standard practice to develop this information first because available information can often provide a good understanding of the overall hydrogeologic framework. This information includes regional geology, ground water flow conditions, and ground water quality. This knowledge is critical to focusing the on-site evaluations on the most pertinent conditions controlling pollutant mobility. This knowledge makes the on-site investigation more efficient. The preliminary evaluation often provides enough information for the facility owner or operator to determine whether the site is likely to prove suitable for construction of a land disposal facility. Therefore, gathering available published and unpublished information is reasonable.

Available information includes reports, data, well logs, maps, and aerial photography. This information may be available from State, federal and local agencies; research findings; and other sources, such as well drillers and privately-commissioned studies. Information on the area surrounding the facility is required because ground water flow does not begin or end at property boundaries. It is important to understand what off-site conditions control the on-site conditions and what off-site water resources and water uses would be impacted by a release from the facility.

The minimum contents of the phase one report are given in subitems (1) to (6) of item E.

Subitem (1) requires a description of previous investigations of the site and surrounding area. The subitem also requires a discussion of the reliability and completeness of this information. The reasons given in the paragraph above apply here. Quality of hydrogeologic investigations varies. Field work, data reliability, and procedural rigor differ according to the objectives. Some studies may provide information that can be applied to the site with certainty and substituted directly for part of the work. Other studies may provide only a useful working hypothesis that must be established through more complete on-site investigations.

Subitem (2) requires that descriptions, maps, and aerial photographs be submitted for the site and surrounding area, as available. This provision is a listing of the components of any preliminary hydrogeologic evaluation. The components of any preliminary hydrogeologic evaluation include:

a. geologic history;
b. stratigraphic sequence;
c. soils;
d. topography;
e. vegetation;
f. climate;
g. surface water hydrology;
h. area water usage;
i. regional hydrogeologic setting;
j. ground water occurrence at the site;
k. aquifers and aquitards;
l. hydrogeologic parameters such as transmissivity and storage coefficients;
m. recharge and discharge areas;
n. rates and directions of ground water movement; and
o. water quality.

The reasonableness of providing this information is discussed in the following paragraphs.

Geologic history enables a geologist to reach conclusions about soils and bedrock conditions associated with the geologic environment under which these materials were deposited or formed. For example, knowing that a period of glacial advance over a site was preceded by an interval of glacial stagnation will lead the geologist to conclude that a more complex or higher-permeability unit, such as outwash, kame deposits, or stagnation till, probably underlies the surficial till and should be a focus of the on-site investigations.

Topography, vegetation, surface water hydrology, and climate are all important influences on the site's hydrology, slope stability, and potential releases from the facility.

The stratigraphic sequence beneath the site provides the facility owner or operator an understanding of the layering of rocks and of the effects that this layering may have on pollutant migration from a facility. Information on soils is important to consultants, the Agency, and facility owners and operators to assess the likelihood of a site being suitable for use as a land disposal facility. This information is used to plan soil borings and other on-site investigations to evaluate specific conditions at the facility. The importance of soils information indicates the need to include it in all hydrogeologic evaluations.

Considerable information is needed regarding ground water movement and the water usage under the area surrounding a site and the site itself. The regional hydrogeologic setting ground water occurrence at the site, and the distribution of aquifers and aquitards provide a general picture of how a land disposal facility may impact these resources. Guided by this preliminary information, a hydrogeologic evaluation program can be designed to further identify specific areas of concern at a site. Information on the rates and directions of ground water movement would be used to focus investigative field work in the direction of flow. Hydrogeologic parameters may be available from previous pumping tests of aquifer yield. The parameters specifically listed, transmissivity and storage coefficient, are standard measures of the formation's ability to yield water. Recharge and discharge areas, where they can be identified, are important to understanding the ground water flow system and the points where ground water and surface water may be most vulnerable. Recharge areas are locations where an aquifer receives its water from either direct infiltration of precipitation or leakage from overlying units. More care is needed to protect ground water in recharge areas. Discharge areas are locations where the ground water moves back to the surface, either to surface waters or to plant uptake and direct evaporation from soils. In these areas, where ground water is at less risk, but surface waters and soils are potentially impacted by emerging polluted ground water.

Including as much available information as possible in the preliminary hydrogeologic evaluation ensures the earliest approval or rejection of a site. Additionally, this information will assist in the establishment of the most efficient field investigation program possible.

Subitem (3) requires one or more geologic columns or sections. This is a standard depiction of the vertical sequence, average thicknesses and material type of the geologic units present at a site. It organizes information into a readily understandable format.

Subitem (4) requires cross-sections, oriented along and perpendicular to the directions of ground water flow. A cross-section is a standard geologic visual depiction of a vertical slice of the earth. It differs from the geologic column in that it extends across the site and shows how the soil and bedrock units thicken and thin laterally. Orientation along and perpendicular to the flow directions makes cross-sections more useful in reflecting flow and in revealing geologic conditions controlling flow. Cross-sections are valuable where the available information is sufficient to develop them; the number of cross-sections generated in this preliminary phase is dependent on data availability and site variability. The Agency also recognizes that, due to variability in ground water flow directions, it may only be possible to align cross-sections with the predominant direction of flow, or with the flow in the aquifer of concern.

Subitem (5) requires an inventory and plan map of all active, unused, and abandoned wells within one mile of the facility, and all high-capacity wells and community water supply wells within three miles of the facility. A community water supply, as defined in Minn. Rules pt. 4720.0100, and referred to in part 7035.0300 of these proposed rules, is "a public water supply or system which serves 15 service connections or living units used by year-round residents, or regularly serves at least 25 year-round residents."

The information required in subitem (5) is important because water supplies potentially impact public health and other valuable water uses. High-capacity withdrawals for irrigation, public water supply, or other purposes may draw ground water from the site. Improperly constructed wells, particularly those that are old and not maintained, may provide a vertical connection between aquifers. This enables pollutants to migrate in ways that might not otherwise be discovered. Drillers' logs of well construction and geologic materials encountered provide valuable information about hydrogeologic conditions. The one-mile radius is reasonable; beyond this distance wells are generally not in jeopardy from leachate. A three-mile radius is needed to protect high-capacity wells and community water supplies because of their greater potential to divert ground water flow from its normal flow direction changing the point of impact. The larger radius also reflects a greater public health concern for community water supplies because of the potential to affect more people.

Although the premise of the preliminary investigation is to use already available information with a minimum of on-site work, the last sentence of subitem (5) does allow the Agency to require interviews and surveys of well owners if well logs are not available through other sources. Commentors suggested that this activity represents a more intensive gathering of information that should take place during the detailed site investigation. The Agency believes it may be appropriate to require this information during the preliminary investigation phase if available sources do not yield even a minimal understanding of the hydrogeologic setting.

Subitem (6) requires owners or operators of existing facilities to provide a preliminary evaluation of the adequacy of the water monitoring system, the monitoring points' compliance with the Minnesota Water Well Construction Code, and the water quality monitoring data developed from that monitoring system. Although a more thorough evaluation of existing monitoring points is required later in item H, subitem (1), conducting a visual inspection of the wells and review of the well logs at this stage will determine the validity of the data obtained from these wells. This preliminary evaluation can also help define the testing needed to evaluate the adequacy of the monitoring points.

Items F and G give the requirements for the second major phase of the hydrogeologic evaluation. Item F focuses on what must be done in the detailed site investigation, and item G specifies what must be included in the report on this phase. Item F begins with the general statement that the facility owner or operator must conduct a detailed evaluation of the distribution and properties of the materials underlying the site and the ground water conditions beneath the site. The need and reasonableness of this provision have already been established in the general discussion of subpart 3 above.

Subitem (1) states the conditions that the investigation must identify. For many of the hydrogeologic conditions cited in subitem (1), need and reasonableness have been discussed earlier. Delineating the areal and vertical extent of the soil and bedrock units is needed because changes in the geology normally exert a strong influence on ground water flow and pollutant migration patterns. For instance, it is important to know whether permeable zones offer a continuous path for pollutants to follow, or whether they gradually disappear and have less influence on flow. The role of perched saturated zones in diverting flow laterally in the unsaturated zone has been described under item C, subitem (4), unit (b) above. It is important to define the directions of ground water flow in both their horizontal and vertical dimensions. Upward or downward ground water movement is very common, especially in low permeability units and areas of pumping withdrawals. Vertical components of flow cannot be detected if water level measurements are taken only from wells installed in the top of the uppermost aquifer. If a vertical component of flow goes unrecognized, monitoring systems are much less effective because pollutants flow below the bottom of the monitoring points. Finally, requiring advance prediction of pollutant movement has been discussed regarding subpart 3 and will be further described under item G, subitem (6). This prediction is essential to the design of monitoring systems and corrective actions, as well as facility placement and design.

Subitem (2) specifies the contents of the work plan required for the detailed investigation phase. The work plan must describe the proposed methods of investigation, quality control measures, and the rationale for the proposed work. This provision is needed and reasonable because it provides the Agency with the information needed to comment on the proposed work. The facility owner or operator needs this information to carry out a well-targeted, cost-effective investigation that generates reliable information. It is important to structure the investigation to address anticipated hydrogeologic conditions and to identify the critical aspects of this working hypothesis to be tested. Careful planning minimizes the amount of field work needed.

Subitem (2) further specifies that the work plan describe the planned numbers, location, depths of soil boring and sequence of the hydrogeologic work. This information will enable the Agency and the facility owner or operator to evaluate whether the posed questions can be answered, and whether the investigation will provide the level of resolution necessary to have confidence in those answers. It is reasonable for the facility owner or operator to do this planning to ensure the investigation will meet the Agency's needs and the facility owner's or operator's objectives in the most efficient method. The Agency recognizes the desirability of modifying these plans as the investigation progresses and the information needs change. The Agency does not hold the facility owner or operator rigidly to what was initially approved if conditions warrant change. The proposed rules provide for modification of the work plan under item D.

Subitem (3) requires sufficient soil borings to define the hydrogeologic conditions within the areas specified in item C. The rule states requirements for an initial round of drilling. The results from initial drilling operations normally identify some conditions that were not anticipated, and require additional investigation. In this initial drilling, borings are positioned throughout the site. Borings must be placed within specific geomorphic features because the topographic expression indicates that the underlying geology may differ from the surrounding area. For the same reason, borings must be placed within any geophysical anomalies. Geophysical investigations are often done before any extensive drilling to target areas in which to concentrate the drilling. This provision assures that soils information is generated to verify conditions beneath all portions of the site. Soil borings provide direct information, which is more accurate than geophysical investigation and subject to fewer interpretations.

Minimum numbers of borings are specified for the initial drilling. These numbers have been developed to serve as a starting point and have not been specified in existing guidance documents. <u>See</u> Exhibit XIX. Facility owners and consultants often propose to conduct few soil borings. Their proposals are usually inadequate to determine subsurface conditions because geologic units in Minnesota typically vary in thickness and characteristics over short distances. Specifying the minimum number of soil borings ensures that a minimum level of soils information is obtained in support of the correlations and interpretations used to predict ground water flow. It is also important to recall item D, which provides for alternatives to these soil boring requirements. As previously discussed, item D permits fewer borings if the site has uniform subsurface conditions and the Commissioner approves the change.

In developing the proposed rules, the Agency considered the need to require specific numbers of soil borings to be completed at any one site. As discussed earlier, existing guidance manuals provide little in the way of direction, although minimum numbers of borings have been specified in other states. Facility owners and their consultants are concerned with the cost associated with completing a hydrogeologic evaluation in addition to understanding the site characteristics. Therefore, they wish to minimize the number of borings completed. The Agency is concerned that sufficient detail be gathered about the site conditions to accurately depict subsurface conditions. Except in unusual circumstances, this cannot be accomplished with a handful of borings. In some cases conflict over this issue may result in halting the progress of an investigation until the number of borings can be agreed upon. It is not a useful expenditure of time or money for the consultant, facility owner or operator and Agency staff to argue over the difference in completeness and reliability of the information obtained from four soil borings versus twenty soil borings. The Agency believes it more realistic to establish minimum levels in the rules and provide for some adjustment of these numbers. Minimum levels will provide a starting point from which new information about site conditions can be used to adjust the actual number of borings completed.

The number of borings proposed in the rules is based on the Agency staff's experience with hydrogeologic investigations. The minimum level of borings compels investigations that will provide a reasonable confidence level that variations in the site's geology and hydrology will be detected. Fewer borings would reduce the probability that discontinuous lenses of sand or gravel would be detected. However, greater than 15 borings are not needed on most ten-acre sites.

The number of borings set as minimum requirements for sites of varying sizes was based on the number of borings needed to provide a density similar to that achieved at a site of ten acres with 15 borings. For larger sites, a comparable level of confidence can be obtained with a somewhat lower minimum density. This is because the larger total number of borings increases the odds of at least detecting any anomalous condition. To determine the numbers of borings in subitem (3), a density index was used. The index set the number of soil borings needed on a specific size site to achieve approximately the same spacing of borings without consideration of any specific site characteristics. Using the index formula below, an 80-acre site would require 50 soil borings to maintain a density-spacing comparable to the minimum 15 borings for ten acres. A 100-acre site would require 64 soil borings. The Agency believes these numbers for very large sites to be somewhat excessive for the majority of situations encountered in Minnesota. Therefore, adjustments were made downward. The numbers of borings used in subitem (3) result in some decrease in data density for larger sites. A greater average spacing between the initial soil borings at larger sites assures a similar level of confidence despite a somewhat lower data density.

The establishment of minimum numbers of soil borings in rule provides a reasonable approach for ensuring sufficient data points are obtained to gain an understanding of subsurface conditions without pin cushioning the site. Facility owners are provided with a starting point for estimating the work involved in a hydrogeologic investigation with no existing data available. However, evaluation of the geologic history of the site, boring logs from nearby wells and hydrogeologic maps may provide justification to deviate from these standards. The Agency provides for these adjustments in rule, rather than relying on the variance procedures established in chapter 14.

The following calculation demonstrates the method used to set the spacings between soil borings. From this formula, the minimum number of soil borings was determined based on the control spacing achieved at a ten-acre site with 15 borings completed on it.

$$S = \frac{\sqrt{A}}{\sqrt{n} - 1},$$

where

S = the density index, which is equal to the spacing between borings if the borings are evenly spaced in a perfect square;

A = area of the site, in square feet; and

n = number of borings.

The calculation is based on a square grid of borings on a square site, with borings on the perimeter and in the interior of the site. The density index, or approximate spacing between borings, for sites of various site sizes is as follows:

Size of site (in acres)	Number of borings	S (in feet)
10	15	230
20	25	233
30	30	255
40	35	269
80	45	327
120	55	356

Thus the average distance between borings is approximately the length of a city block, or a football field. The actual fill areas of most future land disposal facilities are expected to range from 10 to 40 acres. The spacings between most borings at these sites would be larger than shown in the above table because borings would be concentrated in local areas of interest, leaving the rest of the site with fewer borings. Again, the gridding above was done only to calculate an index; the actual pattern at a real site would depend on site conditions. The index is used to show that a relatively consistent spacing between soil borings is maintained at all sites, thereby assuming a comparable level of detail and reliability for all sites.

The Agency believes the numbers of borings specified in subitem (3) yield a reasonable data density that will enable interpretations that correctly anticipate ground water and pollutant movement. If the density of borings is excessive at a given facility, the Commissioner may allow fewer borings under item D.

Subitem (3) requires additional investigation, where needed, to delineate the soil and bedrock units identified in the initial drilling. This condition is the normal progression of a hydrogeologic evaluation. A hydrogeologic evaluation is conducted in phases to eliminate completion of unnecessary and expensive investigatory work. The initial drilling phase is conducted in a manner that provides the most information and maximizes the chances of detecting anomalies in the subsurface conditions. The drilling pattern is developed based on existing information. If the initial drillings have not adequately defined the thickness, extent, and properties of the soil and bedrock units, then follow-up investigation is necessary.

Subitem (3) also provides that test pits may be required for examination of the near-surface soils. This may provide a continuous view of the soil that reveals the structure, continuity and other characteristics of the soil units in a way that a few small-diameter soil samples cannot. Pits can be dug quickly using a backhoe or other readily available equipment while providing detailed information on the subsurface conditions. Finally, core samples of bedrock may be required to identify the stratigraphic position of the uppermost bedrock or to determine the water-bearing and water-transmitting properties of the bedrock. Drilling equipment is available to obtain cores and the Agency is limited under this subitem when it may require the owner or operator to incur the expense of rock coring. Rock coring may be required to define the size and orientation of fractures that could control pollution migration.

Subitem (4) requires soil borings to comply with chapter 4725 requirements for test borings done in connection with the installation of water wells. Subitem (4) requires proper sealing of borings before abandonment, so that the borings do not provide conduits for the spread of polluted ground water or poorer quality natural ground water. By referring to Minn. Rules pts. 4725.2700 to 4725.3100, subitem (4) extends the methods specified in the Well Code for sealing abandoned wells to soil borings at land disposal sites. The requirements specified in those rules are a reasonable precaution because the borings are located close to a potential source of ground water pollution. The rules include provisions to remove debris and obstructions before sealing, to use low permeability well seal materials, and to report the sealing to the Minnesota Commissioner of Health. Subitem (4) goes further than the Well Code by requiring approval by the Minnesota Department of Health to seal wells using materials other than grout, bentonite, or other impermeable material. This considers the proximity of the soil borings to a potential pollution source; it ensures prior review of exceptions while providing the flexibility to recognize that grouting might not be justified in high-permeability soils.

Subitem (5) requires soil samplers to use specified ASTM procedures or equivalent methods approved by the Agency. Reference 53. The three standards cited are widely used to obtain undisturbed samples. The methods for collecting undisturbed soil samples have been approved by the American Society for Testing Materials and are recognized by professionals as the appropriate methods for sample collection. Undisturbed samples are needed to accurately describe and classify texture, structure, and other features that influence ground water movement. Undisturbed samples also provide accurate elevations of features occurring within the sampled interval and are used to test gradations and permeability in the laboratory. They are reasonable procedures widely adopted and accepted for many different kinds of geotechnical investigations.

The subitem also contains the specification for sample intervals. Within each soil boring, soil samples must be collected at 5-foot intervals and at changes in soil type. Soil samples are needed to determine soil type, soil structure, and other subsurface conditions accurately. Soil borings may be conducted using rotary augers, but augers mix soil from different depths and destroy the soil structure. Therefore, borings must be sampled using methods capable of pulling undisturbed soil cores out of the hole. Five-foot intervals provide a reasonable vertical spacing between samples that provides sufficient detail to characterize subsurface soil conditions without impeding the investigation unnecessarily. Smaller intervals between samples would add considerable time to the investigation and are selectively employed. Provisions are included to address the situations when soil conditions appear to change. This determination is made during the boring process from cuttings and difficulty of boring.

Subitem (5) also requires that at least one boring per ten acres of proposed waste fill be continuously sampled below the elevation of the base of the fill. Continuous sampling is slower than taking a sample every five feet. It is a common practice in site investigations determining the extent of pollutant impacts on a site, and is increasingly common in evaluating proposed sites. It provides soils information that cannot be obtained with interval sampling. The continuous record ensures that thin units will not be missed. These units may influence ground water flow by acting as either barriers or conduits. Also under subitem (5), the Commissioner shall require more of these continuously sampled holes or other procedures if needed to determine detailed stratigraphy (i.e., the sequence, thicknesses and description of the soil or bedrock units). The Commissioner is required by this provision to justify any additional borings completed for continuous sampling. This condition is required only if necessary; thus, preventing any unnecessary work by the facility owner.

Last, subitem (5) requires samples to be preserved and transported in accordance with another widely used ASTM industry standard. Reference 53. It requires protective shipping containers and other reasonable means to prevent damage, drying, cracking, and other disturbance that might preclude accurate description and testing.

Subitem (6) requires that the soils and bedrock be described and classified using laboratory information, field observations and any geophysical logs. Field observations are needed because drilling conditions and other observations assist in interpretations of soil types, contacts between soils, and ground water occurrence. Geophysical logs are valuable in identifying thin units and defining the scale of these units and the accurate elevations of contacts between units. No specific classification method is specified because the relative merits of the widely-used Unified Soil Classification System (ASTM Standard D 2487) and the U.S. Department of Agriculture soil classification and other alternatives are not settled. Instead, subitem (6) requires soils descriptions to include properties that may affect the correlation of soil units from one location to the next, or may influence pollutant movement. Examples of these properties are soil texture (particle size distribution and related properties), primary structure (i.e., deposition or other features associated with soil formation), secondary structure (e.g., fractures), and voids (empty holes). Each of these properties may influence water and pollutant movement. Last, subitem (6) requires description and classification of rock cores or samples using accepted geologic classification systems and nomenclature. Since there is no universally-used classification system, this provision makes sure the facility owner or operator uses a system that is widely acceptable.

Subitem (7) requires that, based on the descriptions and testing required in subitems (6), (8) and (9), the soils and bedrock be classified and correlated over the site. This correlation of soil samples among many borings establishes the lateral extent and variability of individual soil units. Again, the occurrence and configuration of high- and low-permeability units are important because they are the main determinants of ground water flow patterns.

Subitems (8) and (9) require laboratory and field (in situ) testing of soils, respectively. Each test is needed to verify the results of the other. Separate tests identify conditions that might cause a difference in results. Subitem (8) requires laboratory testing of a series of soil samples taken from different borings and elevations within each soil unit identified on the site. This distribution of samples helps ensure that the samples tested accurately represent the variability within soil units, both laterally and vertically. Subitem (8) requires development of a specific procedure and supporting rationale to select test samples that are either representative of the unit or are from key or critically-located points within the unit. This allows flexibility to respond to conditions encountered at each site.

The laboratory testing and field testing must determine the water-bearing and water-transmitting properties of the soil units. As was stated under subitem (7), these are the key physical properties of soils that control the rates and directions of ground water and pollutant movement. Specific properties are required as appropriate for each site. The properties include particle size distribution, porosity, vertical permeability, and clay mineral content or cation exchange capacity. Any or all of these conditions may be important for a given combination of site, facility design, and leachate composition. They will be required only where important. The test for particle size distribution is a common ASTM procedure and is a predictor of permeability, porosity, and capacity to adsorb or absorb pollutants. Porosity, the percentage of pore volume between soil particles, is easy to measure by comparing wet and dry weights of a soil sample. It represents the volume of space available for ground water and pollutant movement and is important in calculating pollutant migration rates.

The test for vertical permeability measures the soil's or rock's ability to allow vertical ground water flow, which is often much different from horizontal permeability, or the bulk permeability measured by some in situ test methods. The term permeability can be confusing. As defined in part 7035.0300, permeability is synonymous with the term hydraulic conductivity as used in the hydrogeologic literature, or coefficient of permeability as used in the engineering literature, rather than the term intrinsic permeability used in hydrogeologic literature. Vertical permeability often is lower than horizontal permeability. It can be more than 100 times lower in compacted clay-rich soils or shales. Vertical permeability can also be greater than horizontal permeability due to fracturing. The directions of ground water flow depend on the sequence of horizontal and vertical permeabilities encountered. Low vertical permeabilities will tend to drive ground water laterally, while higher vertical permeabilities will decrease lateral flow. Knowledge of the distribution of horizontal and vertical permeability is essential to accurate prediction of ground water movement.

Testing for clay mineral content may be appropriate under some circumstances. Some of the common clay minerals have the ability to adsorb or attenuate heavy metals and might need to be tested if the soils' attenuative capacity or the leachate's metals content are issues. Another potentially important aspect of clay mineral behavior is the tendency of some clays to shrink, swell, crack, and increase in permeability when attacked by concentrated synthetic organic liquids. The test for cation exchange capacity measures the soil's ability to exchange ions in the water for ions held in the mineral structure. It is another test that may be appropriate if the soil's ability to attenuate pollutants is at issue.

Subitem (8) prohibits combining soil samples into composite samples for classification or testing. Because composites are much less representative of actual soils content, structure, and permeability, classification and testing of composites will not provide an accurate picture of the soil in an undisturbed state. Samples used to test permeability must not be compacted because compaction will dramatically lower permeability. This provision is reasonable because the intent is to obtain an accurate picture of existing site conditions. This is best achieved using uncompacted samples. Disturbance to samples must be minimized because cracking, crushing, mixing, or otherwise disturbing samples can impede identification of important features and preclude accurate testing. Testing and quality assurance must conform with methods approved by the ASTM or other standard methods. These testing industry standards provide confidence in the reliability of the results.

Subitem (9) requires a program to determine in-place permeabilities.

Laboratory testing provides permeability results that may be unrepresentative of in-place conditions. The discrepancy may be because the small sample cannot accurately simulate the varying permeabilities surrounding the actual sample site, as can be done with in-place testing. Test results from the laboratory sample may be reasonably accurate for the soil sample, but the actual setting may contain fractures or higher-permeability zones not represented in the small sample. The discrepancy may also result from disturbance of the soil structure, compaction in laboratory samples, or testing conditions that cannot simulate real-world flow paths and rates. Conversely, field testing can have its problems under a variety of specific conditions. The combination of the two methods is the common practice. It assures confidence in the permeability values.

It is important to formulate criteria for the placement of test wells or piezometers. Subitem (9) requires placement criteria to ensure testing sites are representative, targeted, or otherwise positioned with a guiding rationale. Test locations must be at or adjacent to logged borings to guide the positioning of test equipment and to enable cross-checking and interpretation of the results. Finally, test locations must be well-distributed to characterize the variation in the permeabilities of soil or bedrock units. As discussed above regarding subitem (8), the distribution of permeabilities controls ground water flow directions and rates. The design of monitoring and corrective actions depends on knowledge of ground water flow.

This dependence on knowledge of ground water flow also demonstrates the need for and reasonableness of subitem (10). Subitem (10) requires that ground water flow conditions must be defined in detail within the zone evaluated according to the provisions of item C. If flow conditions are not defined in detail within this zone, the monitoring system could be rendered ineffective due to flow around, under, or above the monitoring points. A series of piezometers must be installed to map the location of the water level (hydraulic head) within this zone. Piezometers are observation wells tapping a specific section of the ground water found beneath the site. The water levels in these wells provide a direct measure of hydraulic head. Hydraulic head is the driving force behind ground water movement as it represents the pressure exerted on the water. Piezometers have been a standard tool of ground water investigations and geotechnical investigations for construction sites for many years. Direct water level measurement is essential for predicting flow directions. Commentors have suggested that it would save steps and money to bypass piezometer installation and install only monitoring wells. However, in most cases, insufficient understanding about flow conditions exists. This causes many wells to be placed incorrectly. Monitoring wells do not represent the hydraulic head in the surrounding soils as correctly as piezometers because of construction differences Piezometers can be constructed quickly at a lower cost and with fewer precautions because they are not intended to be sampling points. Piezometer installation is a standard practice that ensures more reliable results used to make informed decisions in designing the monitoring system.

Subitem (10) further requires determination of the range of fluctuation in hydraulic head from historical records and on-site measurements, or approved alternative methods. Water levels can rise and fall many feet over time. Reference 54. This can be important even if heads change synchronously throughout the ground water system. It is especially important at sites where seasonal recharge localized below topographic depressions causes flow to change directions entirely. Reference 55. Knowledge of high water levels can also be important to facility design to ensure that the facility is not constructed so that it intersects the water table during periods of high ground water. Lastly, the effects of pumping from high-capacity wells must be evaluated because pumpage can change in water levels, ground water flow, and rates of ground water recharge.

Subitem (11) requires the facility owner or operator to submit logs of all soil and bedrock borings to the Commissioner. This condition is reasonable because it makes needed information available to the Agency for immediate and future review. The requirement does not duplicate any other agency's review.

Subitem (11) requires that logs must contain the information generated in the investigation and a scale drawing of the soil types encountered. The drawing and most of the information required are standard practice. Inclusion of laboratory test results and field observations on the logs is standard practice for many consultants. This information must be assembled with the logs so that it can be understood and compared with the corresponding stratigraphic sequence.

Information required on the logs includes the date of the boring and name and address of the driller and testing firm. This information ensures the ability to check records when the need arises. It can also be useful to check other information, such as the firms' qualifications and weather conditions on the day of drilling. Drilling and sampling methods are needed to understand the degree and nature of disturbance to samples, the sensitivity of the drilling equipment to changes in drilling conditions, other field observations, and the constraints on obtaining samples.

Surveyed elevation of the ground surface above mean sea level is important for constructing cross-sections, correlating soils between borings, and correlating soils to subsequent design drawings. Using the mean sea level enables correlations to be made with topographic maps and survey information from surrounding areas. It is common practice to use the mean sea level elevations because permanent benchmarks established by the U.S. Geological Survey and other agencies are related to sea level and are widely distributed throughout Minnesota. The use of permanent benchmarks adds or confirms previous survey results at any time without resurveying. The use of permanent benchmarks as reference points and maintaining consistency in elevation data provides a common data base for site evaluations and makes the review of data accuracy easier.

The need for and reasonableness of the remaining information required in subpart (11) has already been discussed under subitems (3) to (8), except for blow counts. Blow count is the number of hammer drops required to drive the soil sampler under the ASTM standard D1586 required in subpart 5. It is a measure of soil density and compaction which is recorded as part of the D1586 procedure. This information provides a measure of the strength of the foundation in the parts of the site where construction will occur. It is also useful in interpreting and correlating soils information.

Subitem (12) requires that the inventory of wells surrounding the site must be field-checked and updated to include all wells within the distances prescribed in item E, subitem (5). Owners of structures and facilities that have wells must be contacted directly. The need for the inventory has been established in the discussion of item E, subitem (5). Direct contacts with owners are essential because collections of well logs available through State and local agencies and drillers are not complete. For instance, the Minnesota Geological Survey has logs for about 100,000 wells. There are many times more active and abandoned wells in Minnesota. Property owners are often the only persons who know anything about the well depth or construction, and the only ones aware of the existence of old, inactive, or abandoned wells on their property. Often this information dies with the property owner. For this reason, and because direct contacts with property owners are the only way to obtain the needed information about soils, water levels, water use, and potential pollutant migration paths along the wells, direct contact with property owners of wells within the prescribed area is required here.

Item G specifies the required minimum contents of the report for the detailed investigation phase of the hydrogeologic evaluation. It should be remembered that the report is subject to possible change from the specified contents under item D. Listing the required contents will ensure completeness. Furthermore, requiring that the listed information be assembled in the report, even if well logs or other data have been previously submitted, ensures availability of all data needed to support the report's conclusions and interpretations.

Subitem (1) requires the logs of soil borings, piezometers, and any monitoring wells installed. This information is justified in the discussions of item F, subitem (11) above, and subpart 10, items O to Q.

Subitem (2) requires descriptions of the soil and bedrock units and of the properties that may influence water movement. The need for and reasonableness of this information has been established throughout the discussion of subpart 3 and under item F above. The first data specifically required, soil texture and classification (unit (a)) are standard summary descriptors. Particle size distributions (unit (b)) may be required under item F, subitem (8) above; the need and reasonableness are given in the discussion of that provision. Mineral composition (unit (c)) may be needed and reasonable as a measure of potential attenuation of pollutants; the further need for information about clay mineral composition is also given under item F, subitem (8). Cementation is the welding together of particles by chemical precipitates, as in well-cemented (or consolidated) sandstones. If present, this cement may appreciably reduce the pore space available for ground water and pollutant movement, reduce permeability, and affect the bedrock or soil's adsorption and attenuation characteristics. Soil structure has been described under item F, subitem (6) and is an important determinant of soil permeability and the channeling of infiltrating water through the soil.

Unit (d), geologic structure, is important because of the influence or control it may have over ground water flow. Strike and dip are measures of the direction and degree of inclination of nonhorizontal units. Folding can occur on a variety of scales and can indicate the likelihood that related structures may be present, such as jointing or faulting. These latter structures represent breaks in the soil or rock that may serve as conduits for rapid ground water movement even in settings composed of otherwise low permeability soil or rock materials. There may be no geologic structure observed at many sites in Minnesota where bedrock is too deep to be of interest.

The need for and reasonableness of the requirement in unit (e) for information on permeability has been established under item F, subitems (7) to (9); and for vertical permeability and porosity, under item F, subitem (8). Unit (f) requires the definition of heterogeneity or variations from uniformity within units and within the subsurface. These features can have controlling influence in diverting, redirecting, channeling, or blocking ground water flow. The importance of defining these features has also been discussed under unit (d) above, and under item F, subitem (1).

Subitem (3) requires one or more geologic columns. Need and reasonabless have been established under item E, subitem (3). The requirement is repeated in the detailed investigation report for completeness and ready reference.

Information developed under the detailed investigation may indicate the need to revise the geologic column to better reflect the sequences and thicknesses of units observed.

Subitem (4) requires descriptions and thicknesses of the hydrologic units within the saturated zone. This information defines and interprets ground water flow patterns. Delineation of major units is important in planning monitoring systems and corrective actions, and in interpreting differences in water quality between units. Requiring information on hydraulic properties has been discussed under item E, subitem (2) and item F, subitems (8) to (10). The role and importance of soil or bedrock units as aquifers, aquitards, or perched saturated zones has been discussed under item C, subitem (4). Information on actual or potential use of aquifers as water supplies is needed to protect these aquifers and uses. Current or planned use of the aquifers adds an immediate public health and welfare dimension to the usual concerns about ground water protection.

Subitem (5) requires plan-view maps and a series of cross-sections. They make large quantities of logs and other raw data understandable, and show the correlations that connect soils identified in various borings into continuous units. A spacing no greater than 500 feet between cross-sections is specified. This provision depicts the continuity or variability of soils units and ensures that correlations of units are not made over long distances. The total number of cross-sections that will result is not excessive and may need to be increased in some cases. For a 40-acre area measuring a quarter mile square, three cross-sections are needed in each perpendicular direction, for a total of six. The minimum number of cross-sections rises to twelve, six in each direction, for a 160-acre area (one-half mile square). For a larger site with uniform conditions, the required number of cross-sections might become too great. Changes can then be requested under item D. The required orientation of cross-sections parallel and perpendicular to the directions of ground water flow has been established under item E, subitem (4) above.

The maps and cross-sections required in subitem (5) must show, in addition to the soil and bedrock units, the water table and measured values of hydraulic head. This information assists the analyst to visually organize the data on which ground water flow interpretations are based. The information also is used to make comparisons of water levels within and between geologic units. Ground water moves from areas of higher hydraulic head to lower hydraulic head. Data describing water levels that decrease from left to right and downward instantly indicate that ground water flow will reflect some combination of left-to-right and downward movement. The actual inclination of the descending flow will depend on the difference between the horizontal and vertical permeabilities.

In the same way that a topographic map showing contours of equal elevation is more useable than a map showing only points and their corresponding elevations, hydraulic head data on maps and cross-sections is more useable when the map shows contours. Lines of equal head are called equipotentials. Equipotential lines show that ground water flow is across the direction of the equipotential. The requirement to depict equipotentials is a standard practice because knowledge of ground water flow directions helps establish adequate monitoring systems. Ground water flow may actually be perpendicular to the equipotentials where permeability is the same in all directions. In these cases, streamlines showing the path of ground water flow can be drawn perpendicular to the equipotentials to reveal flow directions. If a unit has different values for horizontal and vertical permeability, the unit can be mathematically transformed to enable construction of streamlines. At sites where the complexity of the conditions makes machine computation or computer modeling necessary to generate flow directions, knowledge of ground water flow directions is essential to facility design and ground water monitoring.

Subitem (5) further requires that maps and cross-sections show soil or bedrock borings, locations and construction of piezometers and monitoring points, and locations of any geophysical measurements used to prepare the cross-sections. The required information shows how well the data support the interpretations, such as the soils correlations, equipotentials and streamlines. The information also describes the positions within the soils or bedrock units and overall flowfield of piezometers and monitoring wells. Beyond this, the plan map depicting these data points serves as an index, so that boring logs and other data in the report can be quickly related to their location on the site.

Subitem (6) requires a description and evaluation of the ground water flow system. The significance for ground water flow and pollutant migration must be discussed. Unit (a) asks for a discussion of local, intermediate and regional flow systems. This division of flow systems was conceptualized nearly 25 years ago by Toth and has been reflected in the hydrogeologic literature since that time. References 56 and 57. In local flow systems, ground water flows from its infiltration area to a directly adjacent discharge area (stream, lake or wetland). Intermediate flow systems bypass one or more local discharges before emerging at a somewhat more distant location. In regional ground water flow, ground water takes a deeper route, passes under the overlying local discharge areas, and exits to major discharge rivers and streams that may be miles away from its source. One or more of the flow systems may be absent in some settings. The importance of describing these systems is based on the potential for polluted ground water to divide into distinct flow systems and may travel in very different directions. If the local flow system is readily identified and mistakenly assumed to be the only flow system, the more far-reaching path of pollutant migration may be missed entirely. Therefore, all flow systems beneath the site must be addressed.

Under unit (b), recharge and discharge areas must be described and evaluated with ground water-surface water interactions and the facility's effect on recharge rates. As previously discussed under item E, subitem (2), these provisions are needed to assess where ground water may be most vulnerable (areas of focused recharge) and where impacts on land and surface water may occur in discharge areas. It is important to know whether surface waters serve as discharge zones or are supplying water to the ground water system and influencing ground water flow paths. Finally, the facility itself can affect ground water flow paths. Unlined and poorly covered facilities often change the ground water flow system altogether by allowing increased rainwater infiltration and recharge, or by covering discharge areas. These conditions can lead to the formation of ground water mounds beneath or extending into the fill areas. In contrast, state-of-the-art lined and capped facilities could reduce net recharge, which would lower the water table and perhaps induce significant changes in ground water flow patterns or rates. The potential for such effects must be considered.

Under unit (c), the report must evaluate existing or proposed ground water and surface water withdrawals. The influence of ground water withdrawals on ground water flow is highly dependent on the amount withdrawn, the aquifer source, and the proximity of the withdrawal source to the site. Surface water withdrawals generally induce increased ground water discharge. This could increase the ground water flow rate, pollutant migration rates, and impacts on surface water quality. Water appropriations are regulated by the Minnesota Department of Natural Resources under Minn. Rules ch. 6115, which can provide information on locations and withdrawal rates for large appropriations. Because withdrawals may have localized and more regional impacts on pollutant migration, these withdrawal rates must be considered in the report.

Under unit (d), the report must evaluate the effect of heterogeneity, fractures, or directional differences in permeability on ground water movement. The influence of heterogeneity and fractures on ground water flow has been demonstrated in the discussions of item F, subitems (1) and (2), and item G, subitem (2), unit (f). The importance of permeability under item F, subitems (7) to (9), and item G, subitem (2), unit (e) and subitem (5) is also reflected in this evaluation. The evaluation will not always be easy or straightforward, but it is a reasonable requirement because of the importance of the information. The importance of this information warrants the effort of using available field tests, computer analysis, and other simpler desktop analyses to evaluate these conditions.

Unit (e) requires discussion of directions of ground water movement including vertical components of flow, specific discharge rates, and average linear velocities within the hydrologic units identified. Descending ground water may bypass monitoring points and corrective action installations by dropping below them, as has been discussed under item F, subitem (1). The other two quantities listed are measures of ground water flow rates. The specific discharge is a measure of the volume of water that moves past a point in a given time period. The average linear velocity of ground water and the rate at which dissolved pollutants travel is faster than the flow rate given by the commonly calculated specific discharge. Both quantities are readily calculated. They are measures of ground water and pollutant migration and are important in determining routes of exposure from a land disposal facility.

Unit (f) requires evaluation of seasonal or other temporal fluctuations in potentiometric head, for which need and reasonableness have been demonstrated under item F, subitem (10).

Subitem (7) requires an analysis of potential impacts on ground water and surface water quality and on water users in the event of a release from the facility. The potential environmental and public health impacts should be identified in advance of permitting in order to be reflected in facility design, monitoring and contingency action plans. The analysis must include both water-soluble and low-solubility components of leachate. For example, leachate contains organic compounds that do not dissolve readily in water. The lighter-weight compounds separate out to form the film often observed floating on seeping leachate. Low-density insoluble components will accumulate at or near the water table. Heavy insoluble components tend to separate from the ground water flow field and descend until they are stopped by the first clay, bedrock, or other barrier. The pooled accumulations of denser organics may warrant special monitoring, especially if this interface is tapped by downgradient water supply wells. The analysis may not provide a definitive answer as to where insoluble components will go, but it can outline and evaluate the possibilities and determine the need for monitoring at these locations. These possible flow paths should be determined as early as possible so consideration can be given to the monitoring needs.

Subitem (8) requires that where mathematical or analog models are used to simulate ground water flow or contaminant migration, the report must thoroughly describe the model, its capabilities, limitations, and assumptions and approximations. All models have limitations and simplifying assumptions. The assumptions affect the accuracy and reliability of the results. If the uncertainties are left unstated, it is difficult to understand the quantities that are derived results from a model, subject to inaccuracies, and the quantities verified by input data. Thus subitem (8) requires identification of quantities or values derived from the model and not confirmed by direct measurement, and evaluation of the reliability and accuracy of the results.

Item H contains requirements for the work plan and report for the third phase of the hydrogeologic evaluation. This phase includes the design and installation of the water monitoring system. The third phase is based on the information about hydrogeologic conditions obtained in the preliminary and detailed site investigations. The reasoning for developing this information before installing the monitoring system has been discussed under item B and item F, subitem (9) above. The monitoring system design requirements are given in subpart 10.

Subitem (1) specifies the required contents of the work plan for this phase. Under unit (a), the work plan must include a description of the proposed monitoring system and individual monitoring points. The required descriptions are needed to evaluate the technical soundness of the monitoring system and individual monitoring points. Any necessary changes are much cheaper and easier for the facility owner or operator to make before installation. It is recognized that there will be good reason for minor changes during the installation. The Agency will expect some modification of the work plan during the installation. The work plan must evaluate the suitability of any existing monitoring points proposed for inclusion in the monitoring system. Deficiencies in their compliance with subpart 10 must be noted. This condition ensures that old monitoring wells were adequately constructed, maintained, and logged and will provide representative samples from known positions within the ground water flow system. The evaluation will normally consist of visual inspection, examination of well logs, and in some cases downhole video camera inspection and caliper or geophysical logging. Wells that meet the requirements of subpart 10 may be deemed adequate.

Under unit (b), the work plan must explain how the proposed monitoring system addresses the hydrogeologic conditions identified in the previous investigations. This provision is needed to ensure that the monitoring points have been located and vertically positioned to reflect specific site conditions controlling ground water and pollutant movement. It has been the Agency's experience that monitoring wells are often placed with no plan other than to monitor a few randomly chosen downgradient and upgradient locations. The unit (b) requirement remedies the lack of planning in such situations.

Unit (c) requires a preliminary version of the monitoring protocol required under subpart 14. The monitoring protocol documents the procedures for sampling and laboratory analysis. The preliminary protocol is needed before the monitoring system is constructed to ensure that it will be feasible and practical to sample the wells, and that the well construction materials selected will yield representative samples. As will be discussed under subparts 10 and 14, these are important considerations, since sampling can be very time-consuming if large volumes of water must be removed before drawing the sample. Some well construction materials may not be suitable for sampling certain classes of pollutants. For instance, solvent welded plastic pipe may be an inappropriate well material if organic pollutants are of concern.

Subitem (2) specifies the required contents of the monitoring system report. Unit (a) requires the report to contain the monitoring point construction and installation records required under subpart 10. These records include the well logs, information on well development, other testing, and a plan map showing the location of the monitoring points. This provision is needed because the information is pertinent to the adequacy of the monitoring system. This information should be assembled so that there is one document that can be referred to for any questions on the monitoring system.

Unit (b) requires a description of any changes from the locations, design, and installation procedures identified in the work plan. These changes may not have been reviewed or approved. It should be made clear to future users of the information what was actually done.

Unit (c) requires an evaluation of any differences from previously reported soils and bedrock conditions, water levels, or ground water flow conditions. This provision ensures that the data from well logs and testing is compared with the previous interpretations, and that any inconsistencies are explained and their importance evaluated.

Item I contains requirements for the fourth phase of the hydrogeologic evaluation, water quality sampling. Background sampling and analysis is the key to evaluating future results for impacts. This is the first step in determining the facility's impact on the ground water and surface water. This initial sampling indicates impacts an existing facility is having on the local environment. At a new facility, it provides a record of the background water quality that can be compared with future water quality data to identify any changes that may be due to the facility. The information on water quality is a further check on the validity of the interpretations made in the hydrogeologic evaluation, and it may reveal inadequacies in monitoring point construction. Specific requirements for sampling, analysis, and reporting are given in subpart 14.

Subitem (1) contains requirements for the work plan. The proposed monitoring protocol ensures advance planning of the sampling and analytical procedures. Advance planning is necessary for selecting and obtaining suitable equipment to conduct the work. The proposed sampling plan will allow the Agency to view the sampling procedures for adequacy and arrange to split samples as a cross-check on the analytical results obtained. The dates included in the plan indicate how many rounds of initial samples will be conducted, the time interval between sampling, and the timing of the sampling relative to the seasons. The inclusion of proposed analytical constituents and measurements in the work plan is reasonable and necessary to provide the Agency an opportunity for review. The Agency will verify that the proposed testing provides adequate information to determine the monitoring requirements for the facility's operation, and to make recommendations to assist the facility owner or operator in the sampling and analysis. Finally, the work plan must contain the methods of data analysis and interpretation. This provision ensures that the sampling frequencies, analytical testing, and other proposed procedures are designed to provide the information needed for verifying hydrogeologic interpretations made about subsurface conditions.

Subitem (2) specifies requirements for the report on the water quality monitoring phase. In addition to the monitoring data, the report must contain the quality assurance data. Quality assurance is described further under subpart 14. The requirement for quality assurance data is needed because this data serves as the means of evaluating the accuracy and reliability of the monitoring data. Secondly, the report must analyze the trends in the water quality results. The analysis of trends is needed to determine whether the facility or other causes unrelated to the facility may have a long-term adverse impact on water quality. Finally, the report must identify constituents that exceed ground water performance standards or surface water quality standards. This provision is needed to identify possible adverse impacts on water quality and noncompliance with required water quality standards, and to determine the suitability of an existing facility to continue operation.

Subpart 4. Ground water performance standards. The discussion of this subpart describes the Agency's statutory authority to establish ground water quality standards, federal regulation of ground water quality, existing state rules governing ground water quality, and the need for and reasonableness of the proposed ground water performance standards for mixed municipal solid waste land disposal facilities.

The Agency's general powers and duties include the authority to establish pollution standards for any waters of the State:

> The agency is hereby given and charged with the following powers and duties: . . . .

> (c) To establish and alter such reasonable pollution standards for any waters of the state in relation to the public use to which they are or may be put as it shall deem necessary . . . .

Minn. Stat. § 115.03, subd. 1 (1986).

The main statutory direction regarding water quality standards is given in Minn. Stat. § 115.44 (1986), Classification of Waters; Standards of Quality and Purity, which pertains to both surface and ground waters:

> Subd. 2. In order to attain the objectives of Laws 1963, chapter 874, the agency after proper study, and after conducting public hearing upon due notice, shall, as soon as practicable, group the designated waters of the state into classes, and adopt classifications and standards of purity and quality therefor. Such classification shall be made in accordance with considerations of best usage in the interest of the public and with regard to the considerations mentioned in subdivision 3 hereof.
>
> Subd. 3. In adopting the classification of waters and the standards of purity and quality above mentioned, the agency shall give consideration to: . . . .
> (c) The uses which have been made, are being made, or may be made of said waters for transportation, domestic and industrial consumption, bathing, fishing and fish culture, fire prevention, the disposal of sewage, industrial wastes and other wastes or other uses within this state, ...
> (d) The extent of present defilement or fouling of said waters which has already occurred or resulted from past discharges therein; . . . .
> (f) Such other considerations as the agency deems proper.

Minn. Stat. § 115.44, subds. 1,2 and 3 (1986).

Additional statutory authorities which relate specifically to solid waste do not further define the objectives of ground water quality standards. The Agency is directed to adopt standards for the control of solid waste disposal "for the prevention and abatement of water, air and land pollution." Minn. Stat. § 116.07, subd. 2 (1986). Similarly, the Agency is empowered to adopt rules and standards for the "disposal of solid waste and the prevention, abatement, or control of water, air, and land pollution which may be related thereto." Minn. Stat. § 116.07, subd. 4 (1986).

Two other statutes are also relevant. The Environmental Policy Act charges all state agencies and departments to act "as trustee of the environment for succeeding generations." Minn. Stat. § 116D.02, subd. 2(a) (1986). Moreover, the 1986 amendments to the Waste Management Act of 1980 added to Chapter 115 a strong statement of the State's potable water protection policy regarding hazardous and radioactive waste. While not aimed directly at solid waste disposal, this language is the most specific and most recent articulation of the Legislature's findings regarding the need to protect ground water and other potable water.

> The legislature finds that:
> (1) the waters of the state, because of their abundant quantity and high natural quality, constitute a unique natural resource of immeasurable value which must be protected and conserved for the benefit of the health, safety, welfare, and economic well-being of present and future generations of the people of the state; [and]
> (2) the actual or potential use of the waters of the state for potable water supply is the highest priority use of that water and deserves maximum protection by the state . . . .

Minn. Stat. § 115.063 (1986).

The language in this statute indicates the value the Legislature places on actual or potential sources of potable water. Ground water is by far the most abundant potable water supply, and it must be protected.

In general, the federal government's authority to regulate ground water is fragmented and limited. However, more specific authority exists with respect to ground water at waste disposal facilities.

Nearly all the federal authority under the Clean Water Act, including the authority to establish water quality standards, is limited to "navigable waters," i.e., surface waters. 33 U.S.C. §§ 1251 et seq. Under the Safe Drinking Water Act (SDWA), the EPA administers regulations to protect water supplies, regardless of the source of the water. 42 U.S.C. §§ 300f et seq. Among these are the National Primary Drinking Water Regulations, which establish maximum contaminant levels in public water systems that exceed a given size and usage rate. 40 CFR part 141. The maximum contaminant levels, commonly referred to as primary drinking water standards, do not apply directly to the untreated ground water or surface water supplying the system, but rather to the finished drinking water delivered to the consumer after any treatment. Standards for individual contaminants are developed by considering potential health effects and the feasibility of detecting and treating the contaminant to safe levels using best available technologies. As an intermediate step in developing standards, a health effects limit or maximum contaminant level goal is determined. This health-based limit is used in the proposed rule to establish ground water quality standards.

The federal authority with respect to ground water at mixed municipal solid waste land disposal facilities is more specific. The 1984 Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act (RCRA) strengthened federal authority over state regulation of ground water quality at land disposal facilities. 42 U.S.C. §§ 6901 et seq. The amendments require that, by November 1987, states adopt and implement a permit program or other system of prior approval to ensure that land disposal facilities accepting household hazardous waste or small quantity generator waste comply with the open dump criteria of Subtitle D of RCRA. Section 4005(c) of RCRA, codified as 42 U.S.C. 6945(c). This requirement is directed at mixed municipal solid waste land disposal facilities, since they are the facilities that accept this waste. Under RCRA, the open dump criteria "shall provide that a facility may be classified as a sanitary landfill and not an open dump only if there is no reasonable probability of adverse effects on health or the environment from disposal of solid waste at such facility." RCRA, section 4004(a), codified as 42 U.S.C. § 6944(a).

The open dump criteria with which land disposal facilities and state regulatory programs must comply are given in 40 CFR part 257 (1986). Reference 47. One of these criteria, entitled "Ground water," requires that:

> (a) A facility or practice shall not contaminate an underground drinking water source beyond the solid waste boundary or beyond an alternative boundary . . . .

40 CFR § 257.3-4 (1986).

The Agency proposes that the compliance boundary, where compliance with the ground water standards is measured, be located at or beyond the solid waste fill limits. Thus it is important to examine the conditions under which the federal criteria allow the use of the "alternative boundary:"

> (b)(2) . . . [T]he State may establish an alternative boundary for a facility to be used in lieu of the solid waste boundary only if it finds that such a change would not result in the contamination of ground water which may be needed or used for human consumption. Such a finding shall be based on an analysis and consideration of all of the factors identified in paragraph (b)(1) of this section that are relevant.

40 CFR § 257.3-4 (1986).

Contamination as used above means to exceed the maximum contaminant levels given in Appendix I of part 257 or background concentrations, whichever are higher. Appendix I maximum contaminant levels are taken from the National Primary Drinking Water Regulations, and are essentially the same limits for the same substances listed in those regulations. The proposed Minnesota solid waste rules use ground water quality standards that are more restrictive than these levels, but the proposed standards are applied at an alternate boundary. The factors that must be analyzed and considered in establishing an alternative boundary rather than the solid waste boundary are as follows:

> (i) The hydrogeological characteristics of the facility and surrounding land, including any natural attenuation and dilution characteristics of the aquifer;
> (ii) The volume and physical and chemical characteristics of the leachate;
> (iii) The quantity, quality, and direction of flow of ground water underlying the facility;
> (iv) The proximity and withdrawal rates of ground-water users;
> (v) The availability of alternative drinking water supplies;
> (vi) The existing quality of the ground water, including other sources of contamination and their cumulative impacts on the ground water;
> (vii) Public health, safety, and welfare effects.

40 CFR § 257.3-4 (b)(1) (1986).

These criteria are incorporated into the proposed solid waste rules, as will also be discussed below.

In summary, even with the limited federal authority over ground water quality in general, federal law does establish minimum ground water protection requirements for state regulatory programs governing mixed municipal solid waste land disposal facilities.

Pursuant to the authorities under Minn. Stat. §§ 115.03 and 115.44, the Agency developed rules for the classification of waters of the State and water quality standards for these waters. The large range of variability in surface water quality was reflected in the many classes and corresponding standards established in the rules. Minn. Rules ch. 7050 (1987).

The characteristics of Minnesota's ground water indicated that a different approach was needed for ground water quality regulation. First, ground water quality in Minnesota generally is of a much higher, more uniform quality than surface water. Because of its high quality and widespread accessibility, ground water has been extensively used for many purposes, including drinking water. In most areas of the State, ground water quality is suitable for use as a drinking water supply with minimal or no treatment. If contaminants are present at all, their concentrations generally are low in comparison to federal drinking water standards for protection of human health. As a result, ground water has become the source of water supply for approximately 75 percent of the State's population. Total ground water usage is increasing in Minnesota and nationwide.

This vital resource is quite vulnerable. Ground water quality is protected from most naturally-occurring contaminants by various removal mechanisms, such as adsorption of contaminants by soil materials and biological transformations. These natural mechanisms are easily overwhelmed by many human activities, however, and many contaminants are not effectively removed by natural processes. Many contaminants, particularly various manmade organic chemicals, pose a risk to human health at extremely low concentrations, if consumed. The health risk criteria can be exceeded even when small quantities of contaminants are released to the environment. Most importantly, the slow rate at which ground water moves means that, once polluted, ground water may remain polluted for many years. Ground water pollution often is essentially permanent unless expensive, long-term cleanup is undertaken.

Because of the high risk and resultant cost involved with ground water pollution, Minnesota and many other states have adopted a highly protective nondegradation policy for ground water. These policies have as their aim the preservation of ground water quality as nearly as possible in its natural state. Minnesota's nondegradation policy is contained in the main State rule governing ground water quality, adopted in 1973. Minn. Rules ch. 7060 (1987). <u>See</u> Exhibit XX. Important provisions of chapter 7060 include:

> 7060.0100 Purpose.
> It is the purpose of this chapter to preserve and protect the underground waters of the state by preventing any new pollution and abating existing pollution.
>
> 7060.0200 Policy.
> It is the policy of the agency to consider the actual or potential use of the underground waters for potable water supply as constituting the highest priority use and as such to provide maximum protection to all underground waters. The ready availability nearly statewide of underground water constitutes a natural resource of immeasurable value which must be protected as nearly as possible in its natural condition. For the conservation of underground water supplies for present and future generations and prevention of possible health hazards, it is necessary and proper that the agency

employ a nondegradation policy to prevent pollution of the underground waters of the state.

. . . .

7060.0400 Uses of underground waters.

The waters of the state are classified according to their highest priority use, which for underground waters of suitable natural quality is their use now or in the future as a source of drinking, culinary, or food processing water. . . . This classification is established to protect the underground waters as potable water supplies by preventing and abating pollution. In making this classification, the agency recognizes that the underground waters of the state are contained in a series of related and often interconnected aquifers, such that if sewage, industrial waste, other waste, or other pollutants enter the underground water system, they may spread both vertically and horizontally. Thus, all underground waters are best classified for use as potable water supply in order to preserve high quality waters by minimizing spreading of pollutants, by prohibiting further discharges of wastes thereto, and to maximize the possibility of rehabilitating degraded waters for their priority use.

. . . .

7060.0500 Nondegradation policy.

It is the policy of the agency that the disposal of sewage, industrial waste, and other wastes shall be controlled as may be necessary to ensure that to the maximum practicable extent the underground waters of the state are maintained at their natural quality unless a determination is made by the agency that a change is justifiable by reason of necessary economic or social development and will not preclude appropriate beneficial present and future uses of the waters.

Minn. Rules pts. 7060.0100, 7060.0200, 7060.0400, and 7060.0500 (1986).

Chapter 7060 also contains prohibitions against waste discharge directly into the saturated zone, or into the unsaturated zone or in any other place, manner, or quantity, that might "actually or potentially" pollute or preclude use of the ground water as a potable water supply. Minn. Rules pt. 7060.0600, subp. 2 (1987). Treatment, safeguards, or other control measures must be provided for any such discharges that have occurred, "to the extent necessary to ensure that the same will not constitute or continue to be a source of pollution of the underground waters or impair the natural quality thereof." Minn. Rules pt. 7060.0600, subp.3 (1987). Toxic pollutants may "not be discharged or deposited in any manner such as to endanger the quality or uses of the underground waters." Minn. Rules pt. 7060.0600, subp.4 (1987). Finally, variances are available under some circumstances:

> 7060.0900 Variance.
>
> In any cases where, upon application of the responsible person or persons, the agency finds that by reason of exceptional circumstances the strict enforcement of any provision of these standards would cause undue hardship, that disposal of the . . . waste is necessary for the public health, safety, or welfare, or that strict conformity with the standards would be unreasonable, impractical, or not feasible under the circumstances, the agency in its discretion may permit a variance therefrom upon such conditions as it may prescribe for prevention, control, or abatement of pollution in harmony with the general purpose of these standards and the intent of the applicable state and federal laws.

Minn. Rules pt. 7060.0900 (1987).

To summarize, the key provisions of chapter 7060 include nondegradation, preservation of natural groundwater quality and classification of all underground water due to its interconnected nature, according to its current or future use as potable water supply, and control of waste disposal to the maximum practicable extent. Changes from this level of control are justified based on necessary economic or social reasons if present and future uses of the water are preserved; and variances may be granted under exceptional circumstances.

Chapter 7050 of Minnesota Rules regarding classification and standards for waters of the State, also pertains to ground water. Chapter 7050 has been used almost entirely to regulate surface water quality, but more properly it governs "waters of the state," which include both surface and ground waters. Water quality standards are established for various classes of waters. These classes are grouped according to the designated public use or benefit of the waters. Four classes (1A, 1B, 1C, and 1D) are established for underground or surface waters used for domestic consumption; the standards for these classes differ in the level of treatment needed before they can be consumed. The standards for Class 1A, 1B, and 1C waters, which apply to most ground water, are given as both the mandatory and recommended requirements of the 1962 U.S. Public Health Service Drinking Water Standards "and any revisions, amendments, or supplements thereto." Minn. Rules pt. 7050.0220, subp.2, item A (1987). These 1962 standards were superseded by the National Primary Drinking Water Regulations promulgated pursuant to the Safe Drinking Water Act. 40 CFR part 141. The proposed rules establish ground water performance standards for mixed municipal solid waste land disposal facilities that are more restrictive than drinking water quality, for reasons that will be discussed below.

The Minnesota Department of Health regulates public water supplies under rules similar to the National Primary Drinking Water Regulations. Minn.

Rules ch. 4720 (1987). These rules contain maximum contaminant levels adopted from the federal regulations, and like the federal rules, they apply to public water supplies rather than to ground water.

The pervasive ground water quality impacts from land disposal facilities demonstrate how large the gap is between the current nondegradation requirements and the pollution found at existing facilities. Volatile organic chemicals have been found in downgradient ground water at 60 of the 61 Minnesota mixed municipal solid waste land disposal facilities at which testing has been done and ground water quality is known to be adversely affected at 44 percent of the State's permitted facilities. Furthermore, the design requirements proposed in the rules will not eliminate all release of pollutants.

The nondegradation rationale remains valid. However, there is also a strong need for numerical ground water quality standards, given that land disposal so often causes pollution. Because land disposal facilities pollute, regulators, facility owners, area residents, and other affected parties repeatedly face the dilemma of defining the acceptable severity of a facility's impact on ground water and how large an area or volume of polluted ground water is acceptable. The proposed ground water quality standards will give all parties a precise measure; a unit of comparison that can guide decisions.

Competing interests often advocate remedial measures that would result in greatly different levels of ground water cleanup and cost. Agency staff recognizes there are many situations in which cleanup back to natural ground water quality is neither feasible nor justified based on loss of resource value. Yet, in the interests of both environmental protection and equitable regulation, the Agency must not negotiate every situation on a completely case-by-case basis, with no fixed expectations for all facilities. This is why it is important to define the limits of acceptability for both the severity and areal extent of ground water pollution from land disposal facilities.

The Agency's response to this need is the ground water performance standards of subpart 4. The Agency proposes a system consisting of ground water quality standards, which are limits on the concentration or severity of ground water pollution, and compliance boundaries, which limit the area around the facility that may be impacted to levels which exceed the standards. In order to intervene before pollution reaches the noncompliance stage, there are intervention limits, concentrations which serve as an early warning of potentially unacceptable degrees of pollution. Finally, there are many provisions that allow flexibility to deal with site-specific variations. These include a surface water compliance boundary, to limit impacts on surface water quality; a lower compliance boundary, to help protect deeper water supply aquifers; and alternative standards, site-specific standards that can be established under several circumstances defined in the rules. This system is more fully explained in the item-by-item descriptions below.

The proposed ground water performance standards maintain a reasonable balance between competing needs. One need is for rules that are consistent, and predictable; rules that maintain comparable levels of environmental protection from one facility to another. Another need is for rules that are flexible and responsive to differences in the circumstances, and site conditions among facilities. The proposed standards are appropriately protective with a reasonable safety factor to account for the many uncertainties that exist in understanding subsurface conditions, and are attainable at costs that are reasonable in relation to the potential loss in value of the resource. The standards are also a measure of the performance of liners and other engineered containment, and they are based on reasonable expectations for the performance of lined land disposal facilities.

The standards are consistent with the statutory direction to protect waters of the State for their present or potential future use as potable water supplies, and to protect this "unique natural resource of immeasurable value" for future generations. Minn. Stat. §§ 115.063 and 116D.02, subd. 2(a) (1986). Although the standards represent a departure from absolute nondegradation, Agency staff believe this departure is "justifiable by reason of necessary economic or social development" as required under existing regulation. Minn. Rules pt. 7060.0500 (1987).

The proposed standards maintain a proper blend of rule discretion and Board decisionmaking. Most notably, Board approval, and the opportunity for public involvement, is required whenever the alternative standard proposed for a facility exceeds the concentration limits for human consumption.

The concepts of ground water standards and compliance boundaries have precedent outside Minnesota. A compliance boundary approach has been adopted elsewhere in various forms, most notably in Wisconsin. There, the compliance boundary approach, together with ground water standards and preventive action limits (the equivalent of intervention limits), was required by 1984 legislation, which applied to all facilities and practices with potential ground water impacts. References 58 and 59.

Administration and enforcement of the proposed ground water performance standards will require flexibility. In spite of provisions allowing an attenuation zone around the facility, some portion of the existing facilities will be in noncompliance with the standards as soon as a compliance boundary is established. The Agency staff and Board may well receive variance requests to establish less restrictive alternative standards for some of these facilities. Since these facilities were not constructed for leachate containment, the Agency needs to maintain flexibility to handle the difference in design criteria between existing facilities and state-of-the-art facilities constructed with containment as their objective. The Agency believes it is reasonable to allow for this adjustment to be made by the Agency Board - within the proposed rules rather than through processing of variances. This process allows for public input into the criteria used to allow adjustments through the rulemaking process and establishes boundaries for the adjustment at a given facility.

Ground water cleanup takes time. The proposed standards are not intended to preclude the selection of cleanup methods that correct a problem more gradually than other available methods, if the site circumstances are appropriate. The time for attaining compliance is best left discretionary. However, the proposed rules do permit public input into the decision process at Agency Board meetings and the right to request hearings.

Finally, the Agency will not require immediate cleanup at the first evidence of a polluted concentration exceeding the standards. An analytical result that barely exceeds a standard may not represent true ground water conditions. Therefore, it is reasonable to address the need for pollutant cleanup activities on a case-by-case basis.

The EPA and others have done considerable research and development to determine how best to define the conditions that reliably indicate an exceedance or violation. Elaborate statistical procedures have been devised and repeatedly revised. Because these methods are the subject of continuing scrutiny and controversy, the Agency has elected not to impose requirements for statistical procedures in the proposed rules. Reference 60.

If there is doubt whether a violation has occurred and uncertainty exists whether the violation is due to an inadequate statistical sample, analytical uncertainty, natural fluctuations in background water quality, or other sources of error, the Agency will require resampling and statistical analyses appropriate to the level of seriousness and urgency of the situation. It is reasonable to address statistical procedures then because the collection and analyses of samples based to achieve statistical goals can add significant costs, which may be unnecessary under normal conditions.

In summary, the inclusion of ground water performance standards is reasonable, environmentally protective, and consistent with statutory authorities and other existing regulation.

Item A contains in effect an index to subpart 4 and a brief summary of the requirements included in the subpart.

Item B requires the facility owner or operator to propose the locations of the compliance boundary and to submit the proposal, together with supporting rationale and information, to the Commissioner for review and approval.

This provision requires facility owner or operator participation in the designation of this important design constraint while ensuring that the Commissioner has the information necessary to determine whether the proposal is acceptable. Item B is consistent with the approach throughout these rules to make the facility owner or operator responsible for the design of the facility, but to afford the Commissioner full opportunity to review and approve the design.

Supporting information is needed because the geology, topography, accessibility, easements, rights-of-way, and other factors impose constraints on the location of proposed or future monitoring wells. The Agency also needs information about the locations of property lines, water-supply wells and surface water bodies to make sure that compliance boundaries are sufficiently separated from these features. This allows for response to ground water quality problems before water users or off-property ground water are affected. It is reasonable that the facility owner or operator should provide this information because the Commissioner will use the information to evaluate the suitability of a monitoring system for the detection of ground water impacts before off-site users or ground water are affected.

Item C contains the requirements for positioning the compliance boundary. As defined in part 7035.0300, subpart 18, the compliance boundary is like a cylinder surrounding the facility and extending vertically downward from the land surface. As viewed on a map, the compliance boundary forms a continuous loop encircling the fill area. It is located fully within the facility property, between the waste and the property boundary.

Subitem (1) requires that the compliance boundary surround the waste fill and associated leachate treatment facilities. This does not mean that monitoring wells must encircle the facility. Monitoring will be focussed upgradient and downgradient from the facility. Ground water upgradient from the facility flows toward the facility, and normally is unaffected by seepage from the fill area or other site structures. Ground water downgradient from the facility flows away from the facility after moving under the fill area and other site structures. An alternative approach would have been to designate the compliance boundary only downgradient from the facility. Incomplete knowledge of both current and future ground water flow conditions often makes it difficult to predict the precise limits of some future contaminant plume. The approach in subitem (1) ensures that if a pollutant plume should expand to encompass a monitoring well along the compliance boundary, drilling sites will be available to extend the monitoring.

Subitem (1) further requires that the compliance boundary be located on the facility property. Ground water impacts are allowed to exceed the standards inside the compliance boundary, and it would be unreasonable to allow this zone of potential degradation to extend onto adjoining properties, which are beyond the control of the facility owner. The compliance boundary also must be set back from the property boundary a sufficient distance to allow the facility owner or operator to install, operate and maintain monitoring wells and corrective action measures, such as ground water pump-out wells or impermeable flow barriers. Corrective action may entail installations placed at or inside the compliance boundary, in order to maintain compliance with standards at that boundary.

Units (a) to (c) of subitem (1), list the factors the Commissioner must consider in approving the proposed compliance boundary: (a) the site hydrogeologic conditions, (b) the feasibility of monitoring at the boundary, and (c) the feasibility of successfully correcting any ground water pollution which has exceeded standards at or beyond the boundary.

The first of these conditions is required by federal law. 40 CFR § 257.3-4(b)(1). Site hydrogeology controls the rates and directions of pollutant movement and the degree of uncertainty about pollutant migration paths. Two examples will illustrate the relevance of these conditions. First, the compliance boundary must not be set so far from the facility that it becomes questionable whether the compliance boundary is even along the path of flow from the facility. This is particularly relevant for sites with a substantial downward component of ground water flow. Second, for sites with rapid ground water movement, the compliance boundary should be placed far enough from the property boundary and from water users in the downgradient direction to ensure that there is time to respond before the impacts extend off-site.

The inclusion of units (b) and (c) assures that the compliance boundary is located where monitoring and corrective actions are feasible. Without these provisions, the purpose of designating a compliance boundary would be defeated because its location could be under water, on a steep slope, or in some other location where monitoring and corrective action are infeasible.

Units (d) to (f) of subitem (1) require consideration of three more factors in establishing the compliance boundary location: (d) leachate volume, composition, and characteristics, (e) water users and the availability of alternative water supplies, and (f) other public health, safety, and welfare effects. Again, these criteria are required by federal law. 40 CFR § 257.3-4(b)(1). Each is an essential consideration in evaluating what risk to public health and the ground water resource is posed by a given compliance boundary location.

Subitem (2) places limits on the distance between the waste boundary and the compliance boundary. The facility owner or operator should not have the right to degrade a large zone of ground water. This approach is prudent because corrective actions limited to a smaller area will be less complicated, less costly, and more likely to succeed than if the affected area is large.

Subitem (2) limits the separation distance between a new mixed municipal solid waste land disposal facility and the compliance boundary to no more than 200 feet. Facilities developed under these proposed rules will be designed to contain leachate and minimize ground water impacts. It would be inconsistent with the goal of containment to allow a large zone of degradation around the facility. Moreover, 200 feet provides adequate opportunity for any chemical or biological attenuation to occur. This attenuation will be most active and effective close to the pollution source. If pollutant concentrations have not been sufficiently reduced close to the source, complete removal at some greater distance should not be counted on. The choice of 200 feet allows a zone for attenuation.

The Commissioner may require a smaller separation distance if ground water flow rates are very slow or additional protection of ground water is needed. At sites with very slow flow rates, subsurface materials are generally of very low permeability and are often characterized by substantial vertical components of flow. Determining flow directions can be difficult in such a setting. The farther monitoring wells are placed from the waste boundary, it is more uncertain whether the monitoring points are in the pollutants' flowpaths. For these settings, and others where downward flow may occur, this provision allows setting of a compliance boundary at a distance where monitoring is more reliable. Different compliance boundaries should be established whenever additional protection to ground water is needed.

Although 200 feet is a reasonable offset for new containment facilities, it may not be reasonable for existing facilities that were not constructed to contain leachate. Most of these facilities are known to have adverse ground water quality impacts. A compliance boundary positioned 200 feet downgradient might put many existing facilities into immediate noncompliance. For these facilities, it may be necessary to allow an offset greater than 200 feet, provided that three conditions minimizing risks and uncertainties of extending the distance are met. This discretion extends to expansion areas, since it may be difficult or impossible to separate the impacts of adjacent new and old areas.

Subitem (2), unit (a) lists the first condition on allowing a more distant compliance boundary. The Commissioner must determine that the facility owner or operator has provided sufficient monitoring to assure reliable detection and tracking of pollutant migration within the larger area. Additional monitoring points may be needed to reliably cover the larger zone enclosed by the compliance boundary. The facility owner or operator should provide this assurance in return for the facility's appropriation of a larger zone of degradation.

Unit (a) also requires a determination that the larger separation presents no greater risk to water quality and water use than a separation distance of 200 feet or less. This condition assures that downgradient water resources and water users do not bear additional risk as a result of expanding the allowable zone of degradation. At sites where it is doubtful whether the water quality impacts can be contained within even a more distant compliance boundary, it would be unreasonable to allow an enlarged zone of degradation.

Unit (b) gives the second condition for allowing the compliance boundary to be offset more than 200 feet from the waste boundary. This condition is that the hydrogeologic evaluation under subpart 3 is complete or will be completed according to a compliance schedule and the potential risks with a greater offset are known. This requirement ensures that potential pollutant pathways are well known and indicate the greater separation distance does not result in more uncertain monitoring and greater overall risk.

Unit (c) gives the final condition for allowing the compliance boundary to be offset more than 200 feet from the waste boundary. Under unit (c), the facility owner or operator must revise the cost estimate for contingency action to reflect any greater costs for additional ground water monitoring, containment, removal, and treatment or other corrective action as a result of the larger offset. The facility owner or operator must provide evidence of financial assurance to pay for the increased costs. The area of potential ground water impacts increases as the compliance boundary moves farther from the fill. Estimated corrective action costs will also increase. Monitoring costs generally increase as more ground water is monitored. Similarly, corrective actions must be directed at a larger affected area, which will increase costs and the probability that more costly corrective actions will be necessary. Thus, the rule requires the facility owner or operator to determine the impact of a more distant compliance boundary on the costs of monitoring and corrective action and to provide additional financial assurance to cover these costs. Increased costs due to the greater offset cannot be ignored when determining the appropriate level of financial assurance.

Item D requires the Commissioner to designate a lower compliance boundary if there is potential for substantial pollutant migration downward to a deeper aquifer that is used locally as a source of water supply. As defined part 7035.0300, subpart 62, the lower compliance boundary is an approximately horizontal plane located beneath the facility, normally within the saturated zone. Standards must be met in ground water at or below that plane. A lower compliance boundary is needed where users of deeper ground water are at substantial risk if pollutants reach the deeper aquifer. The spread of pollutants within a surficial aquifer may be less important than downward migration, and the lower compliance boundary should be established to demonstrate the facility's preservation of deeper ground water quality.

Consider an example in which a lower compliance boundary is established at a facility situated over a multi-aquifer system. Municipal water supply wells nearly a mile from the facility induce ground water to flow first downward to the main water-supply aquifer and then horizontally to the withdrawal wells. A lower compliance boundary would be designated at a position above the water-supply aquifer, and the facility owner or operator would be required to comply with the standards at all points within the deeper aquifer. This would enable an earlier determination of impacts then with no lower compliance boundary. The pollution would not be allowed to enter the water-supply aquifer or possibly be drawn into the capture zone of the municipal well field before corrective action could be taken.

Item D requires that the lower compliance boundary be designated at a geologic stratum or contact or other identifiable plane within the saturated zone. This condition reasonably prevents disputes about compliance with standards because the location of the compliance boundary was ambiguously defined. Finally, item D requires that the lower compliance boundary must be located to prevent adverse effects on water supplies. This requirement reasonably directs the Commissioner to use the lower compliance boundary only where it does prevent pollution of a deeper water supply and to choose a position for the lower compliance boundary that supports this objective.

Item E allows the Commissioner to establish a surface water compliance boundary and site-specific water quality standards enforceable at or beyond this boundary. Item E addresses facility impacts on streams, lakes, ponds, and wetlands caused by the movement of polluted ground water into these surface waters. Facilities can adversely affect surface water quality, either by direct overland run-off of leachate or by the outflow, or discharge, of polluted ground water into the surface water. The ground water standards in subpart 4 have been developed for the protection of potable water supplies, not aquatic life. Many pollutants pose a risk to human health at concentrations much lower than would harm aquatic life. At the same time, other substances, such as copper, are much more toxic to aquatic organisms than to humans; for these substances the ground water standards would not adequately protect surface waters. The ground water standards could be unreasonably restrictive or inadequate if applied to protect surface waters. Surface water standards have been developed by the Agency's Division of Water Quality to protect fisheries and aquatic life. The proposed solid waste rules should take them into account.

Item E allows establishment of the surface water compliance boundary if pollutants entering the ground water from the facility may migrate to surface water at concentrations that could adversely affect the quality of surface water. It would not be reasonable to establish a surface water compliance boundary if the facility is located far from any surface water, or if the surface water body is a major river in which the impact from slowly discharging ground water would never be detectable. A surface water compliance boundary would serve no purpose. Subitem (1) specifies that the surface water compliance boundary be designated as a vertical plane extending downward from the land surface or as some other readily definable plane located between the land disposal facility and the surface water. The surface water compliance boundary would be monitored by means of ground water monitoring wells because it provides a warning of developing problems and an opportunity to take corrective action that is not provided if monitoring and compliance were required only within the surface water. Impacts on surface water quality could be missed in direct sampling of the surface water if the impacts are detectable only during low stream flows and sampling does not coincide with these low flows. Pollutants may accumulate to harmful levels in bottom sediments without any detectable change in the surface water quality. Commentors criticized the alternative of designating this boundary at the stream bed or lake bottom as imprudent because it would allow only for reactive correction action, rather than for preventive corrective action. Monitoring in the ground water close to the potentially impacted surface water allows for intervention before harmful impacts occur in the bed sediments or the surface water.

Subitem (2) provides that the surface water compliance boundary may either replace a portion of the compliance boundary or be designated in addition to the compliance boundary. It may substitute entirely for a portion of the compliance boundary if the facility is within 500 feet of the surface water and the Commissioner determines that all pollutants entering the ground water from the facility will discharge into that surface water. Under those restrictions, the surface water may be the only important water resource at risk. If these restrictions are not met, the surface water compliance boundary may be designated only in addition to the compliance boundary. The 500-foot distance reasonably limits using this provision to circumvent the compliance boundary.

Subitem (3) requires that the standards and intervention limits for the surface water compliance boundary be established in the facility permit based on the applicable provisions of Minn. Rules ch. 7050. These rules classify surface waters according to their quality and use, and apply different standards to each class. For example, standards are not based on drinking water quality if the surface water is not used for that purpose.

Subitem (3) further provides that if the surface water recharges an aquifer used as a source of water, the Commissioner shall establish standards and intervention limits which are protective of both the surface water and the ground water. In Minnesota, this condition can occur in some lakes and stream segments under natural conditions, and where large ground water withdrawals induce recharge of the aquifer from a surface water body. The proposed rule reasonably ensures that surface water impacted by a facility will not pose a risk to water supplies if it re-enters the ground water system.

Under subitem (4), the Commissioner shall require submission of any facility or site information needed to establish standards and intervention limits for the surface water compliance boundary. Knowledge of low-flow stream discharge rates and mixing characteristics and rates is essential to determine the possible impacts on the surface water body. Information about biological communities may be needed to establish the appropriate surface water classification and to identify species that are sensitive to the anticipated pollutants. Chemical analyses of the leachate and of the surface water may be needed to determine acceptable pollutant levels. This information is routinely required by the Agency's Division of Water Quality for point discharges. The Commissioner will not require the facility owner or operator to conduct primary research, toxicology testing, and similar testing programs.

Item F lists the standards and intervention limits that apply at the compliance boundary and lower compliance boundary. Standards and intervention limits are given for 73 substances.

With two exceptions, the substances listed, and their limits, are developed from a list of "Recommended Allowable Limits for Drinking Water" reported by the Minnesota Department of Health (MDH) in February 1986. See Exhibit XXI. MDH developed these units as one of the main activities of an Interagency Toxics Committee. The Interagency Toxics Committee consisted of Agency staff and MDH staff responsible for establishing standards for water quality of the State. The main question before this committee was the establishment of appropriate drinking water standards for domestic water supplies in the State of Minnsota. MDH provides an explanation how the substances were selected and how the RALs were derived in a report entitled "Derivation of RALs for Drinking Water." See Appendix VI. All of the substances are of concern because of their potential toxicity or carcinogenicity when ingested by humans.

For each substance, the ground water standard in item F is established at a different level than the maximum concentration recommended by MDH for drinking water; the rationale for this distinction between the ground water standard and a drinking water limit will be described.

The substances listed are those that MDH determined had the most reliable available toxicity data and health risk criteria from EPA. All are substances that EPA has identified as priorities, as evidenced by their inclusion in the revisions of the National Primary Drinking Water Regulations and associated health advisories now in effect or through the designation of priority pollutants under the Clean Water Act. See Exhibits XXII, XXIII, XXIV, XXV and XXVI. Other substances that are also of health concern were not listed if MDH determined that their suggested limits had not been subject to sufficient review and scrutiny.

Standards for two chemicals reflect changes recommended by MDH after the February 1986 report. A limit for 1-3-dichlorobenzene was later forwarded to the Agency. The limit for 1-4-dichlorobenzene was lowered after the EPA revised its Maximum Contaminant Level Goal. See Appendix VI.

The MDH developed the RALs to cover a wide variety of situations. They did not evaluate the likelihood of each substance being present in ground water below land disposal facilities. Data have been compiled on the frequency of occurrence of 54 volatile organic chemicals at Minnesota land disposal facilities. Twenty-six of the volatile organic chemicals are listed in item F. See Appendix VI. The discussion of subpart 14, item C, subitem (2) also addresses the reasonableness of listing these chemicals. Many of the substances have been analyzed infrequently or not at all at Minnesota facilities (for example, most of the pesticides listed). A few of the substances listed have limited use in products distributed and disposed of in Minnesota. Thus, inclusion or exclusion on the list has no direct relationship to the likelihood of occurrence in ground water at a facility.

It is reasonable to establish standards based on the availability of health risk criteria, rather than listing only substances that have created health or environmental problems at land disposal facilities. As has been discussed, these substances have been identified as potential pollutants or contaminants by EPA. EPA has established them as such through the evaluation of data from extensive surveys of public water supplies, data on industrial production and use of chemicals, and other data pertinent to assessing the problem posed by each.

The Agency does not intend to require monitoring for all these substances that have standards, and probably would not require monitoring for many of them unless the routine monitoring program discovered large numbers of pollutants. Of the 73 substances with standards in item F, only 32 of them are listed as constituents for which ground water monitoring is required in subpart 14, item C. There are more potential pollutants than standards could be developed to cover. More than 70,000 chemicals are in production in the United States.

Many find their way into land disposal facilities. The Agency believes that even if reliable health risk criteria are available for only 73 chemicals, it is prudent and protective of public health to establish standards for the chemicals.

Establishing standards will permit a determination on the need for corrective action. Monitoring parameters are reasonably limited to the parameters most commonly found in ground water below land disposal facilities and indicator parameters.

For substances classified by EPA's Carcinogen Assessment Group as human carcinogens or probable human carcinogens, the MDH's RALs are the concentrations that yield a unit cancer risk of 1 in 100,000; referred to as the 10^{-5} risk level. This is the concentration that, if ingested over a lifetime, is calculated to increase the risk of cancer by one case per 100,000 persons. The reasons why Minnesota has used the 10^{-5} risk level were explained in a September 1985 MDH report entitled "Tolerable Risk". See Appendix XI.

Exposure to any concentration of a carcinogen is believed to carry with it some risk. Because exposures to carcinogens are an inevitable by-product of modern technology, some degree of risk must be accepted. The 10^{-5} risk is the limit that the MDH has identified as the tolerable extent of exposure to carcinogens.

For the noncarcinogenic toxic substances, the RALs generally are based on Reference Doses determined by EPA from toxicologic testing. In most cases, EPA has used these Reference Doses as the basis for establishing Maximum Contaminant Level Goals (MCLGs) under the Safe Drinking Water Act. The MCLGs are established "at the level at which no known or anticipated adverse effects on the health of persons occur and which allow an adequate margin of safety" to persons consuming the water over a lifetime. See Exhibits XXII, XXIII and XXIV.

The Agency determined that the maximum concentrations recommended for drinking water consumption are not protective enough to serve as the goal for ground water protection at facilities designed specifically to contain pollutants. The Agency believes a more conservative approach than drinking water standards must be applied to ground water. Therefore, ground water standards and intervention limits were set at 25 percent of the RALs for drinking water. Twenty-five percent was chosen because it provides a reasonable protection standard based on the existing quality of ground water in Minnesota and the design criteria for land disposal facilities. The following discussion further details how the Agency chose this approach.

For most substances, the RALs or other drinking water criteria are set at much higher concentrations than typically occur in Minnesota's ground water. Allowing ground water quality to be routinely degraded to the levels of the drinking water limits would represent substantial degradation, to a degree that would be inconsistent with the nondegradation policy of Minn. Rules ch. 7060 (1987), and with the emphasis for facilities designed to contain pollutants. The Agency believes that to the extent practicable the nondegradation policy must be adhered to most closely for facilities engineered to contain pollutants and prevent adverse impacts on ground water quality. Therefore, standards must closely appproximate background levels.

Agency staff has prepared several figures and tables to demonstrate the high quality quality of typical Minnesota ground water. The data on ambient ground water comes from the Agency's ambient ground water monitoring program, which is described in a series of reports. Reference 61. In the ambient program, Agency staff sample major aquifers and aquifer types statewide to define the time and spatial variation in ground water quality. Sampling efforts are more detailed in aquifers that are known to be vulnerable to pollution or are heavily used, so statistics on the data base may be biased toward poorer quality ground water. Even so, the typical ambient concentrations of pollutants are very much lower than the MDH's standards for drinking water.

Table 1 summarizes the median concentrations of ambient ground water. Ambient data are available for 41 of the 73 substances for which standards and intervention units are established in item F. Two hundred or more sample analyses have been performed for 35 of these 41. A more comprehensive statistical compilation is available. See Appendix XII.

TABLE 1

COMPARISON OF MINNESOTA AMBIENT GROUND WATER QUALITY WITH STANDARDS IN PROPOSED SOLID WASTE RULES

PROPOSED RULES, PT. 7035.2815, SUBP. 4(F), SUBITEM NUMBER:	SUBSTANCE	AMBIENT GROUND WATER QUALITY: NUMBER OF SAMPLES	MEDIAN CONCEN-TRATION (ug/l)	PROPOSED GROUND WATER QUALITY STANDARD (ug/l)	PERCENT OF SAMPLES EXCEEDING PROPOSED STANDARD
1	Acrylamide	---	---	0.025	---
2	Acrylonitrile	---	---	0.17	---
3	Alachlor	---	---	2.5	---
4	Aldicarb	---	---	2.3	---
5	Aldrin	---	---	0.0075	---
6	Allyl chloride	200	<0.5	7.35	0
7	Arsenic	248	<1.0	12.5	4
8	Asbestos: medium and long (greater than 10 microns) fibers per liter	---	---	1800000	---
9	Barium	361	66	375	2
10	Benzene	243	<0.6	3	0
11	Bis(2-chloroethyl)ether	---	---	0.078	---
12	Cadmium	498	0.019	1.25	1
13	Carbofuran	---	---	9	---
14	Carbon tetrachloride	228	<0.2	0.67	0
15	Chlordane	35	<0.1	0.055	0
16	Chlorobenzene (monochlorobenzene)	228	<0.5	15	0
17	Chloroform	228	<0.2	1.3	1
18	Chromium	497	<0.5	30	0
19	Copper	361	7.5	325	0
20	DDT	43	<0.09	0.25	0
21	Dibromochloropropane (DBCP)	---	---	0.063	---
22	1,2-Dibromoethane (Ethylene dibromide, EDB)	200	<0.7	0.002	0
23	1,2-Dichlorobenzene (ortho-)	243	<1.2	155	0
24	1,3-Dichlorobenzene (meta-)	243	<1.2	155	0
25	1,4-Dichlorobenzene (para-)	243	<1.2	18.8	0

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26	Dichlorobenzidine	---	---	0.052	---
27	1,2-Dichloroethane	228	<0.2	0.95	0
28	1,1-Dichloroethylene	228	<0.2	1.8	0
29	1,2-Dichloroethylene (cis-)	200	<0.2	17	0
30	1,2-Dichloroethylene (trans-)	228	<0.2	17	0
31	Dichloromethane (methylene chloride)	228	<1.0	12	0
32	2,4-Dichlorophenoxyacetic acid (2,4-D)	46	<0.14	17	0
33	1,2-Dichloropropane	228	<0.2	1.5	0
34	Dieldrin	---	---	0.0025	---
35	2,4-Dinitrotoluene	---	---	0.27	---
36	Diphenylhydrazine	---	---	0.11	---
37	Epichlorohydrin	---	---	8.9	---
38	Ethylbenzene	243	<0.6	170	0
39	Heptachlor	---	---	0.025	---
40	Heptachlor epoxide	---	---	0.0015	---
41	Hexachlorobenzene	---	---	0.053	---
42	Hexachlorobutadiene	---	---	1.1	---
43	Hexachlorocyclohexane (alpha-)	---	---	0.0075	---
44	Hexachlorocyclohexane (beta-)	---	---	0.047	---
45	Hexachlorocyclohexane (gamma-) (Lindane)	---	---	0.05	---
46	Hexachlorodibenzodioxin	---	---	0.000015	---
47	Hexachloroethane	---	---	6.2	---
48	Lead	499	0.9	5.0	14
49	Mercury	485	0.12	0.75	2
50	Methyl ethyl ketone	243	<5.0	43	0

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PROPOSED RULES, PT. 7035.2815, SUBP. 4(F), SUBITEM NUMBER:	SUBSTANCE	AMBIENT GROUND WATER QUALITY: NUMBER OF SAMPLES	MEDIAN CONCEN-TRATION (ug/l)	PROPOSED GROUND WATER QUALITY STANDARD (ug/l)	PERCENT OF SAMPLES EXCEEDING PROPOSED STANDARD
51	Methoxychlor	---	---	85	---
52	Nickel	496	<2.2	38	0
53	Nitrate (as nitrogen)	743	30	2500	20
54	Nitrite (as nitrogen)	299	<10	250	2
55	N-Nitrosodimethylamine	---	---	0.0035	---
56	N-Nitrosodiphenylamine	---	---	17.8	---
57	Total carcinogenic polynuclear aromatic hydrocarbons (PAH)	---	---	0.007	---
58	Polychlorinated biphenyls (PCB's)	---	---	0.02	---
59	Pentachlorophenol	---	---	55	---
60	Selenium	361	<1.0	11	1
61	Styrene	47	<1.0	35	0
62	2,3,7,8-Tetrachlorodibenzo-p-dioxin (-TCDD)	---	---	0.0000005	---
63	1,1,2,2-Tetrachloroethane	200	<2.0	0.44	0
64	Tetrachloroethylene	228	<2.0	1.7	0
65	Toluene	243	<0.6	500	0
66	Toxaphene	43	<0.09	0.075	0
67	1,1,1-Trichloroethane	228	<0.2	50	0
68	1,1,2-Trichloroethane	228	<0.2	1.5	0
69	Trichloroethylene	228	<0.2	7.8	0
70	2,4,6-Trichlorophenol	---	---	4.4	---

TABLE 1

COMPARISON OF MINNESOTA AMBIENT GROUND WATER QUALITY WITH STANDARDS IN PROPOSED SOLID WASTE RULES

PROPOSED RULES, PT. 7035.2815, SUBP. 4(F), SUBITEM NUMBER:	SUBSTANCE	AMBIENT GROUND WATER QUALITY: NUMBER OF SAMPLES	MEDIAN CONCEN-TRATION (ug/l)	PROPOSED GROUND WATER QUALITY STANDARD (ug/l)	PERCENT OF SAMPLES EXCEEDING PROPOSED STANDARD
71	2,4,5-TP (Silvex)	46	<0.01	13	0
72	Vinyl chloride	---	---	0.037	---
73	Xylene	243	<0.6	110	0

Includes data collected 1978 through 1984 for all monitored aquifers. Source of information is: Sabel, Gretchen, 1985, Ground Water Quality Monitoring Program: An Appraisal of Minnesota's Ground Water Quality, 1985, Minnesota Pollution Control Agency, Division of Solid and Hazardous Waste, and more recent data retrievals from the STORET ambient ground water quality data base. <u>See</u> Exhibit XIX.

Table 1 lists the median ambient concentration for each contaminant (half of all the measured ambient concentrations are less than or equal to this concentration, half are greater than or equal to this concentration). For 35 of the 41 contaminants, more than half the analyses could not detect the contaminant; for these, the median is given as less than (<) the mean analytical detection limit. The median concentrations of the other six are far below the proposed item F standards, and even farther below the MDH's RALs.

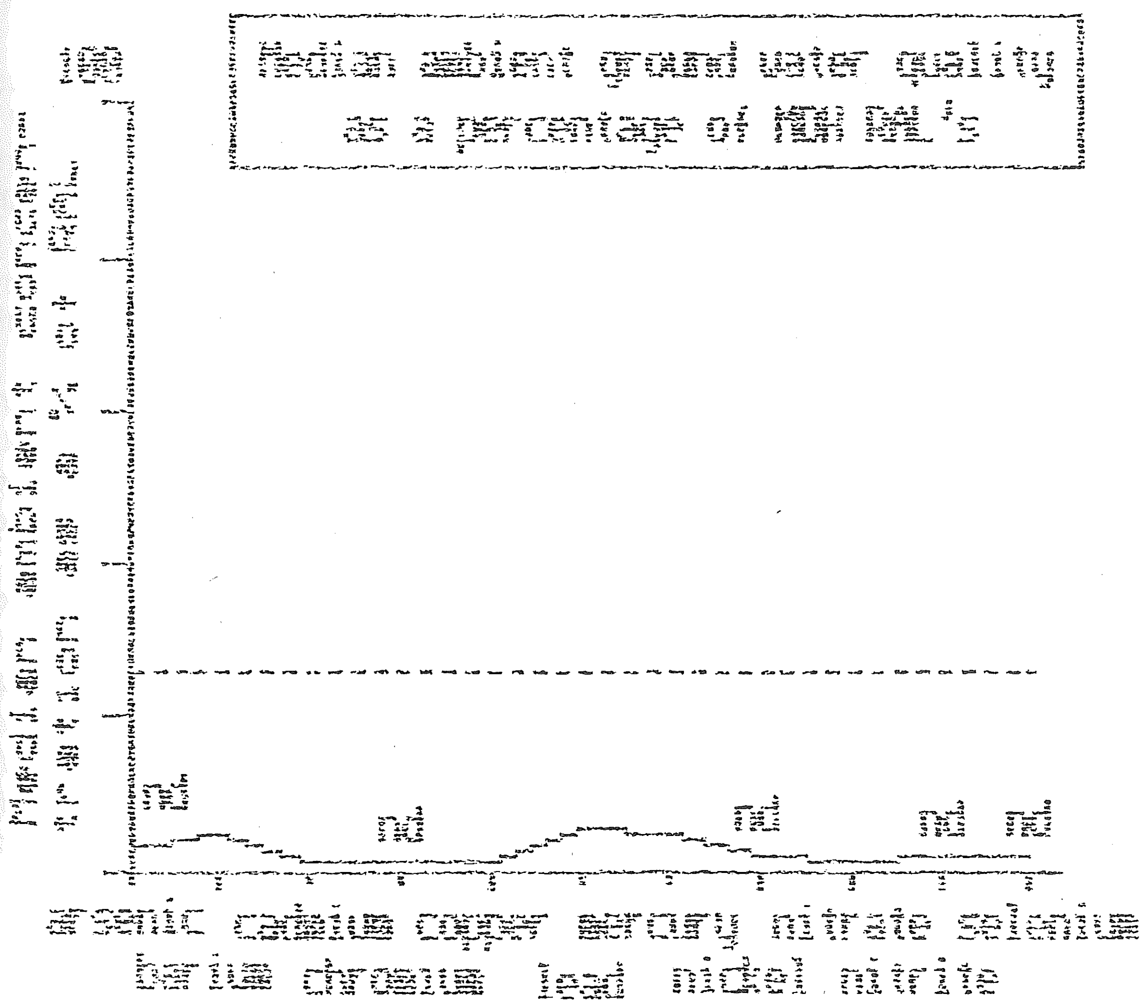
The last column of Table 1 lists the percentage of samples in the ambient data base that exceeds the proposed item F standards. This percentage is 2 percent or less for 38 of the 41 contaminants. A portion based on the percentages of the ambient analyses exceed the proposed standards only for arsenic (4 percent), lead (14 percent), and nitrate (20 percent). Even for these, 80 to 96 percent of the ambient ground water samples are of better quality than the proposed standard. For the instances where the ambient concentration of a constituent does exceed the proposed standard at a given facility, the proposed rules provide that the background concentration be used as the standard, as will be discussed under item H.

Using the data summarized in Table 1, Agency staff has prepared two figures comparing ambient ground water concentrations, the proposed ground water standards and intervention units, and MDH's RALs for drinking water. On these figures, the ambient ground water concentrations are expressed as a percentage of the MDH's RALs.

Figure 5 compares the median ambient concentrations of the inorganic substances included in Table 1. As indicated, the median concentration is shown as a percentage of the drinking water limit not the actual concentration. For example, MDH's RAL for lead is 20 micrograms per liter. The median ambient concentration is 0.9 micrograms per liter. The figure used on the graph is the percentage (4.5). For substances such as arsenic or chromium, the percentage was based on the analytical detection limit because the levels of these substances in ambient ground waters were nondetectable (ND). A review of this graph shows that among the six substances with medians at detectable units, none exceeds 4.5 percent of the RAL for drinking water. This indicates the high quality of drinking water found in Minnesota.

Figure 5 also compares the median ambient concentrations, as a percentage of the RALs to the proposed standards and intervention limits, which are 25 percent of the RALs. The proposed standards are represented by the dashed line corresponding to 25 percent of the RAL. Again the median ambient concentrations of inorganic substances are signficantly below the proposed standards and intervention limits. The difference between the median ambient ground water levels and the proposed standards and intervention limits shows that comparatively speaking significant amounts of ground water degradation will be permitted. For example, in Figure 5, the substance whose median ambient concentration is highest in relation to the proposed standard is lead (4.5 percent of RAL). As seen in Figure 5, the proposed standard for lead, at 25 percent of the RAL, is more than five times higher than the median ambient concentration. For the other 10 substances shown, the proposed standards are larger multiples of the median ambient concentrations. The Agency concludes from this information that although the 25 percent level is a conservative number for standards and intervention limits when compared directly to the RALs, it allows substantial increases above the current conditions. Further justification for these increases is discussed in the following paragraphs.

FIGURE 5



It has been demonstrated that Minnesota ground water on average is of higher quality than the ground water standards proposed in the rules. It is also pertinent to compare Minnesota's poorer quality ground water with the proposed standards. This comparison will illustrate whether the standards are reasonable for the vast majority of the State's ground water, or only for the median or average conditions.

The median is the fiftieth percentile in the ambient ground water data base -- 50 percent of the ground water is of better quality, 50 percent is of poorer quality. Similarly, the ninetieth percentile concentrations provide a means of describing typical poorer quality ground water. Ninety percent of the ground water sampled in the ambient program is of better quality, i.e., lower concentrations, than the ninetieth percentile concentrations.

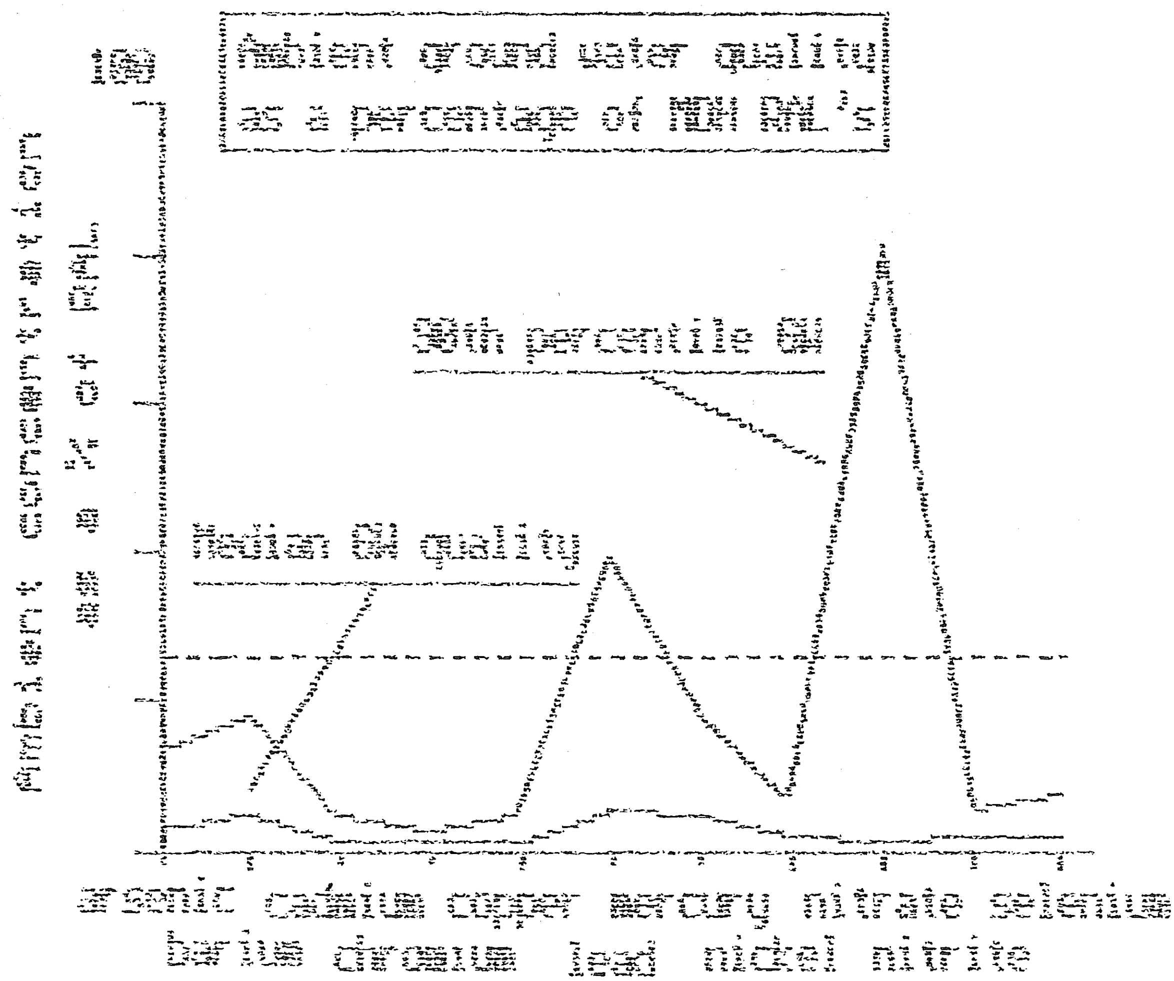
These ninetieth percentile concentrations are compared with the proposed standards in Figure 6. Again the horizontal dashed line at 25 percent of the RALs represents the proposed ground water standards of item F. The lower line on the figure duplicates Figure 5. The upper line shows the ninetieth percentile ambient concentrations, also expressed as a percentage of the RALs. In other words, 90 percent of the ambient analyses for each substance are of better quality than the points along the upper line and would plot below that line on the figure. For example, as listed in Appendix XII, 90 percent of the ambient lead concentrations are lower than 7.1 ug/l. This concentration is plotted on Figure 6 as 35.5 percent of lead's RAL of 20 ug/l. Only 10 percent of the ambient analyses exceed this small fraction of the drinking water limit.

The ninetieth percentile ambient concentration is below the analytical detection limit for 27 of the 41 substances tested. See Appendix XII. Of the remaining 14, all have ninetieth percentile concentrations lower than the RALs, most far lower than the RALs. Only lead (14 percent) and nitrate (20 percent) have more than 10 percent of the ambient concentrations exceeding the proposed item F ground water standards for land disposal facilities.

These observations indicate that even poorer quality Minnesota ground water has pollutant concentrations well below the ground water standards proposed in item F. Thus the proposed standards would allow some degradation not only at facilities with median ground water quality, but also at facilities with poorer quality ground water. Furthermore, the proposed standards provide a level of ground water protection much more consistent with the natural high quality of Minnesota ground water than if the standards had been set at the drinking water limits or some larger fraction of the drinking water limits.

The Agency believes it would be bad public policy to allow future land disposal facilities to routinely degrade ground water to the levels of the drinking water limits. To do so would violate the state environmental policy

FIGURE 6


Ambient ground water quality
as a percentage of MDH RAL's
90th percentile GW
Median GW quality
arsenic cadmium copper mercury nitrate selenium
barium chromium lead nickel nitrite

contained in Minn. Stat. §§ 116D.01 and 116D.02 advocating the promotion of "efforts that will prevent or eliminate damage to the environment" and "assure for all people of the state safe, healthful, productive, and aesthetically and culturally pleasing surroundings." By establishing standards below the drinking water limits the Agency ensures the public's ability to continue using ground water as a drinking water source.

Allowing facilities to degrade to drinking water limits would be inconsistent with the proposed rules' extensive provisions to contain leachate and minimize ground water quality impacts, based on current technology to abate the management of solid waste and endanger human health. Nor would such a blanket sanction be consistent with the policy in existing rules to control waste disposal as necessary "to ensure that to the maximum practicable extent the underground waters of the state are maintained at their natural quality." Minn. Rules pt. 7060.0500 (1987).

Because future facilities will be designed and constructed for containment and isolation of contaminants from the environment, the Agency believes it is feasible, reasonable, and good public policy to establish a higher performance standard for these facilities than for existing facilities. It would not be reasonable to expect existing facilities to comply with the proposed standards in all cases as they were not designed with this performance goal in mind; provisions to allow less restrictive standards on a site-by-site basis are discussed under item H.

The agency believes that the degradation allowed under the proposed standards is "justifiable by reason of necessary economic or social development" under part 7060.0500. Some mixed municipal solid waste will continue to be placed in land disposal facilities even after the adoption of alternative waste management practices. Although these future facilities will be designed to contain pollutants, even they will not be able to guarantee absolute nondegradation because 100 percent containment is not required under the proposed rules. The Agency believes that it is unreasonable to require total containment due to the substantial costs needed to attain such a goal. This will be further discussed under the design provisions of this part, subparts 5 to 9.

The main reasons for establishing a ground water standard substantially lower than the drinking water limits, then, are the extremely high quality of Minnesota's ground water, generally very much better than the drinking water limits, and the greater consistency between these standards, state statutes, and the containment objectives of the design requirements. There are a number of secondary reasons that also support the adoption of more restrictive ground water standards. The following discussions address these secondary reasons.

The MDH issues well advisories recommending against continued use of a private water supply if the RALs for drinking water are exceeded. Ground water that has been degraded to the point where it barely complies with the drinking water limits is on the verge of being declared unfit for long-term human consumption. From this perspective, ground water standards set at or near the drinking water limits appear to be too permissive, and not adequately protective of human health or the ground water resource.

A ground water standard established at the recommended allowable health risk levels would incorporate toxicologic safety factors. However, it would provide no margin for error, or margin of safety, to account for the many uncertainties associated with monitoring and hydrogeologic assessments, except for the possibility of further dilution and attenuation as the polluted zone migrates beyond the compliance boundary. The use of drinking water limits as ground water standards would not provide the level of confidence and security warranted for protecting ground water as potable water supply. In view of the containment goal, such standards do not protect on-site or area ground water as a potential potable water supply to the degree implied under Minn. Rules pts. 7060.0200 and 7060.0400 ("to the maximum practicable extent") and Minn. Stat. §§ 115.03, subd. 1, item (c); 115.44, subds. 2 and 3 (c); 116.07, subd. 4; and 115.063 (1) and (2) (1986).

By contrast, the proposed ground water quality standards do provide an adequate margin of safety against hydrogeologic uncertainties, and they provide confidence that the change from nondegradation "will not preclude appropriate beneficial present and future uses of the waters," as required by part 7060.0500.

Statistical analyses are often used to characterize the overall uncertainty in the determination of whether ground water concentrations exceed some standard or reference value. Many sources of error or uncertainty are introduced during sample collection, storage, transportation, and analysis. Uncertainty also arises from fluctuations in water quality and variable water chemistry among samples taken at different times or from different wells. As a result, it is not always apparent whether a reported concentration exceeding the standard should be treated as a violation. Often, sampling results which considerably exceed a standard do not prove a violation. Conversely, a sample result equal to the standard has some probability that the true ground water concentration actually exceeds the standard.

From a statistical viewpoint, the proposed ground water standards help ensure that uncertainty occurs within a range of concentrations lower than the drinking water limits. The proposed standards are far enough below the drinking water limits that a sample result exceeding the drinking water limits is almost certain to be identified statistically as a violation of the standards. Thus, the proposed standards are more protective of ground water than standards set at or close to the drinking water limits.

After a ground water problem is detected and confirmed, there is a time lag before the corrective actions can be designed, constructed, and operated to contain the plume and reverse its movement. A violation of the ground water standards will not always be fully anticipated, and corrective actions may take time to be effective. The time lag could result in continued deterioration of ground water quality and continued movement of the polluted plume beyond the compliance boundary and possibly beyond the property boundary. Setting ground water standards at levels well below the drinking water limits increases the likelihood that any continued deterioration, and any unrecovered portions of the contaminant plume, will remain below the drinking water limits.

EPA advises that toxic substances found together in water can have interactive health effects, such that their measures of toxicity or carcinogenicity should be combined in health risk evaluations. See Exhibit XXVII. The combined toxicity or risk for the water sample as a whole should be compared against the criterion for acceptability. This more conservative additive approach is provided for in item J, subitem (2). However, additivity has limits when applied to the complex mixtures of substances occurring in ground water polluted by mixed municipal solid waste leachate. Ground water polluted by leachate contains pollutants that do not have recommended limits and pollutants that are not detected because of the analytical method used. The additivity calculation for a given site or sample could not factor in these substances. Therefore, it would underestimate the true carcinogenicity or toxicity potential of the water. Water calculated to be marginally adequate to drink might carry a much greater true risk, as a result of unquantified and undetected substances.

Two statistics help us understand these concerns. First, while more than 70,000 different chemical compounds are produced in the United States, thousands of which may be present in mixed municipal solid waste land disposal facilities, ground water monitoring normally tests for a limited number of substances due to analytical and cost constraints. Obviously, a great many substances are not sought in ground water analyses. Second, regarding about two-thirds of the organic compounds that have been identified nationwide in ground water, and about one-half of the inorganics compounds, no health risk limits have been established. Reference 62.

Setting ground water contamination standards lower than the drinking water health risk limits affords some safety factor to address additive effects. If the total quantified risk approaches the standard (e.g., 25 percent of the 10^{-5}

risk level), then the concentration range from 25 percent to 100 percent of the drinking water limits provides a margin of safety for the unquantified or unidentified risk.

The Agency believes this margin of safety is necessary to protect users of ground water, considering the uncertainties that exist with the interaction of carcinogens and toxic pollutants. The conservative approach taken by EPA and adopted by the MDH and the Agency is that the carcinogenicity of a ground water sample is increased with each carcinogen present. The actual impact may be greater than the sum, but this greater than additive interaction has been quantified for only a few combinations of chemicals. Therefore, establishing ground water standards significantly below the drinking water limits provides assurance that when one or more carcinogens are present in a ground water sample, they will not pose a substantial risk to human health.

Ground water monitoring systems necessarily consist of a limited number of monitoring points. Each monitoring well collects water from a given depth within a saturated zone. The number of points at which ground water quality can be measured is quite small relative to the size, thickness, and complexity of pollutant plumes. The concentrations detected by a monitoring system and used to measure compliance may be exceeded somewhere along the compliance boundary. As with the other sources of uncertainty, the proposed standards offer more assurance that ground water is of drinking water quality at the unmonitored points along the compliance boundary than if the drinking water limits are used as standards.

Recommended health risk limits change as a result of additional toxicologic studies. For those substances where the currently recommended drinking water limits are eventually revised downward, the ground water standards proposed in item F provide some insurance against exceeding the reduced drinking water limits. Should the RALs be raised the ground water standards are, although conservative, result in no increased burden to the facility owner or operator as compliance standards are unchanged.

It should be noted that the ground water standards in item F will need to be maintained and updated as health risk limits are revised. The same need arises as standards are established on the basis of toxicologic studies. As the information base grows, the toxicity estimates are refined, and any corresponding ground water standards should also be revised. The Agency and the MDH monitor the health risk information produced by EPA and others. They are aware of the changes in these standards and recommended limits. The Agency will revise the standards in item F as needed to ensure that they remain appropriately protective of human health.

A few users of ground water require water of higher quality than the drinking water limits. The users include certain industrial water users, food and beverage processors, commercial fisheries and aquaculture, and commercial greenhouses whose plant stocks can be harmed by herbicides at concentrations well below the human health criteria. Reference 63. The proposed ground water standards are more protective of these current and potential uses of the ground water than drinking water standards.

In summary, the proposed standards are needed to preserve Minnesota's high natural ground water quality for use as a public water supply and industrial water supply. It is reasonable to maintain the high standard quality of ground water because more than two thirds of Minnesota's population uses ground water and impacts on the ground water can have detrimental affects on the State economy and the health of its population. Setting the ground water standards at 25 percent of the drinking water limits for engineered containment facilities is consistent with the nondegradation policy and is reasonable because absolute containment is not possible.

Item F also sets intervention limits at 25 percent of the drinking water limits. Even though they are at the same concentrations as the ground water standards, these intervention limits provide an early warning because they are applied <u>inside</u> the compliance boundary. If pollutant concentrations exceed the intervention limits in detection monitoring wells positioned close to the waste, the follow-up actions established in item G are triggered, including evaluation of the need for corrective action. Setting intervention limits at 25 percent of the drinking water limits enables early corrective action. The corrective action may prevent an impending violation of standards at the compliance boundary. Alternatively, it may lead only to the conclusion that the degradation allowed inside the compliance boundary is a stable situation and poses little risk of violating standards outside the compliance zone. This conclusion would require little corrective action but may cause an increase in monitoring at established points or in the number of points monitored. The Agency's goal is the nondegradation of ground water to the extent practicable. The use of intervention limits establishes a reasonable method to ensure ground water impacts are monitored and corrective actions are implemented expeditiously.

Item G requires specific follow-up actions by the facility owner or operator if an intervention limit established under items E to H is exceeded at any location where impacts are monitored. As discussed under item F, monitoring locations are inside, at, or beyond the compliance boundary. Again, the intervention limit is needed to trigger action before actual violations of standards occur.

Subitem (1) requires immediate notification of the Commissioner in writing. This provision ensures that the Commissioner knows of possible ground water quality impacts as soon as possible. The Agency then has sufficient time to prepare appropriate responses such as additional monitoring, and technical assistance. The requirement makes it clear to the facility owner or operator that exceeding intervention limits is a serious matter demanding further attention and follow-up. Requiring the notice to be in writing ensures that the notification is accurate, complete, and indisputable.

Subitems (2) and (3) require either immediate resampling for a new violation of the intervention limit or evaluation of the need for immediate resampling. Resampling is a standard practice to ensure that a sample result exceeding a limit reflects actual conditions, rather than sampling or laboratory error, or a temporary condition. The slow movement of ground water tends to ensure that if an analysis is accurate, a subsequent analysis will tend to confirm the first results. Any follow-up action should respond to a real condition, not an incorrect one. The subitem (3) provision for evaluation of the need to resample eliminates the resampling requirement when the elevated concentrations are already well known and past monitoring results provide all the confirmation needed.

Subitem (4) requires the facility owner or operator to evaluate the significance of the concentration of pollutants and the source or cause of the intervention limits being exceeded. The concentration found could be due to circumstances other than a leachate release from the facility. It is important to rule out these other possibilities before assuming the facility is the source. The findings might be the result of contamination from extraneous sources during sampling or in the laboratory. Other facilities or activities may be the cause of the problem rather than the land disposal facility.

For naturally-occurring substances, the range of natural fluctuations in water quality must be examined to determine whether the findings are within or outside of this range. Some commentors have suggested that the rules spell out the statistical criteria by which this range is defined. Such provisions were not included because there are a variety of approaches in use. Statistical methods are evolving as more is understood about their reliability. For example, problems with the statistical requirements in federal hazardous waste regulations have forced substantial recent rules revisions. Reference 60. The Agency does not believe it is wise to lock in an unfamiliar statistical procedure that might be flawed. By not specifying exactly how the data must be evaluated, the rule allows flexibility and judgment by the Agency and the facility owner or operator. The evaluation will be conducted based on the Agency's and facility owner's or operator's experience with specific statistical evaluation methods.

Subitem (5) requires evaluation of the need for immediate corrective action to prevent pollutant concentrations from approaching or exceeding standards at any of the boundaries where compliance is measured. Recall that there is no prohibition on exceeding intervention limits in ground water located within the area enclosed by the compliance boundary. Some degradation may occur within that attenuation zone. However, it would not be prudent to wait for a violation to occur at or outside the compliance boundary while the impacts get out of hand inside the compliance boundary. Where the trend inside the compliance boundary is toward an imminent or eventual violation of standards, procedures followed under subitem (5) serve notice that corrective action may be needed to prevent the violation. The need for corrective action could be indicated, for instance, by the detection of very high pollutant concentrations that obviously exceed the site's ability to dilute or attenuate the contaminants. Expansion of a polluted zone makes corrective action more difficult, more costly, and less assured of success, and represents an unnecessary loss of additional resources. Subitem (5) ensures that the compliance boundary concept does not become a license for delay and inaction.

Subitem (6) requires the facility owner or operator to evaluate the need for changes in water monitoring if intervention limits are exceeded. Possible changes include sampling frequencies, constituents analyzed, and installation of additional monitoring points. Initial monitoring systems and testing requirements focus on detecting pollutants but not necessarily on evaluating or tracking a polluted condition. The monitoring systems may consist of a single line of wells with no in-place backup wells, and the routine testing requirements may be limited to selected indicator parameters. When an intervention limit is exceeded, it is necessary to re-evaluate the monitoring program to determine whether it can yield the information needed to evaluate the source, extent, and future course of the pollutants. As the person responsible for the facility, it is the facility owner's or operator's duty to conduct this evaluation.

Subitem (7) requires the facility owner or operator to submit a written report to the Agency within 30 days after obtaining the sample results that showed an intervention limit was exceeded. The report must describe the evaluations and conclusions reached under subitems (2) to (6) and the actions taken under subitem (8). This provision ensures that the facility owner or operator responds to the exceeding of intervention limits without delay. The short time allowed for submitting the report reflects the Agency's view that warnings of possible failure of the facility's leachate containment system should be treated seriously and evaluated promptly. The Agency recognizes that it will not always be possible to complete all aspects of a thorough evaluation within 30 days, particularly if additional field installations are needed. In these cases, a follow-up report will be appropriate. The facility owner or operator should make advance arrangements with persons having the technical expertise and familiarity with the site to quickly assess the appropriate action.

This reasoning leads to the requirement in subitem (8). That the facility owner or operator take actions described in the facility's contingency action plan and in subpart 15 and part 7035.2615. This requirement simply triggers additional follow-up actions already planned and/or required.

Item H provides flexibility in applying the ground water standards to individual facilities. Item H allows the Commissioner to deviate from the standards and intervention limits under six specified circumstances. Under these circumstances, the Commissioner may establish alternative standards and intervention limits for one or more substances in the facility permit in lieu of the standards and intervention limits specified in items E to G of the proposed rules.

The flexibility provided in item H is limited by appropriate conditions on the use of alternative standards, which preserve the goal of maintaining high ground water quality. This flexibility is consistent with the goals of regulating facilities equally and preserving water quality. Throughout the comment period, the Agency has received no comments opposed to facility-specific alternative standards.

Subitem (1) provides that if the background concentration of any constituent in the ground water at a facility is greater than a standard or intervention limit established in subpart 4, the background concentration of the constituent must be used as the standard or intervention limit. Background refers to the condition of ground water whose quality has not been affected by leakage or losses from the land disposal facility. Higher background concentrations may be due to natural conditions or to other sources off the facility property. The facility owner or operator should not be held accountable for conditions that are not due to facility operations and are not within the facility owner's or operator's control.

If the elevated concentrations are due to reasons other than the facility, however, subitem (1) reasonably allows no further measurable degradation from the facility. If the background concentration exceeds a drinking water standard, this provision ensures that potential uses of the water are not further jeopardized by additional degradation, and that other higher quality ground water is not put at greater risk. A second case is when the background concentration does not exceed the drinking water standard but does exceed the ground water standard under item F or an alternative standard that would otherwise be established under this item. Subitem (1) reasonably preserves as much of the remaining difference between the standards as possible, and thereby maintains consistency with the level of water quality required for other constituents.

If the elevated background concentrations can be improved through actions by other, off-site pollution sources, it is appropriate to prevent the land disposal facility from further impacting ground water quality. Allowing additional degradation beyond elevated background levels could preclude other efforts to improve ground water quality. The nondegradation approach in subitem (1) reasonably leaves open the possibility that the background water quality can improve.

Subitem (1) further provides that if the variability of background water quality is inadequately defined, the Commissioner may require additional evaluation including, sampling, statistical analysis of sampling data, and installation of additional monitoring points. Ground water quality varies by location and depth and over time. The background sampling must contain enough dates, seasons, locations, and depths to accurately define water quality. Otherwise, the background sampling may be unrepresentative of the true range in ground water quality, and alternative standards may be set too high or too low to reflect the actual water quality variations.

As mentioned regarding item G, subitem (3), ground water data is often analyzed statistically. By using statistical analyses of background data an alternative standard can be established at various concentrations, depending on the confidence level and the amount of background data available. The first step is to determine the desired degree of assurance (the confidence level) that an elevated concentration represents a deviation from normal background fluctuations and can be attributed to the facility. For example, a 95 percent confidence level is a greater degree of certainty than a 90 percent confidence level. An alternative standard established at a 95 percent confidence level will always be a higher concentration than a standard set at a 90 percent level. But a standard also depends on the number and representativeness of the data available. In general, the fewer the number of representative background data, the higher the concentration at which the alternative standard must be set to achieve the desired confidence level. Conversely, if more background data are available, the concentration of the alternative standard will be lower without introducing too many random false positive readings. The second step considers the acceptability of the resultant limit.

Based on experience from Wisconsin, this statistical approach will result in an alternative standard that is anywhere from two to four or more times the mean concentration of the background data. The multiplier in a given situation will depend on both the range of variability in the actual background water quality and the number and representativeness of the sample data. It would be unreasonable to establish alternative standards at a high multiple of the mean background concentration unless there is enough background data to demonstrate that the background water quality really does vary significantly. The Agency's goal in establishing standards is the protection of ground water quality. To establish a standard two or more times higher than the mean background concentration would conflict with this goal. Thus it is reasonable to allow the Commissioner to require additional background data if alternative standards are to be kept reasonably protective.

Finally, subitem (1) allows the Commissioner to change the alternative standards or intervention limits if background water quality changes due to actions or events occurring outside the facility property and beyond the facility owner's or operator's control. This provision acknowledges that the facility owner or operator should not be held responsible for exceeding a standard if deteriorating background water quality is due to events beyond the facility owner's or operator's control. It is possible that this provision could result in lowering the standard if background water quality improves. Even if background water quality improved, the Commissioner would consider the reasonableness of lowering any standard used to determine the degree of containment needed in the facility design.

Subitem (2) provides that, upon request by the facility owner or operator, the Commissioner may establish alternative limits for portions of a facility that were filled before these rules revisions become effective. This provision reasonably acknowledges that most existing facilities were not constructed to contain leachate. Such facilities can not meet many of the ground water standards that are established based on containment. The different approach given for existing facilities appears in subitem (2). If the ground water flowing beneath new and old portions of the facility can be separately monitored, it would be unreasonable to allow more leakage from the new areas by applying the more lenient alternative standards to the entire facility. If the impacts from the older and newer portions cannot be separately monitored, the alternative standards would prevail for the entire facility.

Subitem (2) further provides that the alternative standards for an existing fill must not exceed four times the concentrations given in item F unless approved by the Agency, or by the Commissioner if the background concentration is higher than the standards. Where the proposed alternative standards exceed drinking water limits, the opportunity for public review and comment on action by the Agency is appropriate. As previously discussed, ground water is to be protected as a source of potable water supply under the statutory direction in Minn. Stat. § 115.063 and the provisions of Minn. Rules ch. 7060, except as the variance provisions and other language in chapter 7060 provide otherwise. The requirement that the Agency must approve an alternative standard that may result in nonpotable ground water is consistent with chapter 7060. Cleanup to drinking water standards may not be feasible or may require an unreasonable commitment of resources. The Agency staff may support some requests for higher alternative standards, but the decision to disregard ground water as a potable water source appropriately rests with the Agency. The alternative standard would be stated in enforcement documents, including permits, stipulation agreements, and orders, which require Agency approval.

Alternative standards can be established under subitem (2) only if the facility owner or operator has established the need for the change. The facility owner or operator must have completed a remedial investigation study and a feasibility study. These studies must evaluate the extent and severity of ground water pollution at the facility and the feasibility and environmental and economic costs, risks, and benefits of the possible alternative corrective actions. There are several reasons for these requirements. First, they assure that there is a demonstrated basis for allowing a greater degree of ground water degradation. Second, the required remedial investigation ensures that enough is known about the severity of pollution so that the alternative standards are established at obtainable levels. Finally, the required feasibility study assures that the consequences of increased degradation have been thoroughly analyzed and can be considered in determining the alternative standards.

The alternative approaches to standards evaluated in the feasibility study must include corrective actions intended to achieve compliance with the standards under items E to H. This provision ensures that the option of staying with the listed standards has been demonstrated to be infeasible or unreasonable. The feasibility study must also evaluate at least one additional approach intended to maintain ground water concentrations lower than four times the concentrations under item F. This ensures that raising the allowable concentrations to the drinking water limits does not become an automatic response when the ground water standards are thought to be too restrictive. Instead, this provision ensures that alternative standards set at some intermediate level have been considered.

Finally, the feasibility report must contain a determination of the pollutant concentrations that would remain in the ground water after corrective action. After determining these concentrations, the facility owner or operator must evaluate the impacts of using alternative limits on immediate and future ground water use. Chapter 7060 requires that ground water be maintained at a quality sufficient for use as a potable water supply. If the use of alternative limits would preclude this use, the Agency and the facility owner or operator must adequately evaluate these consequences. Feasibility studies should address the impacts on immediate and future use of the ground water because the use of alternative limits may in effect allow one person to control the adequacy of another person's water supplies. Thus, the use of alternative standards must be based on fully informed decisions.

Subitem (3) requires that alternative standards must take into account the quality required of public water supplies. It provides that if a public water supply is potentially affected by leachate migration from a facility, and if the maximum contaminant level (MCL) for a substance under the federal or State regulations governing public water supplies is a lower concentration than the standards under items E and F, the Commissioner may use the MCL as the alternative standard and intervention limit. Public water supply is defined in part 7035.0300, subpart 86, which refers to the State rules for public water supplies. The MCL can be lower than the standard under items E to H. Currently this is true for trichloroethylene, where the federal MCL is 5 micrograms per liter (ug/l) compared with the ground water standard in item F of 7.8 ug/l. See Exhibit XXIV. The reason for the discrepancy is that the standard in item F is derived from the MDH RAL for untreated private water supplies, which considers only the substance's effects on human health. In contrast, the federal and State MCLs also consider the fact that public water systems provide water treatment to remove contaminants. The RAL of 31.2 ug/l, above which trichloroethylene poses a greater than allowable cancer risk, can be bettered in public water systems through carbon treatment. The MCL of 5 ug/l reflects a more stringent level that is feasible through treatment. The difference between 5 and 7.8 ug/l is small, but the discrepancy could be larger for another substance. If a public water system is nearby, subitem (3) ensures that a land disposal facility will not impact ground water quality to the point where the public water system may be forced to treat its drinking water to comply with the MCL. This is consistent with the State's nondegradation policy in chapter 7060.

Subitem (4) allows the establishment of alternative standards for substances that might impart undesirable taste or odor to drinking water. This provision is needed because water that poses no health threat can be rendered useless by offensive tastes or odors. Recommended criteria are published in federal regulations and other published references. References 64 and 65. Generally, substances that pose a health threat become a cause for concern before substances that impact taste or order to drinking water. However, the Agency should have the ability to establish an alternative standard if taste and odor imparts are present. Subitem (4) limits application of these standards to cases in which the substance is present in the ground water and the MDH issues a concurring recommendation. The Agency will not routinely establish alternative standards under subitem (4). The Agency will exercise judgment about the need for such a standard, since some taste and odor standards are routinely exceeded by Minnesota's ground water.

Subitem (5) allows the establishment of alternative standards for substances not listed in item F. If an unlisted substance has been found by monitoring at the facility and is determined by the MDH to be potentially harmful to health, the Commissioner may establish alternative standards for that substance. This provision is needed on a case-by-case basis to protect human health and the ground water resource from harmful substances that have not yet had formal standards or RALs established. Any number of substances in leachates may have toxic or carcinogenic effects but have not been through the extensive review necessary to support a RAL or other limit. If one or more of these substances is found at elevated concentrations in ground water at a facility, the Commissioner should have the ability to limit that substance. The requirement for a MDH recommendation reasonably assures that any alternative standard will be imposed based on good evidence of the substance's adverse health effects, as determined by professionals with expertise in risk assessment. In practice, unlisted substances are usually accompanied by listed substances in leachate-affected ground water. It is assumed that if ground water complies with all quality standards, the concentrations of other substances for which standards are not available probably are not high either. If the monitoring data does show high levels of an unlisted, potentially harmful substance, however, subitem (5) provides the means to limit its concentration.

Unit (a) specifies procedures for determining the alternative ground water limits. The alternative limits are to be 25 percent of the concentration determined to pose the highest allowable risk from long-term consumption of the water. This is the same approach taken in item F. The same reasons as given under item F apply. For substances not classified by EPA as Group A (human carcinogen) or Group B (probable human carcinogen), the limits are to be set at 25 percent of a recommended allowable limit as determined by MDH. Reference 66. The term recommended allowable limit refers generically to any health-based concentration limit recommended by MDH rather than only those listed in the MDH's publication "Recommended Allowable Limits for Drinking Water." These recommendations are based on a thorough internal review by MDH following procedures similar to those used to develop the RALs; any higher-than-usual degree of uncertainty about a recommended limit is noted by MDH. The Commissioner has the discretion not to establish an alternative standard if the uncertainty is great.

Under unit (b), the alternative standard for a Group A or Group B carcinogen is set at 25 percent of either the concentration corresponding to a risk of one additional case of cancer per 100,000 adults consuming the water over a lifetime (the 10^{-5} standard), as estimated by EPA and MDH, or the recommended allowable limit under unit (a), whichever is lower. The reasonableness of the one-in-100,000 risk level has been described under item F. This risk level is generally at a lower concentration than the recommended allowable limit for noncarcinogenic toxicity effects, but the requirement to use the lower of the two reasonably protects against either harmful effect.

Subitem (6) states that if the recommended allowable limit or the one-in-100,000 risk level is changed, the Commissioner may change the alternative standards. This provision reflects the reality that as more toxicity testing is done, toxicity limits and carcinogenicity estimates change. Subitem (6) reasonably allows the Commissioner to establish standards that reflect the best and most current available information on toxicity. This ensures that the standards are neither underprotective nor overly protective. The Agency recognizes its obligation to revise the standards to reflect changes in the limits, but subitem (6) allows the Commissioner to adopt an alternative standard for a facility if needed. This degree of discretion is consistent with the Agency's broad permitting and standards-setting authorities under Minn. Stat. chs. 115 and 116. Subitem (6) reasonably constrains this discretion. In order for the Commissioner to establish the alternative standard, the substance must be present in the ground water at the facility, and the same 25 percent multiplier used elsewhere in subpart 4 must be applied.

Item I responds to comments from persons who were concerned that their compliance might be questioned if a substance could not be analytically detected down to the levels of the standard. Item I provides that if a substance is not detected and the limit of detection is higher than the intervention limit or standard, the intervention limit or standard will not be assumed to have been attained or exceeded. Laboratories do not report zero concentrations. Instead, when the analytical procedure does not detect a particular chemical, the result is reported as less than the value for the detection level. This provision simply eliminates any confusion that might result if, for example, a result is reported as "less than 10" and the standard is "1." The facility for which this result was obtained would not be out of compliance. A related provision, subpart 14, item M, allows the Commissioner to require lower analytical limits if necessary and feasible, thereby preventing Item I from becoming a loophole.

Item J allows the Commissioner to require corrective action in certain circumstances, even if a standard or intervention limit is not being exceeded. Any such action by the Commissioner must be based on investigation and evaluation. Under subitem (1), the first circumstance under which the Commissioner may act is the event of a substantial release of leachate that the Commissioner may reasonably expect to result in a violation of water quality standards. This provision prevents the facility owner or operator from refusing to act or investigate on the grounds that no limit has yet been exceeded. A number of different situations might necessitate immediate action, such as the rupture of a leachate tank or pond situated over shallow, poorly protected ground water. Item J will apply to emergency situations.

Under subitem (2), the Commissioner may require corrective action based on the additive carcinogenicity or toxicity of a combination of pollutants in the ground water, in lieu of the limits for individual substances under items E to H. The rationale and approach for using additive carcinogenicity or toxicity is given in the 51 Fed. Reg. 34014-34025 (1986). See Exhibit XXVII. This approach reflects the prevailing view that a mixture of many harmful substances, all below their individual health risk limits, poses a greater risk than any one of the individual substances considered singly. To illustrate, a water supply containing one substance at 90 percent of its allowable health limit is marginally safe, while another water supply containing 20 substances, each at 90 percent of its individual health limit, is not safe. The interaction of harmful chemicals in the body is a complex issue not yet well understood. It is known that the toxicity resulting from mixtures of toxins can be either greater than would be expected if the individual toxic effects were simply added (synergistic interaction) or less than would be expected (antagonistic interaction). On average, however, simple additivity has been taken to be the most reasonable approach when, as is usually true, no toxicity testing has been done on the same mixture. The Federal Register notice reasonably prescribes straight additivity unless enough specific toxicologic information is available to quantify synergistic or antagonistic effects. The additive approach is definitely more reasonable and protective than judging overall toxicity solely by comparing the concentrations of individual substances within a mixture to their individual limits. The Commissioner will apply additivity in situations only where many carcinogens are in the ground water and the health risk would obviously be greater than the highest risk posed by any individual carcinogen.

Finally, subitem (2) provides that response actions may be required if the total risk of consuming the water over a lifetime would exceed either 2.5 additional cases of cancer in a population of 1,000,000 persons or, for noncarcinogens, 25 percent of the acceptable concentration for long-term consumption. This provision reasonably maintains the same risk level as is used for individual substances in item F, i.e., 25 percent of the recommended health risk limits. The 25 percent level was already established regarding item F.

subitem (2) reasonably allows the Commissioner discretion in requiring response actions when this level is exceeded. For example, if less restrictive alternative standards had been established for an existing facility under item H, subitem (2), the 25 percent level would not be used to trigger response actions based on additive risk. Instead, the same percentage used to set the alternative standards would be used for the additive risk.

Subpart 5. Design requirements. This subpart establishes the standards for designing any mixed municipal solid waste land disposal facility. These standards provide the basic foundation from which the specific facility design will be established. The more general design standards included here list of the factors that must be considered in designing a mixed municipal solid waste land disposal facility. By providing a listing of the factors, the Agency believes more complete designs will be developed for the facilities and a more consistent review of the final designs will be facilitated.

Item A requires an engineering report to be developed concerning the facility design. The engineering report must address site preparation as it relates to the phase development also discussed in the engineering report. This item also lists the actions involved in site preparation activities. With this information, the facility owner or operator may schedule construction activities in a logical sequence that will not damage already completed work. Sound business practices dictate that a facility owner or operator develop plans for site activities before construction begins. Establishing the items to be addressed in the site preparation design discussion in the engineering report provides the facility owner or operator guidance on what must be considered when evaluating site preparation activities. It does not require more of the facility owner or operator than would be completed as a matter of practice, and will enable consistent review of these activities.

Item B requires the facility owner or operator to develop the site in phases. Each phase must consist of individual cells that promote a rate of vertical development that is faster than the rate of horizontal development. The phases must be designed and constructed to minimize moisture infiltration while maintaining stable side slopes. Seasonal phases based on weather conditions (wet/dry, cold/hot) must be considered when the design for the facility is developed. The site plans show development in chronological order for construction of each phase.

Dividing the facility into phases minimizes the amount of open surface, thus reducing the potential for accumulation of precipitation requiring special handling. Phasing of the facility construction allows each segment to be operated independently. As each section reaches final waste contours the final cover can be placed. The sectional construction technique will reduce run-off controls needed, erosion problems, and the possibility for windblown waste problems. A final advantage of phasing is that premature closure of the facility is more practical and economical in the event of an environmental problem that will require closure. In a well-planned phase development, the facility's end use can also be implemented in sequence. The Agency believes mixed municipal solid waste land disposal facilities should be constructed in phases because of the lower initial cost associated with construction, the reduced maintenance and operation problems and the ease with which the facility design and operation can be modified to accommodate changes in waste flow, in technology, and environmental conditions.

Item C requires that any new fill area at a land disposal facility be located at least 200 feet from the nearest property line. The Commissioner may approve adjustments to this requirement based on existing filling procedures, existing site structures, the facility design, compliance boundaries, and existing land restrictions. Establishing a fill boundary some distance from the property line provides room for site operations and a buffer zone to minimize any environmental impacts off the property should a release of pollutants occur. Land disposal facilities should not be designed or constructed with fill areas abutting property lines because that provides little protection against the migration of a release of pollutants off the facility property. The Agency believes 200 feet provide sufficient room to complete detection monitoring for pollutants in ground water below the fill areas and implementation of corrective actions before pollutants off-site and impacts nearby water supply wells. Requiring a separation distance greater than 200 feet could impose significant cost increases on the facility owner or operator with little additional environmental protection. Additionally, the facility owner or operator may suggest that no corrective actions be taken because the pollutants are not yet nearing potential ground water users. Large separation distances also create a need for more monitoring wells increasing costs incurred by the facility owner or operator. The dispersion characteristics of ground water cause the pollutant plume to spread out requiring the use of more wells to detect potential problems. Establishing a 200-foot setback provides room for site activities but does not waste considerable land as buffer zones.

Item D requires surface water to be drained around and away from the site operating area. The drainage control system may include topographic controls, ditches, berms, culverts, energy breaks, sedimentation ponds, and erosion control measures. The system must incorporate at least the requirements of this item. If surface water is allowed to flow freely over the fill areas, site operations may be disrupted resulting in environmental problems. If excess moisture is allowed into the fill area, the waste may be unable to absorb it and the result will be channelization of the water through the waste creating leachate that must be collected and treated. The additional moisture in the fill area will cause field capacity to be reached sooner than anticipated, influencing leachate generation to proceed at a faster rate than expected. Field capacity is the point at which the waste can hold no more liquid. Other problems associated with excess surface water flowing into the fill area include washout of the compacted waste, erosion of side slopes and liners, and ponding of water at the base of the fill. Excess moisture can cause vehicles to become stuck in the waste and damage the liner and leachate collection system. These problems may shut down filling operations until excess water is removed or the side slopes and liners repaired. Surface water control requirements will minimize potential impacts on the environment.

Subitem (1) requires the surface water control structures to be designed based on the expected final contours and planned drainage pattern. These design features can severely impact the effectiveness of the control structures if not properly addressed.

Subitem (2) requires the drainage pattern of the surrounding area and the possible effects on and by the regional watershed to be considered in the facility design. If the regional watershed is not considered, the facility at the discharge point could be flooded, causing erosion and potentially damaging surface waters due to excess sediment loading. A facility located at the head of the watershed could increase run-off into the watershed due to the removal of vegetation and change of contours disrupting the capabilities of the watershed to handle precipitation events. Because the location of a facility can impact or be impacted by the regional watershed, the facility design should address this concern. The standard should be performance-based because the specific characteristics of a regional watershed will dictate the facility design.

Subitem (3) requires that the need for temporary structures during fill operations be considered in the facility design to control surface water drainage. In order to minimize disruptions to the fill operations during or immediately after a precipitation event, it is necessary to construct temporary berms or ditches to intercept surface water drainage and direct it away from the fill. The berms or ditches may also be used between fill phases to minimize infiltration into a particular fill area until final cover can be placed on this area. Temporary control structures are used to minimize the amount of moisture entering a fill area and exiting as leachate and to permit fill operations to continue during and after precipitation. Temporary structures ensure the performance of the facility, minimize leachate treatment costs, and provide protection against washouts in specific areas of the fill operation and other portions of the facility. Temporary berms are also necessary to preserve the integrity of final cover systems. Temporary structures must be addressed in design plans and specifications.

Subitem (4) requires the base of each fill area and the top of each lift to be graded at a minimum 2 percent slope to encourage run-off and prevent surface water ponding. If surface water is allowed to pond on the fill area, it will move into the fill and generate leachate. Fill areas should be sloped to encourage surface water run-off from the fill area and prevent ponding. A 2 percent slope on the graded areas is a minimum performance/design standard. A 2 percent slope means a vertical difference of 2 feet is achieved for every one-hundred foot horizontal distance travelled. If the slope were permitted to be less than 2 percent, the probability that the correct slope would be achieved is greatly reduced. To grade such tight slopes on a hard surface is easily achieved by an experienced operator; but is very difficult on the jagged surface of compacted waste. A 2 percent standard will provide direction on the amount of slope needed to ensure surface water drainage and prevent ponding as settlement occurs.

Subitem (5) requires that surface water control structures be designed for a ten-year, 24-hour rainfall. Appendix XIII shows that a ten-year, 24-hour rainfall event will surpass the control design about 40 percent of the time if the design life of the facility is five years. A facility permit is effective for five years. As the fill area is increased, the surface water control structures will be constructed in a manner to protect that area. The final closure and postclosure plans will address any changes in the surface water control structures needed to maintain the long-term integrity of the facility. Commentors on the draft rules suggested that a ten-year, 24-hour rainfall event was a reasonable standard considering the opportunity for design revisions and because the standard is written as a minimum standard allowing the facility owner or operator to assess whether this is an acceptable risk. The standard is capable of providing the necessary surface water drainage control needed at facilities.

Item E requires the facility owner or operator to design and maintain slopes and drainageways to prevent erosion. This performance standard is established to maintain the integrity of the facility design, particularly final cover areas and liners. If the final cover is eroded away, it will not prevent the infiltration of precipitation. If the liner is eroded away, it will be unable to contain the leachate as designed, increasing the risk that ground water or surface water will be impacted. Because of the importance of these design features to the overall performance of the facility, a standard is established protecting their integrity.

Item E further requires that slopes greater than 200 feet long include diversion drainage control structures unless the Commissioner approves otherwise based on sedimentation run-off calculations, proposed design features, and sedimentation control devices. The Soil Conservation Service has developed a computer model to determine the expected amount of sediment run-off based on a particular design, soil type and vegetation used. The Universal soil loss equation is the basis for these calculations. Reference 67. The Agency believes this standard provides a commonly-used minimum criterion for controlling soil loss. It also provides the facility owner or operator an opportunity to seek the Commissioner's approval of alternative designs utilizing longer slope runs capable of minimizing erosion at the facility while meeting the specific design and operation needs of the facility.

Under this item, the facility owner or operator is required to consider using flumes or drop structures to control surface water movement from top slopes to steeper side slopes. Any drainageway used to control movement of water from the flatter top slopes to the steeper side slopes must include energy breaks, concrete, or rip-rap reinforcement to prevent erosion of the drainageway or the final cover. When water flows over a relatively flat, wide expanse, it moves slowly and at an even rate. When this water moves onto steeper slopes, its velocity increases. The increased velocity may detach normally stable soil particles. To prevent this sheet erosion, it is necessary to design control structures that collect the water from the top slope and direct it down the steeper slope to minimize soil disruption, e.g., flumes or drainageways with energy breaks. An eroded cover or liner cannot perform as designed, constructed or operated and may impact the environment. Reference 68.

Item F requires the installation of sedimentation ponds if run-off water would carry excess sediment off the facility property. A facility owner or operator electing not to install sedimentation ponds must demonstrate that any sediment carried off-site by surface water drainage will not impact nearby surface waters, drainage ditches or culverts, or other features of concern. In general, land disposal facilities are susceptible to erosion because of the uneven settlement that occurs leaving broken soil clods easily moved by water flowing over the area. Sedimentation ponds will be needed at all facilities except where sufficient land is available to act as a filter before the sediment reaches surface waters or settles out in a drainage ditch or culvert and plugs these structures causing a backup in the system. Nonpoint pollution is caused by sediment with pollutants adsorbed to its surface flowing into nearby surface waters, depleting the waters of oxygen and discharging potentially toxic pollutants into the waterway. <u>See</u> Exhibits XXVIII, XXIX, XXX, XXXI, XXXII and XXXIII.

This item authorizes the Commissioner to require monitoring of the water in the sedimentation pond or beneath the pond and require corrective actions, if necessary. Surface water run-off from fill areas may contain pollutants if the facility is designed such that all run-off is collected in the sedimentation ponds. The water should be tested prior to it leaving the sedimentation pond.

Item G requires the final contours of a mixed municipal solid waste land disposal facility to have at least a 3 percent and no greater than 20 percent slope, unless the Commissioner approves otherwise based on existing site topography, design plans, and operating conditions. The slopes are based on the need to encourage surface water drainage off the cover while minimizing the amount of erosion experienced. The EPA recommends that the top slope be no greater than 5 percent and side slopes no greater than 25 percent. Reference 69. The present requirements of 2 percent slopes on top and 25 percent side slopes have resulted in ponding of surface water on top and erosion of side slopes. The 2 percent slope criterion has failed to maintain itself under settlement of the waste. With consistent, compacted, uniform materials a slope of 1 percent can permit the movement of water off an area. However, the surface of a land disposal facility does not meet this criterion. Settlement occurs at different rates at different points on the surface. The minimum standard of 3 percent is intended to provide ample slope even during periods of mild settlement. The 20 percent maximum side slope was chosen to prevent the soil erosion problems experienced on side slopes of existing land disposal facilities. By decreasing the allowable maximum slope the velocity of the water flowing over the side areas will be decreased, lessening the potential and amount of soil loss experienced. Commentors on the draft rules agreed in principle with the minimum and maximum slope requirements, but suggested that steeper slopes should be permitted, without variance proceedings, if the facility owner or operator can show the Commissioner evidence supporting the alternative design. The Agency agreed and has provided language to that effect in the proposed rules. The Agency believes the standards presented in item G provide a base level assurance on surface water drainage and erosion control while providing the facility owner or operator a method to propose alternative designs suitable to site-specific conditions.

Item H contains a list of references guiding the facility owner or operator to other subparts of this rule that address specific design standards for the systems required at a mixed municipal solid waste land disposal facility. It is reasonable to separate the design requirements for the various systems because it would be long and cumbersome to address all these concerns in one area. By separating the design requirements into smaller subparts, it is easier for the facility owners or operator to locate specific requirements. By providing references, the Agency has further assisted the facility owner or operator in this task. Subitem (5) is of particular interest since it allows a facility owner or operator to justify that a gas monitoring and collection system is not necessary.

Subpart 6. Intermittent, intermediate, and final cover system. This subpart provides the standards governing the design, construction, and operation of the cover systems used at a land disposal facility. The various covers used at a facility have different intended purposes, thus requiring different standards. Regarding cover systems, performance standards alone will not be sufficient to ensure minimum risk management methods are utilized. The main functions of the cover systems are to minimize vector breeding areas and animal attraction; to control water and gas movement; to minimize fire hazards; to minimize aesthetic problems; to prepare for the site's end uses; and many other functions necessary to maintain the facility in a manner that achieves the standards. This Agency recognizes that although the cover functions are straightforward, the interrelationship of the various functions is quite complex. Therefore, performance standards and design standards are interwoven within this subpart.

The owner or operator of a mixed municipal solid waste land disposal facility must design and maintain a cover system capable of:

a. minimizing infiltration of water;
b. preventing surface water ponding;
c. controlling gas movement;
d. preventing erosion of surface and side slopes;
e. reducing wind erosion and wind-blown litter;
f. minimizing dust generation and movement;
g. retaining slope stability;
h. reducing effects of freeze-thaw and other weather conditions;
i. maintaining vegetative growth; and
j. discouraging vector and burrowing animal intrusion.

The cover is intended to minimize the potential risks associated with the design, construction, and operation of mixed municipal solid waste land disposal facilities.

The most basic cover design to meet these criteria would have two layers. The layers would consist of the surface layer for vegetative growth and the hydraulic barrier layer to control gas and water movement. The basic design would only be acceptable in an arid climate with high evaporation and low rainfall. Other climatic regions require other contributing layers to assist in the prime functions of barring downward movement of water into the fill area and limiting upward passage of vapors.

To bar the downward movement of water, the cover must be designed to convert rainfall and melting snow into run-off. This is accomplished by sloping the cover so rainfall and snow melt flows off the site at a rate fast enough to minimize infiltration, but slow enough to avoid erosion and cover damage. A vegetative layer is used to help prevent erosion and encourage evaporation. Below the vegetative layer lies the barrier layer, which is the first element of the cover designed to specifically prohibit infiltration. The barrier layer is not sufficient to totally prevent infiltration into the waste. A drainage layer placed between the vegetative layer and the barrier layer serves to collect and laterally drain away the moisture. It is the Agency's belief that three layers are the minimum number needed for a final cover system to be effective in deterring the downward movement of surface water into the waste. The specific design and performance standards for each layer will be discussed in items C, D and E. The rule gives facility owners and operators sufficient flexibility to include other functional layers into the cover design to control gas movement or act as filter medium.

Cover systems may be composed of combinations of soil, synthetic material, or specialized waste-forms (e.g., lime sludge, foundry sands, compost). Although soil is the predominant choice because of its availability and structural properties, the other materials are functionally acceptable under specific conditions. The final cover design must consider available materials and the function they are to serve in the final cover. For instance, cohesionless soils, sands and gravels, perform best in the drainage layer. Low permeability soils like clay or lime sludge function best in the barrier layer. Compost can be used as the top layer to support vegetation.

The last layer often used in a final cover system is a buffer layer between the waste and the barrier layer. The buffer layer serves as protection to keep solid waste from puncturing the barrier layer. It also serves as load-bearing support for the cover and may contain a portion of the gas collection system. The depth of the buffer layer will depend on the exact functions it is to perform.

The above discussion demonstrates the need for flexibility in the rules to allow facility owners and operators to adapt designs to control risks associated with the management of waste at their land disposal facility. The Agency believes that the facility owner or operator should decide on the risk management techniques suitable for a particular facility. It is reasonable to provide the general performance standards before establishing the requirements for specific features of the cover system because general goals normally influence the specific details.

Item A requires facility owners and operators to place intermittent cover on all exposed solid waste in accordance with the operation and maintenance manual developed for the site. Intermittent cover means material placed over solid waste on a scheduled frequency but not necessarily daily. The material need not be naturally-occurring soils, if another suitable material is available. The intermittent cover design submitted for approval by the Commissioner must include the frequency and depth of placement and the material to be used. The Commissioner's approval will be based on the characteristics of the proposed cover material; the leaching potential of the solid waste; the design and operation of the facility; and the potential for nuisance conditions if an application frequency other than daily is used. The minimum standards to be included are no-less-than-weekly cover and no-less-than-six-inches of cover material, if it is a soil or similar material.

Intermittent cover is used to control blowing litter; vector and animal intrusion; surface water ponding and infiltration; and fire hazards. Intermittent cover provides structural support for the fill area and a surface for vehicular traffic. The design and use of intermittent cover will depend on the availability of soils, the amount of waste received, and filling sequence intended for the facility. The Agency believes the facility owner or operator should be allowed to propose an intermittent cover design compatible with actual site conditions. This allows the facility owner or operator to analyze the cost-effectiveness of various designs, the degree to which a particular design or material will assist in meeting overall facility performance standards, and the risk associated with using one design instead of another.

Technological advances in the area of cover material have provided alternatives to soil for accomplishing the intended performance goals of intermittent cover. Additionally, some forms of solid waste, such as foundry sands, power plant ash, and lime sludges, may be suitable cover materials. Therefore, the facility owner or operator should be permitted to propose a cover material rather than establishing in rule the type of material and requiring variances for the use of other materials. The flexibility of this provision permits technological advances to be incorporated into cover designs without modification of the rules.

The design must also address the depth to which cover must be applied to achieve the performance goals for intermittent cover. Six inches of soil has been found necessary in order to deter animals from scavenging in the waste or vectors from breeding and to promote surface water drainage from the fill area. Reference 69. Some settling of the soil into the waste will occur during placement. The minimum depth of cover needed to address settlement and still completely cover the compacted waste is six inches. In the past, facility owners and operators have complained that no direction is provided indicating where the six inches is to be measured and that not all facilities have sufficient daily cover on-site. The rule provides for six inches as a minimum standard. Specific details on material type, placement depth and measurement are spelled out in the operation and maintenance manual and the construction quality assurance plan. This allows the facility owner or operator an opportunity to scale down cover depth with the use of materials such as foams that hold the cover in place, form a crust that encourages surface water run-off, and will break up and be incorporated into the fill during the following day's activities.

This item requires that the frequency of cover placement must be at least once per week. However, in submitting the cover design, the facility owner or operator may show why daily cover is not necessary and how the proposed frequency will provide sufficient controls on vector and animal intrusion, fire hazards, windblown litter, and infiltration. The owner or operator must address how facility operations will control the potential problems associated with not covering the fill areas daily. Of particular concern to the Agency is the potential for infiltration of water into the fill area during the periods when no cover is on the waste. If infiltration of water into the fill area is not restricted, the waste will become saturated and generate leachate sooner and in larger quantities than expected. Table 2 compares the generation of leachate in an uncovered fill area of compacted waste with areas using various soils as cover. The table shows that even a six-inch cover of uncompacted sand will decrease the amount of leachate generated in one year by 16,000 gallons or 4 percent. Over the life of a facility, on the average 15 years, this amounts to a savings of 240,000 gallons that will not require storage, treatment or disposal. If the facility owner or operator intends not to use daily cover, the change in leachate generation must be considered in designing the leachate collection system. If the collection system is not adequately designed to handle the increased flow, the integrity and ultimate performance of the system may be in jeopardy.

TABLE 2

Leachate Generation*

Cover Type	Leachate Generation (gallons/year)
Uncovered Waste	452,000
Sand	436,000
Silty Sand	394,000
Loam	304,000

* Leachate generation figures are calculated using the HELP model developed by the United States Corps of Engineers. For further detail on the calculations and the HELP model, it is necessary to consult the appropriate exhibits. See Exhibits XXXIV and XXXV.

Shredding and baling waste can deter animal intrusion and blowing litter. Residual waste leachates may not represent the risks expected from mixed municipal solid waste leachate and treatment may not be as difficult; thus reducing the concern for minimizing the infiltration experienced from daily rainfall events. In situations where large amounts of waste are received on a daily basis and filling areas are small for rapid vertical filling, it may be more reasonable to cover after each lift is complete rather than on a 24-hour or working day basis. A lift may be eight feet in height, and if sufficient waste enters the facility on a consistent basis to create a lift in less than 24 hours, the facility may be better served if cover were placed at less often than daily. A facility receiving enough waste to create eight-foot lifts every 24- to 36-hour period will normally need to consider gas collection and treatment systems due to the amount of gas that may be generated during decomposition. In situations like this, allowing cover to be placed less frequently than daily may provide continuation within the lift to promote efficient gas collection. For these reasons, the Agency believes it is reasonable to allow some flexibility in the design of the portion of the cover system used to cover daily fill activities. Facility needs and correct solutions vary and it is necessary to be able to address these in rule.

Item B establishes the requirements for intermediate cover. Intermediate cover must be used when no additional fill will be placed in a particular area for 30 days. The cover must be at least 12 inches thick, if soil or similar materials are used, and graded to prevent surface water ponding. Intermediate cover is intended to minimize infiltration during the period of time filling must occur in another portion of the facility. Intermediate cover normally consists of lower permeability soils than the intermittent cover and these soils may not be present on site. The rule does not require a specific soil type to be used as intermediate cover because the ultimate design and availability of materials will determine whether to use soils, asphalt materials, or synthetic membranes. If intermediate cover is needed rarely at a facility, importing soil cover may not be as cost prohibitive as it would be for a frequent user of intermediate cover. At a facility utilizing intermediate cover on a frequent basis, it may be more realistic to seek cheaper alternatives.

Under subpart 5, the fill plan must consider seasonal and other weather impacts on constructing fill areas, placing final cover, and general maintenance needs within the fill. To meet the performance goal of minimizing infiltration into the fill areas, the Agency expects fill phases to be six months to one year in length. Fill phases designed for longer than six months may result in extended periods of time where intermediate cover is expected to deter moisture movement into the waste. Additionally, the larger horizontal area exposed to moisture prior to the placing of final cover increases the amount of leachate generated. The intermediate cover is intended only as a short term cover system until the next lift of waste is placed in the area. Operational plans should not include significant time blocks allocated to the maintenance of the intermediate cover because this would be extremely time intensive for little return. A more efficient approach is minimizing the size of the working area and eliminating the need for intermediate cover to the extent possible. It is not expected that intermediate cover would be needed with any frequency at most facilities because 30 days represents a significant portion of a six-month fill phase. Thirty days is a reasonable time frame in determining when intermediate cover should be used because precipitation during a 30-day period can be significant. The time frame for intermediate cover also serves to encourage filling in one area, to the extent possible, until final waste elevations are achieved. Once fill elevations are reached, there may be a need for intermediate cover to carry the system over until final cover may be put in place during the spring rather than the winter. Some flexibility should be allowed in designing fill operations while maintaining some basic control on the amount of infiltration through the cover system.

The Agency believes 12 inches of compacted soils is appropriate design standard for intermediate cover. Settlement will occur during the time intermediate cover must serve as a moisture retardant and to discourage animal intrusion. The amount of cracking, sifting, and erosion of the cover is dependent on the amount of settlement that does occur. Because intermediate cover may need to function for as long as six months, winter to summer, before final cover is placed, it is important that the intermediate cover retain its integrity during this time. Twelve inches was chosen as the standard for two reasons. The first reason is experience. Current Agency solid waste rules require 12 inches of intermediate cover and this has worked well. Thus, this requirement would not be a change for facility owners and operators to adjust to when the proposed rules become effective. Second, this depth of soil will allow for some filling of voids in the compacted waste to assure good waste coverage. Intermediate cover provides a base on which the facility owner or operator can grade the final cover or next lift of waste without disturbing the in-place waste. The foundation permits adequate compaction and encourages good buffer between barrier layers and waste fill areas.

Item C establishes the final cover requirement for existing facilities intended to be completely closed within 18 months after the effective date of parts 7035.2525 to 7035.2815. If a facility owner or operator will be closing the land disposal facility within 18 months after the effective date, it would be unreasonable to require the same cover system needed for facilities operating longer. The facility owners and operators facing closure within 18 months will not be able to change the design of the facility to meet the proposed slope requirements or cover design standards before closure. Additionally, the cost of the proposed cover design would not have been incorporated into the facility budget. This would create a need for large increases in the rates to cover expenses. A large rate increase may result in a decrease in business, causing operations to continue longer than expected. The Agency believes it is preferable to allow existing facilities that are nearly complete to be closed under intermediate standards rather than continue the operations for some extended period.

Subitem (1) requires the final cover system to be compatible with the end use of the site. The design and construction requirements of this item are minimum standards only. It is important that the facility owner or operator consider the risks associated with constructing a cover system meeting only the minimum standards. The intention of a final cover system is to minimize infiltration of precipitation entering the fill area resulting in the generation of leachate. If the integrity of this cover system is disrupted, the performance goal of minimizing infiltration will not be met and the risk and liability of impacting ground water or surface water will increase. Therefore, it is important that the facility owner or operator consider the final end use for the site in order that protection measures may be factored into the design of the final cover system.

The facility owner or operator should design and construct a final cover system compatible with the end use because the preplanning efforts will ensure the integrity of the final cover. If the preplanning effort is not reflected in facility design plans and specifications, the final cover system may be completely inadequate to address the potential needs and risks associated with the end use. Finally the requirement to consider the design of the final cover system with the end use of the site is no more than sound business practice.

Subitem (2) requires the final cover system at short-term facilities to be graded in a manner that prevents surface water ponding. The minimum acceptable slope is two percent and the maximum slope is 25 percent. The final cover system is intended to minimize the amount of infiltration into the waste fill areas. Surface water ponding creates pressure on the water above the cover soils, increasing the downward movement of liquids through the cover system and into the waste. The final cover system should be constructed to prevent surface water ponding, thus allowing the cover soils to perform in their intended manner and reducing the amount of infiltration occurring at the facility. The risk associated with the amount of leachate generated will also be reduced.

The minimum slope requirements proposed in this subitem are the standards required under existing Agency solid waste rules and permits. The Agency proposes to retain the existing slope standards for facilities with only 18 months of remaining capacity. New requirements requiring the facility owner or operator to alter the final slopes for the areas to be filled in during the last 18 months would result in considerable design alterations. The design alterations would take some time to complete and be approved. During this time, filling would continue to take place, increasing the difficulty for the facility owner or operator to make the necessary changes in operation and construction. The change in slopes could cause the facility owner or operator to request additional fill capacity and change in final waste contours to allow the remaining fill area to be compatible with previously closed areas, or require the facility owner or operator to lower the final waste elevations in the remaining fill areas to obtain the necessary slopes and be compatible with existing areas. The drop in final waste contours would decrease the total facility capacity, causing the facility owner or operator to close the facility sooner than intended. The earlier closure could prohibit the facility owner or operator from generating sufficient operating revenue to complete closure activities as scheduled and to set aside funds for postclosure care and contingency action.

Subitem (3) establishes the particular final cover design requirements to be followed by the owner or operator of a mixed municipal solid waste land disposal facility with 18 months or less remaining capacity. The standards listed in this subitem are minimum standards and the facility owner or operator may choose to design and construct a final cover system using more stringent standards that minimize the risks associated with the use of a minimum design. Subitem (3) requires the final cover system to be composed of two layers, a barrier layer and a top layer capable of sustaining vegetation. The barrier layer must be at least 24 inches thick, if soils or similar materials are used. If a synthetic material is used as the barrier layer, it must be at least 30/1000 of an inch thick. The barrier layer may have a permeability no greater than 2 x 10^{-6} centimeters per second. The barrier layer must be overlain by at least 12 inches of material of which at least six inches is topsoil. The top layer must be capable of sustaining vegetative growth.

The existing Agency solid waste rules require 24 inches of compacted earth material maintained with sufficient topsoil to provide suitable vegetation. No specific standard is provided as to what earth materials are acceptable. The Agency believes that a more definitive standard must be established to ensure that minimal performance criteria are attained at all mixed municipal solid waste land disposal facilities. This level of protection is necessary to minimize the amount of leachate generated at these facilities. Facilities governed by this subitem, in almost all cases, have no liner or leachate collection system. The fill areas are located in old gravel pits, floodplain areas and other undesirable locations. If the amount of leachate generated is not limited, the risk to ground water and surface water grows. Under the existing final cover criteria, facility owners and operators have used any available soils to attain 24 inches of earthen material with little regard for its potential to retain moisture or retard the downward percolation of moisture. In many cases, this material is high in sand or gravel content, resulting in a highly permeable cover that allows significant amounts of moisture into the fill area. By providing a minimum set of standards, the Agency defines a maximum amount of risk associated with the final cover system. The facility owner or operator must determine the costs and benefits associated with altering the design to further minimize the amounts of leachate generated and the risk associated with it.

In 1981 and thereafter, the Agency began to define the accepted final cover design in facility permits. While remaining within the 24-inch cover requirement, the Agency began to require that the final cover design be capable of minimizing infiltration and promoting surface run-off rather than just function as a support medium for vegetative growth. Under these requirements, final cover systems consisted of 12 inches of a low-permeability soil and twelve inches of on-site soils, six inches of which were capable of sustaining vegetation. The low-permeability soils were to function as a barrier layer and the top on-site soils as a vegetative layer. Although these provisions met the design requirement of 24 inches and attempted to define the characteristics of a final cover design to control infiltration and promote surface run-off, the Agency believes that a more defined set of design standards is needed in rules that will promote a more consistent approach to the design.

For short term land disposal facilities, the Agency believes a compromise must be made on the cover design. Some balance must be achieved between the cost of establishing a good cover over the fill area and the benefits from closing small portions of these facilities with the new cover design. The benefits may be small because previously closed areas may have no more than 24 inches of sand for final cover and were not placed with the intent to mimimize infiltration. The Agency believes the design requirements of subitem (3) are a reasonable attempt to balance costs with the need for good final covers. While maintaining the same slope requirements, the Agency has changed the final cover thickness from 24 inches to 36 inches.

If only one lift were used, the percolation of moisture through the cover would be high. Therefore, it is necessary to use additional lifts to rectify this situation as each succeeding lift builds a firmer base for the compaction equipment to operate on. The Agency believes it is reasonable to require the owners and operators of existing land disposal facilities to construct a final cover with the additional 12 inches of barrier material because it serves not only as a deterrent of downward movement of moisture into the fill areas but also because of the structural support it provides. The requirement that all existing facilities meet this standard eliminates the competitive advantage that may have been given to the facility owners and operators whose permits had not yet been reissued with a defined cover design. All facilities operating at the same time should be required to meet the same minimum standard.

The Agency believes it is necessary to have at least 12 inches of top cover over the barrier layer. The top cover performs many functions in the final cover system. Three of the most important functions are water-holding capacity, vegetative support, and prevention of drying of the barrier layer. The water-holding capacity of a particular soil is directly proportional to the thickness of the soil. For instance, the water-holding capacity of silt is two inches of water per foot of soil. If only six inches of soil were present it would only be able to hold one inch of water. If the cover were doubled to 24 inches it would be able to hold four inches of water. It is important that the soil used for the top layer have good water-holding capacity for two reasons. The first being to minimize infiltration, absorbing as much as possible of the precipitation that does not run off. Second, the moisture after absorption becomes available to the vegetative roots within the top layer. Third, providing a top layer of soil over the barrier layer prevents desiccation of the barrier layer. Because the top layer has the ability to hold a certain amount of moisture, dependent on the type of soil, the moisture held in the barrier layer is not evaporated and desiccation cracks do not develop in the barrier layer. It is important to prevent these cracks as they serve as conduits for moisture to percolate through the barrier layer into the fill. The final function of the top soil layer is as a growth area for the final cover vegetation. A good vegetative growth on the final cover stabilizes the cover soil and minimizes erosion, and encourages evapotranspiration. A normal seed mixture will contain annual ryegrasses, Kentucky blugrass and various fescues. These grasses have a root zone growth between 12 and 18 inches. If the Agency were to allow only a six-inch top layer, the roots would either penetrate the barrier layer providing a conduit for infiltration or die because of insufficient growth area. Thus, the Agency believes a minimum depth of 12 inches should be used as the top layer of the final cover system.

Subitem (3) requires that at least the uppermost six inches of the top layer consist of earthen material classified as topsoil. Topsoil is a loam-type soil that has good moisture holding capacity and nutritive content for supporting vegetative growth. By requiring at least six inches of topsoil, the Agency ensures that suitable moisture will be available to establish vegetation on the final cover and minimize the drying of the barrier layer.

It is unreasonable to require that the entire top layer of the cover system consist of topsoil because of the expense associated with this material. Only six inches of topsoil are needed to germinate seeds, thus the six-inch topsoil requirement would meet this need. The additional soil in the top layer provides additional water-holding capacity and a growing depth for the vegetative roots. The Agency believes this design will provide the minimum depth needed to establish root growth and protect the barrier layer from desiccation, while ensuring that all facilities are constructed with the minimal amount of topsoil needed to germinate the cover grasses. This design establishes minimum criteria consistent for all facilities while allowing the facility owners and operators to use available soils to minimize costs during the last 18 months of operation.

The Agency believes it is reasonable to allow facility owners or operators the option of substituting a synthetic material for soil as the barrier layer. A soil capable of meeting the 2×10^{-6} centimeters per second permeability standard may not always be available on-site. Therefore, the facility owner or operator is allowed to evaluate the cost effectiveness of using synthetic materials for the barrier layer.

The permeability standard of 2×10^{-6} centimeters per second for the barrier layer is needed to control the amount of infiltration of moisture into the fill area. The proposed standard is easily attained in the field under normal fill conditions. Because mixed municipal solid waste does not form a universally firm base in the fill area even when compacted, compacting soils to meet very low permeabilities requires very careful soil selection and field application of compaction techniques. For existing facilities, whose owners and operators have not anticipated costs associated with low-permeability soils, a permeability standard less than 2 x 10^{-6} centimeters per second would be unreasonable. This is particularly true when as much as 50 percent of the fill area may be covered with on-site soils before this standard is in effect.

The proposed permeability standard establishes a necessary basis to deter the downward movements of moisture into the fill area. Table 2 compares the amount of moisture moving through a 24-inch barrier layer of varying permeabilities. The proposed design standard restricts the amount of infiltration into the fill area and is reasonably achieved with commonly found soils and compaction techniques. As with all design standards, the facility owner or operator may choose to use a lower permeability to lower the risk associated with operating the fill. This would be a particularly important consideration for the facility operations that have functioned as area fills and have a majority of the fill area uncovered at the time the rules are effective. By using a final cover design more restrictive than the minimum standards proposed in this subitem, the facility owner or operator may reduce the long-term care needs for the facility by minimizing the amount of infiltration into the fill area.

Subitem (4) requires the facility owner or operator to establish a vegetative cover on the fill areas consisting of shallow-rooted perennial grasses or other suitable vegetation that will not penetrate the barrier layer. A good vegetative cover serves three main functions. First, the root structure of the grasses stabilizes the completed slopes and protects them from erosion. Erosion can expose buried waste, contribute to off-site sedimentation problems, and ultimately impact water quality. Second, vegetative cover helps control water infiltration into the fill areas as growing plants utilize water from the soil and decrease the amount that may percolate into the barrier layer. Finally, vegetative cover enhances the overall site appearance. Vegetative cover is usually the lowest cost item of the final cover system. A good vegetative cover is an easily attainable standard and is not an additional burden placed on the owners and operators. It is required in existing Agency solid waste rules and facility permits.

Item D establishes the final cover design requirements for new mixed municipal solid waste land disposal facilities and existing facilities that will be in operation longer than 18 months after the effective date of parts 7035.2525 to 7035.2815. The minimum design standards proposed in this item are consistent with the Agency's overall risk management approach to the design, construction and operation of solid waste management facilities. It is the Agency's position that the design and performance standards of this item are the basis for developing a facility capable of minimizing the risks associated with land disposal of mixed municipal solid waste. The standards proposed under this item must be reviewed carefully by the facility owner or operator to determine the combination of options that best suits site conditions. If taken as written, the design standards alone will not result in a facility capable of complying with performance standards. That is, the design standards cannot be taken verbatim from the appropriate section for designing a final cover system. The design standards must be used in conjunction with the performance standards to comply with the requirement of this item. The design requirements must be adjusted in some manner to meet the performance standards. Facility owners and operators are required to evaluate the performance of the facility and consider specific site topographic features, hydrogeologic conditions, and operation of the facility in developing the final design. Including minimum design standards in the proposed rules causes the facility owners and operators to know the Agency's position as to what is required to minimize the potential impacts from the operation of a solid waste management facility. The facility owner or operator may make cost/benefit comparisons between designs in the overall facility risk management program. The use of specific design standards coupled with performance standards provides consistency in the amount of work that must be completed by each facility owner and operator. The standards also állow flexibility for modifications above the base level requirement for additional controls that are site-specific.

Subitem (1) requires the final cover system to be compatible with the end use anticipated for the site. The integrity of the final cover system is critical to the overall performance of the facility because of the potential erosion problems, leachate generation, and other problems resulting from the disruption of the final cover. The subitem provides the facility owner or operator flexibility in designing the final cover as it relates to the end use. This subitem does not define one type of final cover for all facilities. This would reduce the options for using the site after closure. For instance, a site to be used as open space would vary in design considerably from a site to be used as a golf course or tree farm. Postclosure care costs and maintenance efforts are directly related to the site design. Only the facility owner or operator can determine the appropriate comfort level for risks associated with facility operations and long-term care.

Subitem (2) requires the facility owner or operator to design and construct a final cover system capable of containing or rejecting at least 90 percent of the precipitation falling on the system. The final cover system is intended to divert moisture away from the fill area to minimize the amount of leachate generated. The standard for containing or rejecting 90 percent of the precipitation falling on the cover system is easily attained when using soils with good moisture-holding capacity and sloping the final cover in a manner that encourages draining off the area. As shown in Table 3, even with careful control on the cover design, including materials used, slopes achieved, and drainage length, the facility owner or operator cannot comply with the performance standard if only the minimum design standards are used. The Agency intended this result. It is the facility owner's or operator's responsibility to determine the actual design. The Agency only establishes minimum protection levels.

TABLE 3

Infiltration Through Final Cover*

Parameter	Volume inches/year	Volume gallons/year
Precipitation	25.76	17,482,000
Runoff	0.658	447,000
Evapotransperation	21.334	14,480,000
Percolation from Base of Cover	3.8019	2,581,000
Drainage from Base of Cover	0.038	26,000

* Design characteristics:

Top layer	18" loam
Drainage layer	6" sand
Barrier layer	24" clay
Drainage length	200 feet

Calculations completed using HELP model. <u>See</u> Exhibits XXXIV and XXXV.

By establishing a performance standard, the Agency allows the facility owner or operator to consider the materials available, the final cover design standards, and the risk associated with just meeting the performance standard as compared to exceeding the standard. The final cover system design is only one component of the overall performance standard to be achieved at the facility. Establishing a base level performance standard serves as a guide in designing final cover systems. The benefits vary with the design unless a minimal level of protection is required. Some soils are better noted for strength while others have a greater moisture-holding capacity. Without a performance criterion either design material may be acceptable. Every final cover system must be able to control infiltration.

The performance standard of 90 percent was chosen by the Agency as a reasonable goal because it requires that consideration be given to the final cover design system yet takes into account the long-term effects Minnesota winters may have on the cover system. A performance standard less than 90 percent can be theoretically achieved by the placement of soils with some moisture-holding capacity. Little advantage is seen in establishing a performance standard less than 90 percent over minimum design standards. For instance, a performance standard of 80 percent would result in 4.5 inches of infiltration in the fill area, assuming 30 inches of precipitation. When compared to the 33 percent decrease in infiltration (3.0 inches) for the 90 percent standard, the advantages become obvious. For the additional effort, considerable costs are saved in the amount of leachate requiring treatment. A performance standard greater than 90 percent does not reflect the freeze-thaw effects nor does it recognize the existence of the barrier liner used to collect infiltrating moisture in the form of leachate. Ninety percent efficiency is attainable without significant changes in the minimum design standards established in rules. The facility owner or operator has the opportunity to evaluate the risks associated with particular designs that meet or exceed this standard.

Subitem (3) requires the final cover system to consist of soils or amended soils in three distinct layers. The uppermost layer is designed to allow only vertical flow downward, or upward through evapotranspiration. This layer provides protection for the lower layers and a medium for vegetative growth. The drainage layer, located immediately below the uppermost layer, is composed of permeable material designed to intercept, collect, and remove water percolating through the surface. This layer will remove water that could infiltrate into the waste and provide some protection from erosion. The lowest layer in the composite system is designed as a barrier layer. The barrier layer is intended to minimize the downward migration of moisture into the fill area and the upward migration of gases. This subitem establishes the minimum design standards for each layer of the final cover system.

Each component must be reviewed for its intended use, its interaction with the other layers, and its cost. The rule establishes the minimal acceptable designs for each layer in order that some of the more costly components of the system are not overlooked. The computerized HELP model allows the facility owner or operator to make these comparisons quickly for use in comparing various design options. <u>See</u> Exhibits XXXIV and XXXV. This model is available from EPA. The Agency uses it when reviewing design proposals. The details of the model will be discussed in conjunction with the liner design and performance standards but are highlighted here to show that assistance is available to the facility owner and operator in evaluating the effectiveness of designs.

The lowermost layer, barrier layer, of the final cover system must be at least 24 inches thick if it consists of soils or amended soils. If placed on an evenly graded firm foundation, a layer of six to twelve inches of compacted soils may result in a barrier capable of minimizing the downward migration of moisture. However, in the case of solid waste land disposal facilities, this condition does not exist. The waste in the fill area is not homogeneous. It consists of large bulky items such as appliances and smaller items such as paper, tree limbs, and cans. When compacting such a wide assortment of materials the facility owner or operator will obtain a completed surface filled with voids and having a sponge-like quality. Uniform compaction of cover material on this surface is difficult. Thus, a safety factor must be considered in the design standards for the construction of the barrier layer and the actual performance of this layer. If sufficient thickness is not used in forming the barrier layer, cracks will form from compaction and shifting of the material on the spongy base. These cracks will then become a controlling factor on the performance of the barrier layer in preventing the downward migration of moisture into the fill area. Additionally, the thickness provided for under this subitem ensures that a minimum level of thickness of material with the proper permeability is achieved. A certain percentage of the cover material, as placement and compaction take place, will filter into the waste below resulting in uneven distribution of the material. The Agency believes 24 inches to be a reasonable minimal thickness for the barrier layer of a final cover system.

The drainage layer must be at least six inches thick. The drainage layer is intended to intercept moisture percolating through the top vegetative layer and carry moisture off the barrier layer. The drainage layer also acts as a protective mechanism for the barrier layer during construction of the final cover system. Six inches is the minimum thickness needed to function as a protective layer and the drainage layer. This layer is normally constructed using poorly sorted sands and gravels that make a highly permeable layer to encourage horizontal movement of moisture off the barrier layer. It is easier to flow through the open pores of sand and gravel than the tightly compacted clay barrier layer. The equipment used to spread the drainage layer is not able to place thin layers of the material with consistency. Thus, the six-inch standard is a minimum construction specification. The six-inch standard is also a suitable thickness to allow a small build-up of moisture on the barrier layer during periods of excessive precipitation. A thorough soaking of the upper layer during these periods creates a need to drain the top layer to provide proper aeration of the root zone for the vegetation. Excess moisture will deplete available oxygen in the root zone and prevent uptake of oxygen and minerals into the plant. A six-inch standard protects the barrier layer during placement of the top layer, is of sufficient depth to hold drainage pipes, if needed as part of the design, and is the minimum depth for placement by large construction equipment.

The top layer must be at least 18 inches thick. The top layer must be thick enough to contain the vegetative roots and to have a water-holding capacity that promotes vegetative growth. At least six inches of the top layer must consist of topsoil. Vegetation is needed to control erosion of the cover system. Vegetation stabilizes the soil structure and controls excessive moisture in the final cover system by absorbing the moisture and using it for growth. Evapotranspiration is a significant factor in maintaining a water balance that will minimize infiltration. Therefore, it is necessary to have a suitable medium for vegetative growth. By requiring the top layer to have a good moisture-holding capacity, the Agency has established the minimum needs (sufficient moisture) for establishing good vegetative growth. The grasses normally used in seeding slopes are Kentucky bluegrasses, perennial ryegrasses, red fescues and clovers. These grasses, although capable of germinating in six inches of soil, need a minimum of 12 inches of suitable soils for good growth. Many of the grasses, such as perennial ryegrass, require 18 inches for good root development. Ryegrasses are important in establishing vegetative growth and stabilizing soil cover as they are fast germinating and have a broad root structure that will help prevent erosion from occurring on the cover. It is reasonable to require a minimum top layer thickness of 18 inches because it provides the growing medium structure for the vegetation, protects the bottom layers from being disrupted by the grass root structures, and is obtainable by facility owners and operators.

Subitem (4) requires the facility owner or operator to design and construct the barrier layer with maximum permeability of 2×10^{-6} centimeters per second. This standard alerts facility owners and operators of the Agency's perspective on cover efficiency. A barrier, in basic terms, may be as simple as a change in permeability from the upper soil layers such that the flow of water in the vertical direction would slow. In some cases this can be attained by using only slightly different soil textures, silty loam versus loamy sand, and compacting each to different densities in order to ensure some minimum level of performance will be achieved by the barrier layer.

Maximizing the final cover system efficiency involves designing a system where horizontal flow within the cover is more dominant than vertical flow into the fill area. This is accomplished by changing permeabilities between soil layers in a sufficient magnitude that the horizontal flow predominates. For instance, water flowing through sand, permeability of 1×10^{-3} centimeters per second, will move vertically because of gravity and the large pore sizes between the grains of sand. When this water hits a clay soil, permeability of 2×10^{-6} centimeters per second, it will move through the sand horizontally across the top of the clay barrier. It is easier for the water to move horizontally along the sloped surface of the clay rather than vertically because movement through the clay is controlled capillary forces pulling the water through the small openings rather than gravity through the larger openings in the sand particles. The permeability requirement for the barrier layer ensures that the drainage layer and the barrier layer will differ in permeabilities in a manner that encourages movement through the drainage layer but not into the waste. If the annual precipitation rate is 30 inches, this would mean at most 3 inches of precipitation could enter the fill area.

A minimum permeability requirement along with the performance standards ensure that vertical flow into the barrier layer is not predominant. This system also allows the facility owners or operators to alter the permeability to achieve a better efficiency rating rather than requiring more materials, collection points, or slopes. The type of soil capable of meeting this permeability is available and the facility owners and operators have sufficient flexibility to alter the permeability to achieve a better efficiency and lower risks associated with the facility operation.

Subitem (5) permits the use of synthetic membranes as the barrier layer. The membrane must be at least 30/1000 of an inch thick and meet the physical property standards for the material type developed by the National Sanitation Foundation. Synthetic membranes are useful substitutes for soil barrier layers in areas where the proper soil types are not available. Properly installed, a synthetic membrane may have a permeability of 1×10^{-10} centimeters per second or less. This makes the synthetic membrane a very good barrier to infiltration. Synthetic membranes may be either factory-or field-seamed with minimal difficulty. Synthetic membranes are easily joined in sections during the closure period of each phase. It is reasonable to require a 30/1000 of an inch thick standard for the synthetic membrane because it provides a low-permeability material with strength to hold up under the strain of installation. A thicker standard is not required because the quantity of water sitting on the membrane is minimal and the risk of rupture under stress due to settlement requiring repairs that would be expensive for other thickness and no additional environmental protection is provided. A thinner standard is not permitted because of the ease by which the material would be punctured by sharp objects in the waste and the difficulty of placement without tears. By providing the option of using synthetic materials as part of the final cover system, the Agency allows facility owners or operators to address specific site concerns and balance the cost of synthetic membranes and soil barrier layers.

The materials used and the construction techniques vary for installation of synthetic membranes. The National Sanitation Foundation is a nationally recognized central clearinghouse for these standards. Reference 70. Additionally, the National Sanitation Foundation continues to work on standarized test procedures for evaluating synthetic membranes to develop consistency within the industry. The National Sanitation Foundation standards are used by the industry and accessible to facility owners and operators.

Subitem (6) requires the layer of topsoil be capable of sustaining vegetative cover consisting of shallow-rooted perennial grasses or other suitable vegetation that will not always be grasses. The final cover system is designed with the anticipated end use for the site in mind. The facility owner or operator may consider uses for the facility other than open space. For instance, a blueberry or raspberry farm might be proposed. These plants, although needing slightly more than 18 inches of soil for root growth, do not require large amounts of cover material as the roots are shallow. However, the nutrient value and pH must be properly controlled to ensure good growth for these plants. Because of the variability in needs for vegetative growth, it is reasonable to propose a general performance standard for the topsoil.

Subitem (7) requires the facility owner or operator to consider the need for drainage ditches, pipes and collection areas to prevent erosion and excessive sediment. It also requires the identification of construction techniques needed to maintain the drainage layer in place on the barrier layer. The concern with land disposal facilities is the control of run-off waters from the facility onto the surrounding area. The sediment run-off waters carry one of the most damaging nonpoint source pollutants in Minnesota. It can affect many miles of surface water. Additionally, other pollutants are transported with it. Sediment can fill in lakes or reservoirs and form thin layers on the bottom of river and stream beds that smother the aquatic habitat. The potential of sediment loss is highest during the initial seeding and grass establishment period. If good vegetation cannot be established because of drainage problems, sediment loss will continue. Thus, design and construction techniques must minimize this potential to the greatest extent. By establishing a performance standard, the Agency permits the facility owner or operator the opportunity to choose a design that is compatible with the overall facility design and operation, and end use intended for the site. The proposed standard allows the facility owner or operator to incorporate this risk management tool into the overall facility program and ensures that actions will be taken before a problem occurs.

The need for maintaining the drainage layer on the barrier layer arises from the potential use of synthetic materials at land disposal facilities as final cover. Synthetic materials will have, in some cases, a very smooth surface that will not be able to hold the drainage soils on steeper slopes. The maximum slope ratio that will hold an earth cover over a smooth liner is three horizontal to one vertical. Even at this slope or flatter slopes, the cover soil should be stable and resist sloughing. Because of the importance of the drainage layer in encouraging horizontal movement of water off the synthetic membrane and in protecting the membrane from punctures and weather conditions, facility owners and operators are required to address how the drainage layer will be maintained, particularly on the steeper side slopes of the fill areas.

The control of sediment loss and erosion is dependent on the speed and area water moves over the cover. Vegetation is used to stabilize the cover soil, but consideration must be given to the use of collection pipes and drainage ditches in controlling water movement. Collection pipes and drainage ditches permit the control of surface water moving over the cover. Using these design components, the facility owner or operator divides the cover into collection areas to control the speed and travel area of surface water. The amount of sediment loss and erosion potential is related to the speed and amount of water drained over a specific area. Facility owners and operators must consider the use of collection pipes and drainage ditches because of the impacts sediment may have on surface water environments.

Subitem (8) requires a buffer layer to be used under the barrier layer. The buffer layer must completely cover the waste to protect the barrier layer from punctures and other disruptions from the waste. By covering the waste completely with a buffer layer, the facility owner or operator will also find it easier to compact soil barrier layers because of the firmer foundation the buffer layer provides. Less soil will be needed in forming the barrier layer because less material will sift into the voids of the waste. Thus, a cost savings will be recognized by the facility owner or operator who will not be using the more expensive lower-permeability soil to fill in voids within the waste. A buffer layer is critical for those situations where a synthetic membrane will be used. When soil barriers are punctured, they can heal themselves somewhat by reforming around the puncture. It is more difficult to puncture the 24 inches of soil barrier layers. If a synthetic membrane is punctured there is no movement to fill the gap left by the hole. Fractures of the membrane in other places due to the stress caused by the puncture can occur as the membrane proceeds to be pulled into the settlement. The barrier layer's integrity must be maintained if the system is to perform effectively.

Subitem (9) requires the final cover system to be graded to a minimum slope of 3 percent and a maximum slope of 20 percent, unless the Commissioner approves otherwise. The Commissioner's approval of changes must consider the ability of the proposal to minimize infiltration and prevent erosion, the design and operational specifications, and the ultimate use for the site. The final cover system must maximize surface water run-off and prevent ponding of surface water. Precipitation is the source of water that runs off the surface of the fill area.

The kind of soil and the type of vegetation growing in it have a major effect on the amount of run-off. The slope of the area affects the rate of run-off more than the amount. It is the rate of run-off that impacts the amount of infiltration or erosion that occurs. On a flat slope water moves slowly off the final cover. Infiltration will be greater than the same final cover system placed at a steeper slope because of less time is available for vertical movement into the soil before water moves off in the horizontal direction. If the slope is steep, the rate of run-off can channelize the soil increasing the amount of sediment lost from the cover.

On slopes of less than 3 percent, the irregularities of the surface and vegetation commonly act as traps for holding run-off and encouraging infiltration. The construction of slopes less than 3 percent is very difficult with the equipment that is used to work on the spongy waste. A 3 percent standard removes the construction difficulties, ensures sufficient slopes exist even with settlement, and protects against erosion from very steep slopes. A 5 percent slope is recommended in landscape maintenance as a sufficient slope to promote run-off without risking excessive erosion. It is reasonable to establish a minimum standard of 3 percent because it provides a base level of protection and allows the facility owner or operator to adjust the slope in a manner that is compatible with the overall design and operation of the facility and intended end use. Too steep a slope would eliminate some potential site uses. The Agency has found that the existing two percent slope requirement has been ineffective at existing facilities in that the slightest amount of settlement eliminated the slope entirely and flat-topped fill areas resulted in unacceptable amounts of surface water ponding. The Agency believes the 3 percent requirement is reasonable because it compels the development of acceptable slopes for existing facilities. Facility owners and operators need not lose large amounts of fill capacity in order to make previously closed areas and areas closed under the new standard compatible.

Designing slopes greater than 5 percent must be considered carefully because excessive slopes lead to settlement. Decomposition of solid waste will cause settlement on the outside edge, causing surface slopes to increase with time. Thus, forethought in designing is necessary to avoid such increases in slopes to the extent that excessive erosion may occur. In order to minimize the problems associated with side slope settlement, the Agency believes a maximum slope of 20 percent is reasonable. The maximum standard prohibits development of steep side slopes so that excessive erosion problems develop due to the inability to place, compact, and maintain final cover on these areas.

This subitem allows the Commissioner to approve alternatives to the minimum and maximum slopes to be proposed by the facility owner or operator. By establishing a method of obtaining approval for designs that differ from the basic standards included in the proposed rules, the Agency provides for flexibility in designs for land disposal facilities without a formal variance procedure.

By establishing the basis for the Commissioner's decision, the rule alerts the facility owner and operator to the information that must be included in any request for change from the minimum or maximum standard required in this subitem. The listing of items to be addressed in any change request will provide consistency in the approval process. The Agency allows the facility owner or operator the opportunity to incorporate a final slope design that is consistent with the entire facility design and operation for minimization of risks associated with the facility. This provision responds to commentors on the rules who suggested that requiring a variance request as the only option for changes to an alteration to final slopes would be unreasonable and an unnecessary burden to facility owners and operators. There are alternative designs, such as terraces on the side slopes, capable of providing an adequate amount of surface water run-off without causing excessive erosion. The Agency agreed that the facility owner or operator would be better served, and no increased risk to human health and the environment would result, from allowing some flexibility in the slope designs, provided the facility owner or operator could show how the alternative design would function. The overall goals of the proposed rules are to provide some combination of design and performance standards that assures the minimum level of protection for human health and the environment. This protection should exist at all facilities. The rules should also allow the facility owner or operator to use designs that vary from the basic design standards so that the facility design may encompass a risk management program capable of meeting the needs of the facility owner or operator. The Agency believes that this subitem is consistent with this approach.

Item E requires the facility owner or operator to place all cover material for the barrier, buffer and drainage layers in lifts of no more than six inches to achieve maximum compaction. Each lift must be compacted within 0 to 5 percent of optimum moisture content to achieve 95 percent Standard Proctor. The uppermost six inches of the top soil must not be compacted in order to allow for seeding and germination of the vegetation. Compaction of cover soils increases the strength of the soil materials and reduces the permeability. The Standard Proctor analysis for evaluating compaction is discussed in detail under subpart 8. However, a portion of that discussion is appropriate at this time.

The Standard Proctor analysis is designed to evaluate the field techniques for compaction on a solid base. Compaction results using the same field techniques for operation on the waste as are used for the work on a solid base often fall short of the desired results. Thus, additional work must be completed to achieve the final compaction results needed to obtain low permeability characteristics for the cover. General guidance has been derived from these results regarding the field compaction efforts necessary at solid waste operations. Although this guidance gives useful information, relations between field compaction and laboratory density curves must be completed on site-specific conditions because of the change in soils and waste.

Natural water content of soils often approaches the optimum for compaction. However, in some cases too little or too much moisture may be present requiring some effort to bring the moisture content within acceptable ranges. Maximum density during field compaction often occurs on the wet side of optimum water content while maximum strength occurs on the dry side of optimum. Thus, there is a need to determine the water content to be used to maximize both density and strength. An additional factor must also be considered. Compaction on the dry side of optimum may be best with swelling soils since the water taken up later will promote further swelling of the soil particles and work against the formation of cracks.

The design requirement for compaction is commonly 95 percent of Standard Proctor in the construction industry. The available equipment, sheepsfoot rollers or rubber-tired rollers, can meet this standard with minimal difficulty. The design and operation plans developed by the facility owner or operator can be used to specify the number of passes needed over the soils to achieve the maximum desired compaction. This item provides the facility owner or operator flexibility in the methods used to achieve compaction and, at the same time, defines a specific performance goal to be met. This promotes consistent results in all cover construction so that baseline compaction needs are met. Fixed standards could make specialized equipment necessary.

Subpart 7. Liner requirements. This subpart establishes the requirements for the design, construction, and operation of liner systems for mixed municipal solid waste land disposal facilities. Liners are required for new facilities and any lateral expansions into previously unfilled areas at existing facilities. The major purpose of the liner is to minimize the migration of leachate out of the fill areas into the surrounding soils and ground water. There are many liner designs capable of meeting this purpose. The proposed requirements establish the minimum design standards needed to ensure that base level construction and performance requirements are met. The Agency believes that a blend of design and performance standards is most appropriate in developing liner system requirements because it allows for innovative design proposals while ensuring minimum protection levels are maintained. These standards are applicable to all facilities and are flexible to allow site-specific design alternatives.

This subpart provides for a time extension for installation of liners at existing land disposal facilities. The Commissioner may grant up to 18 months, from the effective date of the rules, for the facility owner or operator to install the liner. The Commissioner's decision will be based on evidence that a liner is unnecessary based on subsurface geologic conditions, ground water and surface water flow patterns and quality, depth to ground water, distance to surface water, remaining site capacity, design and construction techniques to be used to mitigate leachate generation, and other site conditions. The Agency recognizes that a liner system may not be practical or reasonable in all situations at existing mixed municipal solid waste land disposal facilities. For instance, the environment might be better served if an existing facility with little remaining capacity is designed and constructed with a final cover system that exceeds the minimum standards, rather than to have a small portion of the fill area lined. The costs and benefits of liners for short-term facilities must be compared to determine the appropriateness of granting the time extension for liner installation.

In drafting the proposed rules, the Agency considered the logistical problem of owners and operators of existing facilities to meet a liner requirement. It is reasonable to expect new facilities to address the need for liners as the feasibility study and final design are developed. However, existing facilities were designed and constructed without consideration for liners and immediate compliance may be difficult. In discussing this issue with county officials and permit holders before drafting any requirements, the Agency was further convinced that some flexibility on implementation of liner requirements for existing facilities must be included in the rules. There was no disagreement from the meeting participants that liners are needed at land disposal facilities to protect ground water and surface water from impacts due to leachate migration.

The Agency believes that, although some flexibility is needed as to the timing of liner installation at existing facilities, this flexibility must have limits. Therefore, the Agency proposes that the maximum delay for liner installation at existing facilities be 18 months. This period of time was developed based on the Agency's experience with the development, review, and approval of design plans and the coordination problems for construction of the liner. The Agency believes 18 months provide enough time for owners and operators to submit design plans to the Agency for review and approval while scheduling construction activities. Existing facilities must be redesigned in order to incorporate the liner into existing structures at the facility. Some amount of time is needed for redesign after the rules are effective. Immediate compliance with the rules for all existing facilities is unreasonable. However, it is also unreasonable to allow existing facilities to operate five (until permit reissuance) or more years without the liner. Therefore, the Agency developed a reasonable alternative to these extremes.

The Agency believes construction of the liner to be the largest single factor influencing the timing of implementing liners at existing facilities. Liners can not be installed during the winter months with any confidence. Because soil liners require a particular amount of moisture to obtain good compaction, winter construction may require installers to handle frozen soil, which cannot be adequately compacted to achieve the necessary permeability. Synthetic membrane liners must be seamed using solvents or heat. Neither of these options are particularly suited to winter construction. The Agency believes 18 months is sufficient time for owners and operators to redesign the fill areas and schedule construction activities. To provide longer than 18 months would present an unfair cost advantage to owners and operators requiring more time to install liners than to those constructing liners immediately after the rules are effective. Additionally, the Agency has as a matter of policy required liners in horizontal expansion areas for the past three years, so this is not a totally unexpected development.

As indicated earlier, the facility owner or operator must justify delaying the installation of liners. The justification must discuss actual site conditions and remaining fill capacity. It is reasonable to require the facility owner or operator to address the site conditions and the operation of a land disposal facility before granting an extension for the liner installation because of the potential risks associated with continued operation of unlined facilities. By establishing in rule the areas to be addressed for all extension requests, the Agency informs the facility owners and operators what issues are involved in the decision process so they may submit the necessary information with the request. The rule also informs possible opponents of an extension. The Agency's proposal relieves the obligation of immediate installation at all facilities without compromising on protection for human health and the environment.

A liner is not required for existing disposal areas at existing mixed municipal solid waste land disposal facilities that will be expanded vertically. However, permission for a vertical expansion must be granted by the Commissioner and may be granted only if the facility owner or operator shows that the expansion will not increase the potential for harm to human health and the environment. The Agency believes will allow facility owners and operators an opportunity for vertical expansions after the effective date of these rules.

Vertical expansions may be necessary to achieve better slopes or provide an alternative to early closure. The Agency will allow vertical expansions to be constructed without liners, provided evidence shows no increased impact on the environment will result. The overriding performance goal for the proposed solid waste rules is to minimize the impacts on human health and the environment due to the migration of leachate or gas, sediment movement into surface waters from erosion, or nuisance and safety concerns. The Agency cannot allow vertical expansions of existing facilities designed and operated without these goals in mind. The Agency must consider the potential impacts of each action.

In requesting a vertical expansion, the facility owner or operator must submit to the Commissioner an engineering and hydrogeologic report containing a detailed analysis of the impact the proposed expansion would have on human health and the environment. The report must also contain the design and construction modifications used at the facility to minimize environmental impacts. The report must contain the results of a hydrogeologic evaluation completed in accordance with subpart 3; a feasibility study on minimizing leachate generation, controlling leachate and gas migration, and treating ground water and surface water pollution; an evaluation of long-term monitoring needs; and an appropriate adjustment of financial instruments.

Existing facilities have been constructed and operated without liners and leachate collection, resulting in polluted ground water. The Agency would not be acting responsibly if it allowed the vertical expansion of unlined land disposal facilities without considering the potential impacts on human health and the environment. Polluted ground water and surface water results when pollutants leach from solid waste and migrate out of the fill area. Potential impacts are best evaluated by understanding the hydrogeologic conditions of the site. Essentially, a risk assessment is needed for the facility. A risk assessment involves collecting data about facility and evaluating existing impacts on human health and the environment, operating conditions, and methods to improve conditions at the facility. A risk assessment completed to determine the feasibility of vertically expanding fill operations at an unlined facility must address the increased potential for detrimental impacts from the additional volume of waste placed on the unlined portion of the facility. The evaluation must consider the increase or decrease in leachate generation, the additional pollutant loading due to the waste, the operational practices used, hydrogeologic conditions, and the increased probability that corrective actions will be needed. This evaluation includes methods that might be used to mitigate any increased risk from the vertical expansion. With this information, the Commissioner will decide on the acceptability of the proposed vertical expansion. The risk assessment will present the current impacts of a facility on the surrounding area and the potential increase in impacts related to the vertical expansion.

It is the Agency's position that liners and leachate collection systems are necessary to control the movement of pollutants into the surrounding soils. If facility owners or operators are allowed to vertically expand fill areas on unlined areas, it is critical to the protection of human health that other mitigative actions be evaluated and implemented, as necessary. It may be necessary to construct final cover systems with detailed drainage control systems to prevent moisture from infiltrating into the fill area; leachate collection areas in the side slopes to prevent leachate migration from toe seeps; a more comprehensive monitoring system for early detection of impacts; ground water pump-out systems; and increased funds set aside for postclosure care and corrective actions because of the increased probability that they will be needed. The Agency will expect the facility owner or operator to submit this analysis with the expansion request. Although a risk assessment can be expensive, the Agency expects the facility owner or operator to justify the expansion, especially in light of the savings from not having to install liners and leachate collection systems.

For the areas to be lined at an existing land disposal facility, the facility owner or operator must consider the proximity to the existing unlined fill areas in the design and construction plans. The lined portion must be separated from any existing fill area with low-permeability material to the extent practicable, be designed to collect any additional water movement from the old fill area to the new fill area, and prevent movement of water from the new fill area to the old fill area. The purpose of a liner and leachate collection system is prevention of leachate movement out of the fill area into the surrounding soils and eventually to ground water. If movement from the lined areas to the unlined areas occurs, the reason for installing the liners is lost. Likewise, if the movement of moisture from the old fill area is not considered when designing the leachate collection system for the lined areas, the liner and leachate collection system will not be capable of properly managing the liquids. Therefore, it is necessary that designs for the new fill areas consider control of the flow of liquids between the existing fill areas and the newly constructed fill areas.

The separation of existing fill areas from the newly lined area is not intended to be a complete separation by earthen fill or a liner in all cases. In some instances, the separation may be achieved by partially lining a portion of the connecting area between new and old fill areas with drainage pipes used to control liquid movement between the fill areas. The facility owner or operator must incorporate the newly lined areas into the overall design of the existing facility in order to maximize the site capacity while controlling risks associated with the facility. In some situations, it may be better to move the new fill areas away from existing fill areas in order to control impacts from each area. This would require using more area but gives the facility owner or operator more control in the evaluation of corrective actions needed and installation of monitoring systems.

Items A to N are performance and design standards governing the construction and operation of liner systems at mixed municipal solid waste land disposal facilities. Defining these standards clearly in the rule ensures consistency in the design and construction of fill areas. By establishing minimum standards in rules applicable to all facilities, the Agency will ensure that a base level of performance will be achieved at all facilities.

Item A requires the liner system in combination with the final cover system to achieve an overall site efficiency of 98.5 percent collection or rejection of precipitation falling on the disposal area. The liner system must minimize the amount of leachate leaving the fill site entering the soil and ground water system surrounding the site.

If only a performance standard were used, the facility owner or operator could choose a design that would be most heavily relied upon to control leachate generation and migration. For instance one facility owner might choose to use only the cover as the controlling mechanism while another might choose only the liner. In either case, a particular element of the design could receive less attention than the Agency feels necessary to protect the environment. The Agency believes there are several limitations in a risk-based performance approach. Two of the most important are highlighted here. First, this approach relies on predicted, unverified results using leachate quality, environmental transport, and health effects modeling. Little data currently exists to support an approach based solely on performance standards. In fact under the current solid waste rules, which provide no design standards, facilities have been unable to properly protect the environment. Existing monitoring results would tend to argue against performance standards. However, consideration must be given to the fact design technology has been very poorly developed nationwide until recent years. Second, this approach tends to concentrate on ground water effects and ignore air or surface water effects. However, the performance-based approach does offer flexibility in design as new technological developments occur. Because of the flexibility offered with performance standards and the guidance they provide during the selection of facility designs, the Agency includes performance standards in rules governing the overall operation of the facility.

As stated earlier, the overall goal of design and operation of the fill area is minimization of leachate generation and migration. The performance standard for an overall site efficiency recognizes the importance of the final cover system and the liner in leachate control. Using a good final cover design to minimize the amount of infiltration into the fill area makes the amount of leachate to be handled by the liner system less. Because the cover system is highly susceptible to physical disturbances, such as heavy precipitation, wind, freeze-thaw cycles, animal intrusion, vegetative root penetration, and subsidence, maintenance is critical to its performance. The presence of a cover system does not guarantee that no leachate will be generated. For this reason, the Agency believes it is necessary to incorporate a liner into the facility performance standard. If the facility performance is based entirely on the final cover system, the ability of the system to perform at optimum levels may deteriorate with time because of the physical disturbances highlighted above leaving the environment at an unacceptable level of risk. Excluding the cover system and using the leachate control system to achieve performance, means a failure in the liner could result in major impacts on the environment due to the amount of leachate released from the facility. The design and construction of a cover system must be capable of minimizing infiltration into the fill area. Otherwise, the amount of leachate generated will be directly related to precipitation amounts. This would strain both the liner and leachate collection system capacity and the leachate treatment capacity. Until the final cover is applied, there would be no protection given to the environment, if no liner existed.

The Agency has chosen to combine performance standards for the final cover system and liner system into an overall site efficiency to maximize the advantages of each system and minimize the disadvantages of each system. The Agency believes that an overall site efficiency standard will minimize the amount of leachate generated and released to the environment. A total containment system is nonexistent. Synthetic membrane liners must be seamed in the field and maneuvered into position. These activities provide an avenue for leakage due to punctures and seam failures. Thus, man-made liners are not foolproof and have a tendency to permit the release of leachate to the environment. Recognizing that 100 percent containment of leachate is not a feasible alternative, the Agency believes a more reasonable approach combines efforts to minimize leachate generation and migration at sites.

The specific performance standard of 98.5 percent was chosen based on its correlation with leachate control. The performance standard establishes a framework for designing the facility. Between the final cover system and the liner/leachate collection system, no more than 1.5 percent of the amount of precipitation received each year may leave the facility as leachate migrating through the liner. Table 4 shows that the proposed performance standard releases less than one-third the quantity as a 95 percent standard, one-seventh the quantity as a 90 percent standard, and only fifty percent more than a 99 percent standard. The Agency believes the proposed standard provides a reasonable level of protection against the migration of leachate out of the fill area at a facility. The figures shown in Table 4 show the estimated quantity of leachate migration after the 20 acre site is closed. During the active filling period less leachate will be generated and released to the environment.

While the efficiency standards proposed for the final cover system and the liner/leachate collection system are used as design controls. The overall site performance standard proposed in this time is used to control the amount of pollutants entering the ground water. The reasonableness of the final cover system was discussed under subpart 6. The reasonableness of the liner/leachate collection systems will be discussed in items B to N and subpart 9. The reasonableness of an overall facility performance standard will be discussed now.

TABLE 4

Leachate Volumes Versus Site Efficiency

Efficiency Standard	Volume* Leachate Released	
Percent	Inches/year	gallons/year
90	3.0	1,630,000
95	1.5	815,000
98.5	0.45	244,000
99	0.30	163,000

*Volumes calculated based on a 20 acre site and 30 inches of precipitation experienced each year. Volumes are calculated on facility completely closed.

$$\text{Volume (gallons/year)} = \frac{\text{Leakage rate (inches)}}{\text{year}} \times \frac{1\ \text{foot}}{12\ \text{inches}} \times \frac{43560\ \text{ft}^2}{1\ \text{acre}} \times \frac{1\ \text{gallon}}{.1337\ \text{ft3}} \times 20\ \text{acres}$$

The Agency believes the 98.5 percent site efficiency is attainable by adjusting facility design parameters. It provides protection against impacts on the environment caused by the large quantities of leachate migrating into ground water. The Agency did not propose 100-percent containment because it limits the use of natural soil liners. A total containment standard neglects important issues regarding location and hydrogeologic setting. The Agency believes it to be more practical to allow for site conditions and facility owner or operator risk management programs to provide levels of protection beyond the design standards necessary to ensure ground water and surface water standards are met.

The Agency believes the cost associated with 100 percent containment at land disposal facilities is not justified at all locations, e.g., in clay-rich soil environments or where there is considerable depth to ground water with no nearby users.

The control of leachate migration is the main purpose for establishing performance standards for the design and construction of final cover systems and liner/leachate collection systems. The additional benefit of controlling the amount of leachate is that the amount of pollutants leaving the facility will also be limited. The Agency believes the proposed performance standard not only provides a reasonable control on leachate migration but also provides a reasonable control on the amount of pollutants released into the environment. The Agency believes the performance standard should provide protection of ground water flowing under the facility. This means that a facility designed and constructed to meet the performance standard should be capable of meeting the ground water standards and intervention limits. Therefore, the Agency proposes to show the correlation between the 98.5 percent efficiency standard, the ground water standards and limits.

The Agency chose a conservative model to reflect the impact controlling of leachate has on the facility's ability to comply with the proposed ground water standards and intervention limits. The model assumes that all projected leachate leakage contains a particular concentration of pollutants. The pollutant concentration is only affected by dilution with ground water under the proposed model. No other factors are considered. Thus the model projects a worst case scenario. Figures 7a and 7b show a schematic of the land disposal facility/ground water system used as the basis for the model. The facility design details are presented in Table 5. The facility design is not a reflection of the proposed rules as modifications were needed to meet the performance standard. This is what the Agency expects to happen as the rules are implemented by facility owners and operators. If the proposed design standards fully met the performance standard, there would be no reason for a performance standard. The ground water flow model assumes the pollutants in the system are nonreactive and the aquifer is homogeneous. Homogeneous aquifer means that ground water flows in one pattern, uninfluenced by changes in soil texture. The model assumes mixing occurs to some depth in the ground water system. For example, if no intermixing occurs, the concentration of the nonreactive pollutant in the water is the same as the value leaking from the fill area. If, on the other hand, it is assumed that some intermixing occurs, the pollutant concentration will be reduced.

FIGURE 7a

LANDFILL/GROUND WATER SYSTEM:
Cross-section view A - A'

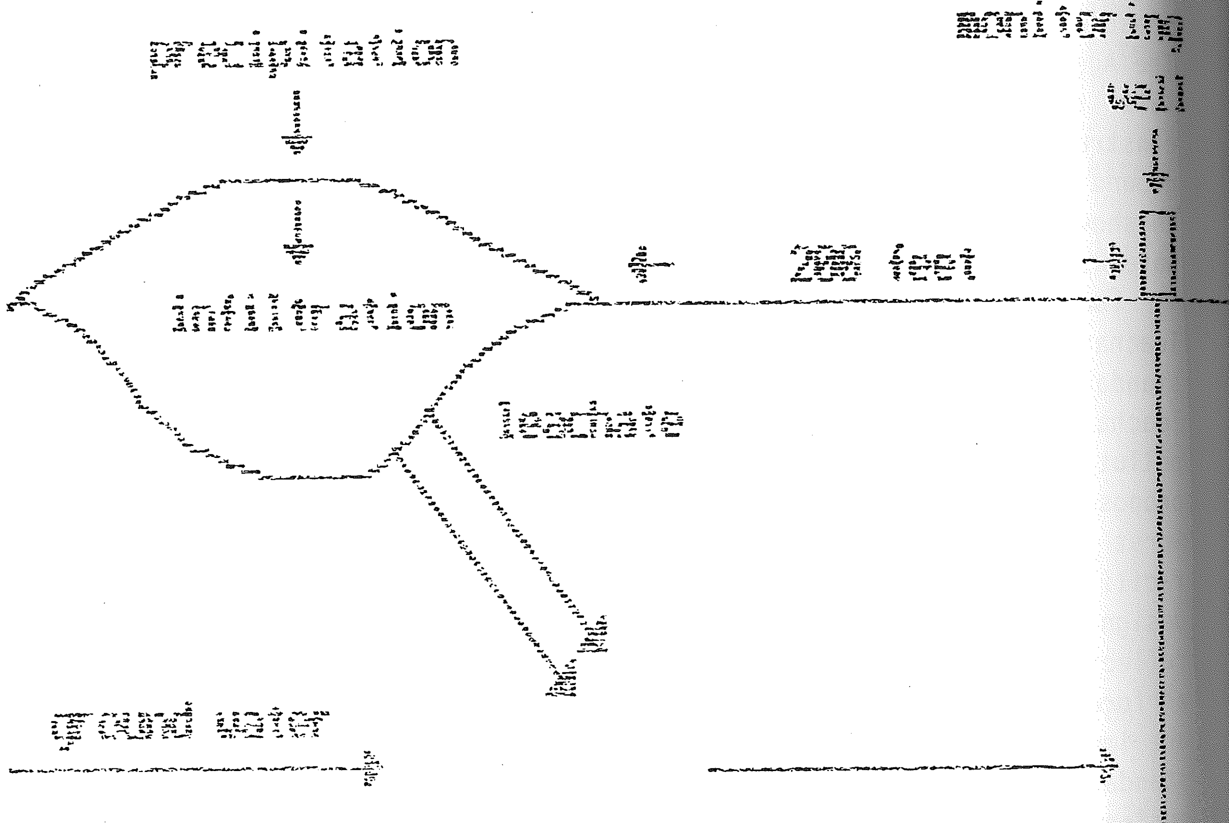


FIGURE 7b

LANDFILL/GROUND WATER SYSTEM:

plan view

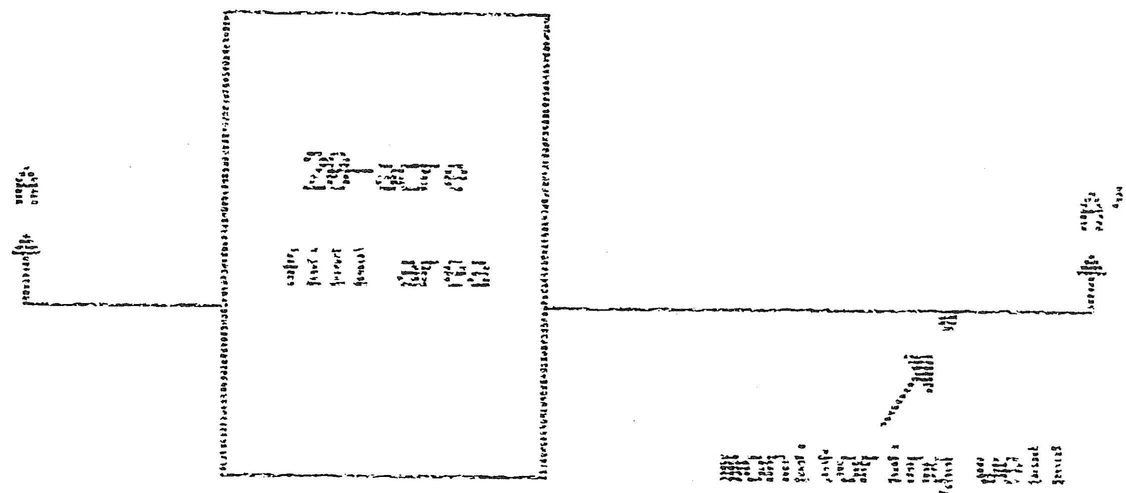


TABLE 5

FACILITY DESIGN PARAMETER

Site Acreage		20 acres
Fill Depth		40 feet
Cover Seed		Good Grass
	Top Layer	18 inches loam
	Drainage	6 inches coarse sand
	Barrier	24 inches clay
Liner		
	Drainage	12 inches coarse sand
	Barrier	48 inches clay
Slope		3 percent cover 2 percent liner
Permeability		
	Drainage	1×10^{-3} cm/sec
	Barrier	1×10^{-8} cm/sec

The Agency believes a more conservative estimate of the potential impacts of leachate on the ground water system is achieved using a simple model. The more complex models consider many factors that influence the movement of leachate in the unsaturated and saturated zones beneath the fill area. Such factors include dispersion, retardance, and density. These factors when taken into consideration during the modeling of ground water flow would serve to decrease the impact leachate has on the ground water as the predicted mass of pollutants decreases. Utilizing a simple model in explaining how the control of leachate also controls the potential impacts from a facility more accurately depicts the entire State. Because actual soil conditions vary around the State, a more complex model, which requires detailed characterization of subsurface conditions, could not reflect the potential impacts expected across the State. Whereas, the simple model using little site-specific data is more reflective of the State.

The model proposed by the Agency to describe the movement of leachate out of the fill area into the ground water system consists of a number of assumptions depicting the leachate seeping out of the fill. These assumptions include the amount of leachate, the pollutant concentration in the leachate, the flow characteristics of the leachate and ground water, and the mixing regime for the system. These factors are used to evaluate the pollutant concentration at a monitoring point 200 feet from the waste boundary (or at the compliance boundary). The results of this model are then compared to the proposed standards for ground water quality.

To calculate the pollutant concentration in a monitoring well at the compliance boundary, a linkage between the leachate generation and ground water pollutant transport model is necessary. The leachate generation figure was calculated on the entire facility after closure. This maximizes the amount of leachate released from the facility. The model also assumes no removal of pollutants occurs before facility closure to maximize the pollutant concentration in the leachate. In addition to leachate generation data, an estimate was made regarding the chemical composition of the leachate. The leachate chemical composition was derived from a report completed by the Wisconsin Department of Natural Resources, because little information is available from Minnesota mixed municipal solid waste land disposal facilities. See Exhibit XXXVI. The leachate values from this report and the proposed ground water standards are shown on Table 6. Considering this data, it is evident that the concentration of a number of parameters must be greatly reduced if the pollutant concentrations at the compliance boundary are to meet ground water standards. The table also contains the pollutant concentration at the compliance boundary as obtained from the model.

During the life of a facility, leachate concentrations vary with time. Previous studies have shown that concentrations increase rapidly, level off, and then decline. See Exhibit XXXVI. For the purposes of this model, it was assumed that the pollutant concentration levels had leveled off and equaled the median value reported by the Wisconsin Department of Natural Resources. In order to operate the model, the principle of flow in equals flow out and the conservation of mass was applied to calculate the mass balance for the leachate-ground water flow system.

The hydraulic conductivity was chosen for a silty sand environment (0.30 feet per day). The hydraulic gradient was chosen to be .006 feet per foot for use in the model calculations. The amount of leachate seeping out of the landfill was found to be 10,200 cubic feet per year based on the design parameters listed in Table 5. The amount of leakage was calculated based on the design parameters listed in Table 5, using the HELP model developed by the United States Corps of Engineers. See Exhibits XXXIV and XXXV. It was further assumed that complete mixing occurred in the distance traveled based on the hydraulic gradient and hydraulic conductivity and that the incoming leachate flow was at steady state. The analysis then estimated the concentration of each substance at the compliance boundary. These results were then compared to the standards applied at the compliance boundary.

TABLE 6

LEACHATE POLLUTANT CONCENTRATIONS

Parameters	Median Leachate Analysis mg/l	Ambient Ground Water mg/l	Rule Standards mg/l	Predicted Monitoring Results mg/l
TDS	25873	N/A		N/A
Specific Conductance	15485	650		7400
TSS	2835	N/A		N/A
BOD	29200	1.14		13200
COD	50450	12.78		22900
TOC	5890	2.66		2700
pH	7.2	2.29		7.25
TOTAL ALKALINITY	6845	26.4		3300
HARDNESS	9380	306		4400
CHLORIDE	2651	20.67		1200
CALCIUM	2100	193.96		1100
SODIUM	1630	26.39		760
TOTAL NITROGEN	1470	0.73		670
IRON	1400	1.55		640
POTASSIUM	1375	3		630
MAGNESIUM	780	113.89		420
AMMONIA NITROGEN	557	N/A		N/A
SULFATE	500	94.19		280
ALUMINUM	85	N/A		N/A
ZINC	54	0.119		25
MANGANESE	25.9	0.212		12
TOTAL PHOSPHORUS	117	0.128		53
BORON	12.3	0.378		6
BARIUM	5	0.092	0.375	2
NICKEL	1.65	0.004	0.038	0.75
NITRATE-NITROGEN	1.4	4.3	2.500	3
LEAD	1.11	0.009	0.005	0.51
CHROMIUM	1	0.003	0.030	0.46
ANTIMONY	0.56	N/A		N/A
COPPER	0.32	0.021	0.325	0.16
THALLIUM	0.31	N/A		N/A
CYANIDE	0.25	0.001		0.11
ARSENIC	0.225	.009	0.0125	0.11
MOLYBDEUM	0.193	N/A		N/A
TIN	0.16	N/A		N/A
NITRITE-NITROGEN	0.11	0.071	0.25	0.09
SELENIUM	0.09	0.003	0.011	0.04
CADMIUM	0.07	0.0002	0.00125	0.032
SILVER	0.024	0.00013		0.011
BERYLLIUM	0.008	N/A		N/A
MERCURY	0.001	0.0004	0.00075	0.0007

Parameters	Median Leachate Analysis mg/l	Ambient Ground Water mg/l	Rule Standards mg/l	Predicted Monitoring Results mg/l
METHYLENE CHLORIDE	.8075	0.0018	0.012	0.36
DICHLOROETHYLENE (1,2-TRANS)	.025	N/A	0.017	N/A
TRICHLOROETHYLENE	ND	0.006	0.0078	N/A
TETRACHLOROETHYLENE	ND	N/A	0.0017	N/A
TRICHLOROETHANE (1,1,1-)	ND	0.0002	0.050	N/A
DICHLOROPROPANE (1,2-)	ND	N/A	0.0015	N/A
CHLOROFORM	ND	0.006	0.0013	N/A
TRICHLOROETHANE (1,1,2-)	ND	0.003	0.0015	N/A
DICHLOROETHANE (1,2-)	ND	0.0004	0.00095	N/A
VINYL CHLORIDE	ND	N/A	0.000037	N/A
TETRACHLOROETHANE (1,1,2,2-)	ND	N/A	0.00044	N/A
TOLUENE	.420	0.0006	0.5	0.19
BENZENE	.046	0.0006	0.003	0.021
ETHYLBENZENE	.007	0.0006	0.170	0.004
DICHLOROBENZENE (1,4-)	ND	N/A	0.0188	N/A
CHLOROBENZENE	ND	N/A	0.015	N/A
DICHLOROBENZENE (1,2-)	ND	N/A	0.155	N/A
PENTACHLOROPHENOL	ND	N/A	0.055	N/A

ND = Not Detectable
N/A = Not Available

The following discussion addresses how the predicted results were obtained. The ground water flow volume was determined as a function of the mixing depth. The mixing depth was assumed to be 25 feet. The width of the facility was considered to be 1000 feet in determining the ground water flow. Thus, the ground water volume was determined by the following equation.

$$Q = -(W \times MD)(S)(HC)$$

where:

Q = volume of ground water per day
W = width of facility waste boundary
MD = mixing depth in ground water
S = slope of ground water surface
HC = hydraulic conductivity of the aquifer

The above equation is based on the transport of nonreactive pollutants in ground water. Reference 71. The equation determines the volume of ground water that the leachate leaking from a land disposal facility will enter. The extent of lateral spreading was neglected and the mixing depth, hydraulic conductivity, and slope of the aquifer were used to calculate the mixing volume of ground water. It is assumed that once a pollutant enters this mixing volume no increase or decrease in concentration results before it reaches the compliance boundary. It is reasonable to assume no change in concentration because the proposed rules establish detection monitoring between the waste boundary and the compliance boundary. The detection monitoring encounters the first wave of pollutants to indicate changes in ground water quality due to the facility.

After calculating the volume of ground water that will be mixed with leachate leaking from the fill area, it is necessary to calculate the concentration of pollutants expected in the ground water after mixing. The calculation determines the mass balance between the pollutants entering the ground water system, the pollutants already in the ground water system and the pollutants leaving the ground water system. This calculation is made when the system is at steady state conditions (no change in concentration). For the purposes of this discussion, no pollutants are removed from the ground water system. The appropriate steady state mass balance is:

$$N_m (Q_g + Q_l) = Q_g N_g + Q_l N_l$$

where:

N_m = maximum concentration of pollutant in monitoring well
Q_g = flow of ground water
Q_l = flow of leachate
Ng = concentration of pollutant in ground water
N_l = concentration of pollutant in leachate

The results from the model runs indicated that a simple dilution could provide compliance with the ground water standards for some parameters. In reviewing the data results presented in Table 6, it must be noted that compliance occurred mainly when the pollutant was at or below the standard. However, in some cases the existing ground water quality contributed a higher pollutant concentration than did the leachate. Additionally, it must be recognized that the situation represented by the model is the most serious anticipated as no consideration was given to the other influences on pollutant concentrations at the point of monitoring.

If mixing were the only influence on pollutant concentration in the ground water, the conclusion reached from reviewing this data would be the need for total containment of leachate or a change in location standards to ensure land disposal facilities are located in areas of high hydraulic conductivity characteristics and high gradients to encourage mixing of leachate and ground water to greater depths. This would increase the amount of dilution experienced. In reality more factors, as discussed earlier, play an important role in evaluating the potential for a site to comply with the ground water standards proposed in this rulemaking.

Recognizing that other factors are involved in the assessment of a particular site's potential to cause ground water quality violations, a short discussion on these factors is necessary. The influence of these factors is highly site-specific. That is the reason they were not included in the model used to determine the impact of the 98.5 percent efficiency standard. As the model shows, mixing may or may not dilute the concentration of pollutants in the leachate to acceptable levels. The Agency believes that the other factors involved in the transport of pollutants in ground water provide natural treatment mechanisms that will decrease the potential for detrimental environmental impacts.

One such treatment factor is adsorption. Adsorption is a physical-chemical process by which molecules are concentrated at the interface between solids and liquids. This means the pollutants in a leachate are concentrated on the surface of soil particles. The adsorption process is affected by the properties of the pollutant and the surrounding soil particles. Important soil characteristics include the chemical composition of the mineral and organic fractions of the soil, the type of chemical bonds it will form, and the temperature and pH of the soil. The pollutant characteristics of interest are the solubility, and affinity of the pollutant for the soil particles. For instance, clay particles and metal cations have a strong mutual attraction. This attraction extracts the metals from the leachate as the fluid moves through the soil. It is expected that metals such as lead, mercury, and cadmium, in all likelihood, will be retained in the clay liner. References 72, 73, 74, 75, 76 and 77. However, if the metal ions do pass through the liner, the locational standards for siting land disposal facilities encourage clay soils below the fill area. These low permeability soils provide extra assurances that the metal pollutants of leachate will be adsorbed before reaching the compliance boundary. Positively charged organic compounds will also be tightly bound to clay soils. Thus, even though the model indicates that dilution is not sufficient to ensure compliance with standards, the Agency believes the combination of dilution and adsorption will ensure compliance. The amount of pollutant uptake through adsorption is limited by the type of soil present. Therefore, it is important to limit the amount of leachate moving out of the fill area and the reason a performance standard is necessary. The proposed standard of 98.5 percent reasonably minimizes the amount of leachate migrating from the fill area while recognizing construction limitations.

The model used to evaluate the facility efficiency standard assumed all pollutants moved at the same velocity in the ground water system. In reality, this would not occur. Rather dispersion would control the movement of pollutants. Dispersion is a physical process where a liquid moves through a porous medium at different velocities. The velocity depends on density and viscosity gradients, and the variation in pore sizes available to conduct the liquid. Dispersion spreads the pollutants in the soil thereby reducing the concentration at a given point over time and it puts the pollutants in contact with more soil particles providing adsorption points. Dispersion may cause relatively low levels of contaminants to arrive at the compliance boundary in advance of the center of mass projected by the model used here. This would permit earlier detection of impacts than would occur under the conservative model used in this discussion. Actions can then be employed prior to the major flux of pollutants reaching the compliance boundary.

An important factor governing the transport of organic pollutants is degradation. Solvent degradation during the movement of a leachate is based on the effects of hydrolysis and biodegradation. Hydrolytic reactions are chemical reactions in which solvents react with water to form weak acids or bases. The weak acids and bases are neutralized by reactions with sulfate and carbonations naturally occurring in soils. Biodegradation is a biochemical process whereby microorganisms break down the organic solvents found in leachate into other smaller compounds. The smaller compounds will be similar to naturally-occuring organic compounds resulting from decomposition of materials in the environment. The slow migration of leachate through the low permeability soils required by the proposed design and location standards permit microorganisms to biodegrade some of the organics present. Not all organics are biodegraded because of the inability of the microorganisms to attack them.

The combined effects of these factors, along with several others, gives a site its attenuation capacity. When evaluating a particular site, it is important that these site-specific characteristics be considered. The model does show that dilution cannot be relied upon entirely to ensure compliance with ground water standards. This is why the Agency believes it is important to site land disposal facilities where the potential for impacts is small (low-permeability soils, deep aquifers, low population areas), collect as much leachate as is reasonable, and control the amount and types of solid waste land disposed. This is the reason for combining design and performance standards in the proposed rules. The combination of standards ensures no particular area is overlooked in evaluating the effectiveness of management system.

Papers written by Mr. Fred Doran, et al. (Reference 78) and Mr. W. R. Roy, et al. (Reference 79) have discussed the potential uses of ground water modeling in evaluating ground water impacts from proposed land disposal facilities. Both papers concluded that site-specific characteristics are needed to determine the compliance potential for facilities. The papers also concluded that good design parameters are essential, since they control the amount of pollutants in leachate leaking to the ground water system. The use of siting criteria, design and waste controls are all important in ensuring minimal impacts of land disposal facilities on the environment.

Complete containment of leachate within the fill area is not possible with soil liners. To require complete containment, the Agency would place unnecessary cost burdens on facility owners and operators, who have sited their facility in low-permeability soils away from population areas. Complete containment provides little incentive for facility owners and operators to carefully consider facility location or other risk management controls. However, some minimum standard is necessary to ensure site conditions are not the sole factor in determining potential risks. The Agency believes the proposed performance standard of 98.5 percent efficiency provides a reasonable control on leachate migrating from a facility and permits site conditions to be factored into the ability of a facility to meet ground water standards.

Item B requires the liner system to be compatible with the solid waste placed in the facility and the leachate generated. Mixed municipal solid waste and the substances leached from it are not inert. Constituents of the leachate can affect liners in different ways, depending on their concentrations in the leachate and on the specific liner materials. Furthermore, the effects of the constituents can be synergistic and can vary with time as the concentrations change with time. For these reasons, it is important that the liner and waste materials be compatible.

Because soil permeability is the essential property considered in the case of soil liners, any alterations of a soil due to the presence of a waste-leachate must be identified. Leachate depends on the composition of the waste and may be aqueous-organic, aqueous-inorganic, or organic. Water is normally viewed as the fluid in leachate. In the case of clay liners in direct contact with concentrated organic fluids, the clay minerals have little adsorption capabilities. However, rarely are concentrated organic fluids in direct contact with the clay liner. The organics are contained in the leachate at low concentrations. The viscosity and dipole moments of the organics are affected by clay minerals. This can affect the mobility of the organics within the clay liner. Depending on the organic substance under consideration, the soil permeability may increase or decrease. The alteration in permeability will also be dependent on the organic substance's concentration in the leachate. See Exhibit XXXVII.

Water is a unique solvent and is particularly sensitive to the substances dissolved in it. Because of this, a clayey soil liner may shrink, swell, heave, or crack. Water may also increase the hydraulic gradient that moves fluids in soil. The most important impacts induced by inorganics in a soil-water phase are flocculation, dissolution, or swelling and cracking, all critical factors on liner performance. Thus, it is essential for the facility owner or operator to consider impacts of leachate on soil liners and then design and operate the facility in a manner that minimizes the impact. Synthetic membranes can also be adversely impacted by their contact with leachate. Tests are available to evaluate the compatibility of the synthetic membrane with the leachate. Further discussions on the impact of leachates on soil and synthetic membrane liners are available in the publication, "Lining of Waste Impoundment and Disposal Facilities," issued by the EPA. See Exhibit XXXVIII.

The proposed requirements for liner compatibility compel a minimum level of environmental protection. The requirements also provide facility owners and operators flexibility in selecting the design and construction of the liner at a land disposal facility.

Item C requires the liner be of a quality that will maintain its integrity through the operating life of the facility and the postclosure care period. The liner is a critical design component of a land disposal facility for containing leachate and minimizing impacts on ground water, surface water, and the surrounding area. Additionally, the liner is one of the most costly components of the disposal facility. If the liner does not function as designed, considerable cost can be incurred by facility owners and operators for correcting polluted areas and money will have been lost due to a bad investment. It is reasonable to require that the liner be designed and constructed of materials capable of maintaining proper performance levels through the site operations and postclosure care period. By requiring this level of performance, the Agency assures site users and the public specific protection and facility owners and operators of a reasonable return on their investment.

Item D contains the basic requirements for the components of the liner system. The liner system must consist of at least three components - a subgrade base, a barrier liner, and a drainage layer. These components along with the leachate collection system are necessary to achieve efficient collection of the leachate generated in the fill area. Reference 80.

Subitem (1) describes the condition to be achieved in the subgrade prior to placement of the barrier liner. The condition of the subgrade is critical to barrier liner performance in that it provides a firm and unyielding support for the barrier liner material. The proposed subitem requires the subgrade to be smooth with all abrasive objects, organic matter and vegetation removed. The subgrade must also be regraded to conform with the proposed slope of the barrier liner. The subgrade includes all excavated soil, engineered fill, and trench backfill. In most liner system installations, the more regular the subgrade base is, the easier and more reliable the installation will be. A rough subgrade or irregular-shaped configuration will increase the potential for punctures or tears in synthetic membranes and create unnecessary difficulties in placing and compacting soil-based liners. This subitem reasonably provides safeguards for the installations of liners in order to preserve the barrier liner's performance efficiency.

Subitem (2) establishes a general performance standard for the barrier liner. The barrier liner is to be designed and constructed in a manner that will ensure its ability to contain leachate and any surface water coming in contact with the waste. The barrier liner is the last facility design feature capable of protecting ground water from pollutants. It is reasonable, therefore, to provide a general performance standard to evaluate the effectiveness of this design feature.

Subitem (3) requires the drainage layer above the barrier to rapidly convey surface water and leachate from the fill area and to protect the barrier liner from punctures or other disruptions that impair the barrier liner's integrity. If the drainage layer does not effectively move liquids off the barrier liner, the liquid build-up on the barrier liner will force the leachate in a downward vertical direction through the barrier liner into the surroundig soils. This increases the potential for ground water degradation and violations of performance standards. For this reason, the drainage layer must be capable of encouraging horizontal flow to collection points in the facility. By including this performance standard in the proposed rules, the Agency requires facility owners and operators to consider using coarse sands and gravel as the drainage layer and avoid silts or peaty soils. The collection efficiency of a liner system is heavily controlled by the horizontal versus vertical flow regime within the fill area. The more the horizontal flow component of leachate in the fill exceeds the vertical component, the greater the amount of leachate collected.

Item E establishes the minimum design thicknesses required for the barrier liner and drainage layer. A barrier layer constructed of natural soils must be at least four feet thick. A synthetic membrane used as the barrier liner must be at least 60/1000 of an inch thick if it is unreinforced and at least 30/1000 of an inch thick if it is reinforced. Reinforced membranes have fabric weaved into the membrane to add strength. This reduces the potential for punctures and stress fractures. A synthetic membrane must be placed over a natural soil barrier liner of at least two feet. The drainage layer must consist of at least 12 inches of suitable soil material or an equivalent synthetic material. The barrier liner is designed and constructed to impede the flow of leachate out of the fill area into the surrounding subsurface environment. Without some minimum design standards, the barrier liner may be designed and constructed without ample protection for the integrity of the system and the environment. The specific design standards included in this item will be discussed in greater detail in the following paragraphs.

A soil barrier liner is constructed of numerous layers compacted to achieve the final desired thickness. Construction techniques, though capable of achieving the necessary permeabilities, cannot be completely relied upon to meet performance standards uniformly across the barrier liner. Permeability depends on the amount of compaction achieved. Compaction is achieved by moving over the soil with appropriate equipment. During this process, each pass must overlap to ensure equal compaction at all portions of the liner. Since it is cost-prohibitive to analyze each foot of the barrier liner for permeability and because a testing program of this magnitude would decrease the overall barrier liner permeability, some safety factor must be built into the system. This is part of the reason for a minimum design and construction standard of four feet for natural soil-based liners. However, the more important reason for the minimum standard of four feet is the control of leachate.

The physical laws governing liquid moving downward through a soil barrier liner include hydraulic head, caused by gravitational forces, and capillary forces drawing liquid into the soil. The smaller the pore radius between soil particles the larger the capillary forces. Thus, soils with high clay content will have very small micropores and very large capillary forces. Because of the variety of different grain sizes in soils, there will be many different sizes of micropores affecting the capillary forces. As the smaller micropores are filled during periods of high soil moisture, the capillary forces tend to form in larger pores. The larger the pores these capillary forces are forming in, the lower the attraction force. Thus, the higher the moisture content of the soil, the lower the capillary force. Moreover, when the soil becomes very dry the capillary forces become so great that they override the gravitational forces.

Four feet of soil material is the minimum design requirement for barrier liner design and construction because of other environmental conditions that can impact the performance of the liner system. These conditions include freeze-thaw effects, cracking, erosion and swelling. By using a four-foot thickness in designing and constructing barrier liners, the impacts from these environmental conditions will be lessened. One season's effect on the barrier liner will not destroy the entire barrier liner except under very unusual circumstances. It is the Agency's belief that if unnoticeable impacts (small cracks, upheavels, etc.) occur, the barrier liner will remain intact. Providing for a barrier liner thickness capable of maintaining the integrity of its function during times of environmental impacts decreases the risks associated with the operation of land disposal facilities. Reference 80.

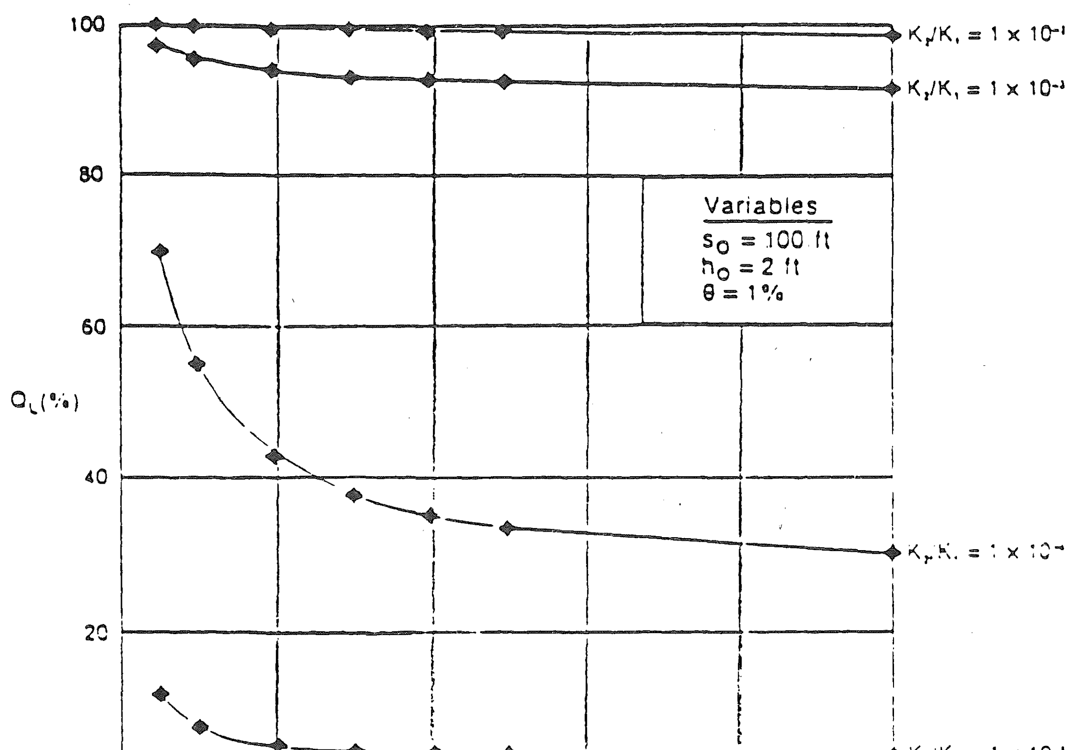
As previously mentioned, the main functions of a barrier liner are impeding leachate movement out of the fill area and attenuating of pollutants. The importance of the soil attenuation mechanisms has been discussed under item A of this subpart. The importance of leachate control will be addressed at this point. There are analytical models available to determine the collection efficiency of a liner design. Two of the more prominent models are the Wong model developed by Mr. J. Wong in 1977 and the HELP model developed by the United States Corps of Engineers. <u>See</u> Exhibits XXXIV and XXXV. In 1981, Mr. Peter Kmet, et al., presented a paper at the Fourth Annual Madison Conference of Applied Research and Practices on Municipal and Industrial Waste analyzing the design parameters affecting the efficiency of clay liners. <u>See</u> Appendix XIV. The paper used the Wong model in evaluating the design parameters affecting collection efficiency. For the purposes of discussion on the barrier liner thickness, the graphic illustrations on the following pages should be consulted. These figures were reproduced from the paper presented by Mr. Kmet, et al., and are used to illustrate the importance of the barrier liner's depth compared to hydraulic conductivity, slope, and the flow distance to collection pipes.

As one would expect, as the liner thickness increases, the percent leakage decreases. Liner thicknesses less than two feet generally results in a sharp increase in leakage. As the liner thickness is increased to four feet there is a correspondingly large reduction in leakage. Thicknesses from four to six feet produce diminishing returns in increased efficiency. Substantially greater thicknesses result in only a minor reduction in leakage. Two models will be discussed in greater detail under item J, although highlighted throughout this subpart. This analysis clearly shows the reasonableness of a four-foot depth requirement. The requirement provides flexibility for facility owners and operators in their design efforts while providing assurances that a base level of efficiency will be achieved.

Synthetic membranes are susceptible to ultraviolet light destruction, chemical attacks, punctures, swelling and other factors that could severely impact their ability to meet performance standards. Therefore, it is necessary to ensure that the synthetic membranes used in lining land disposal facilities are of suitable quality and construction to resist both chemical and physical attacks. The minimum standards of 60/1000 of an inch unreinforced and 30/1000 of an inch reinforced synthetic material were established to provide the protection needed at land disposal facilities. The strength of synthetic membranes is based on the polymers used in the membrane and the manufacturing process followed. The elastomizers and polymers used to manufacture the membrane can be highly susceptible to chemical attack or breakdown due to age weakening the polymeric bond or stiffening the membrane inducing cracking. The standards proposed in this item are reasonable because they are readily available and meet the standards established by the synthetic membrane manufacturers as reported in the National Sanitation Foundation's Standards book Reference 70.

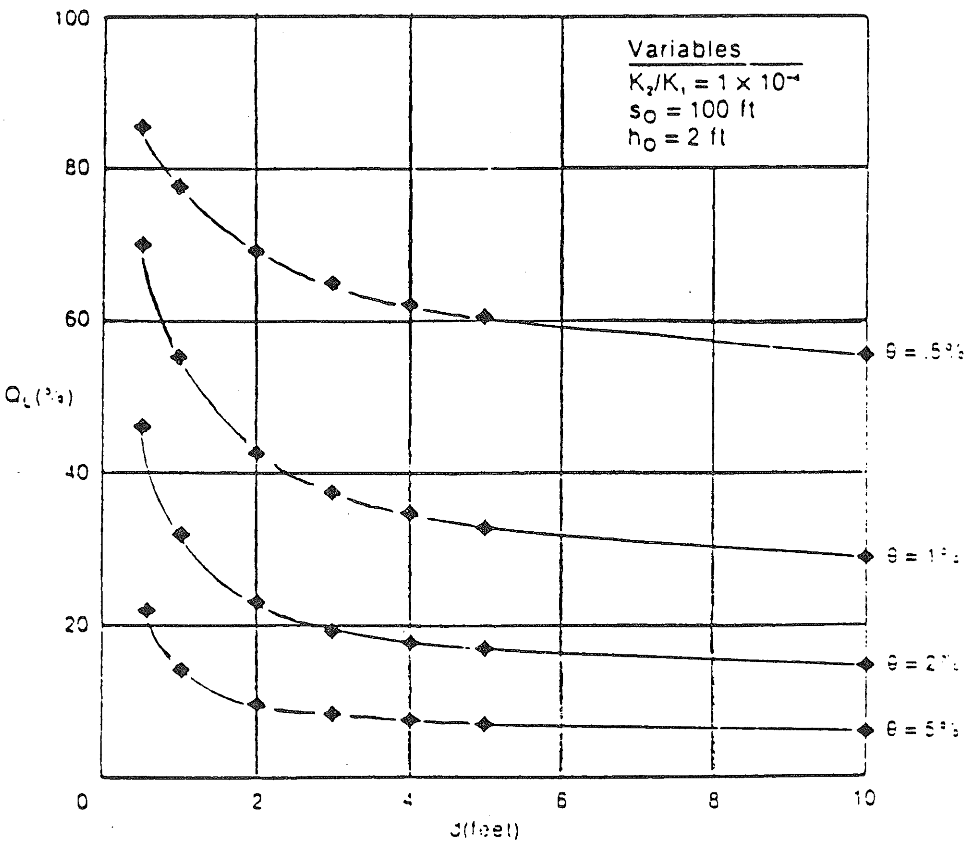
The thickness standards established for the synthetic membranes are based on the need for strength and protection against punctures. The difference in thickness requirements for reinforced and unreinforced membrane (Reference 81) are based on their strength equivalencies. See Exhibit XXXVIII. The strength properties represented by these thicknesses are the minimum needed to resist the stresses placed on the membrane during installation and during filling. Requiring the minimum thickness ensures that suitable protection is achieved yet allows flexibility in the exact design and construction needs of facility owners and operators based on their risk management program.

Graph 1
Liner Thickness Comparison's



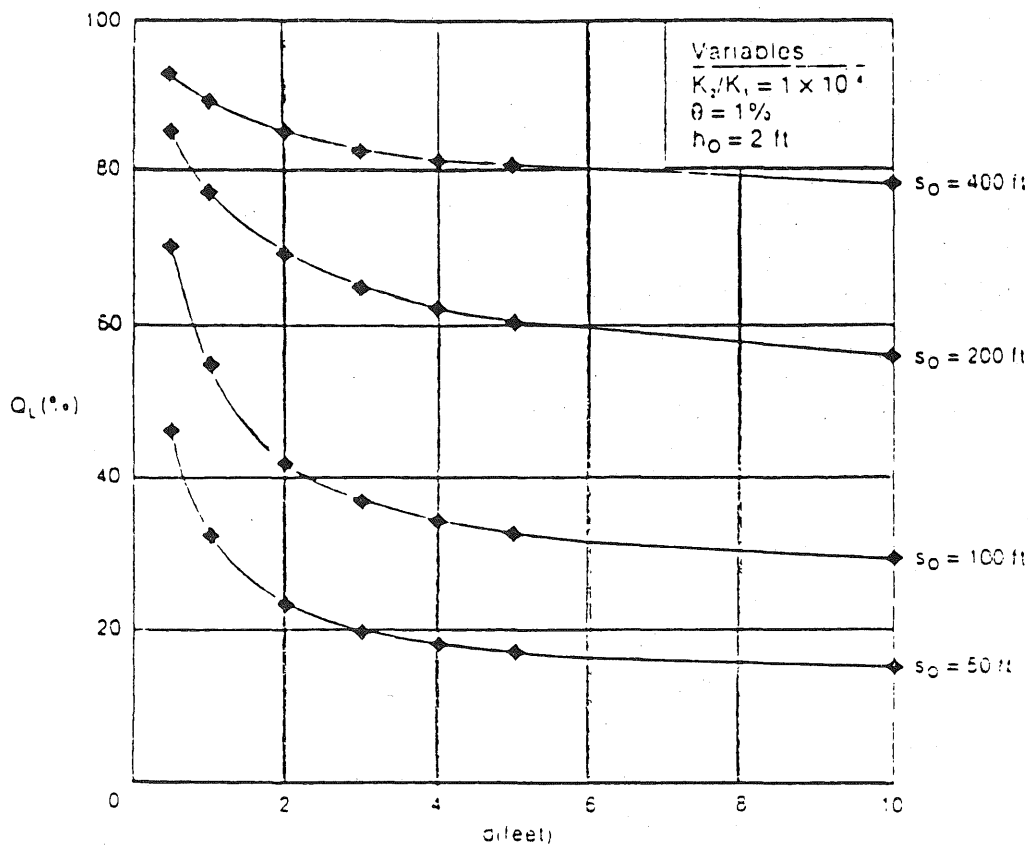
Percent leakage as a function of liner thickness for various hydraulic conductivity ratios

Graph 1
Liner Thickness Comparison's



Percent leakage as a function of liner thickness for various liner slopes

Graph 1
Liner Thickness Comparison's

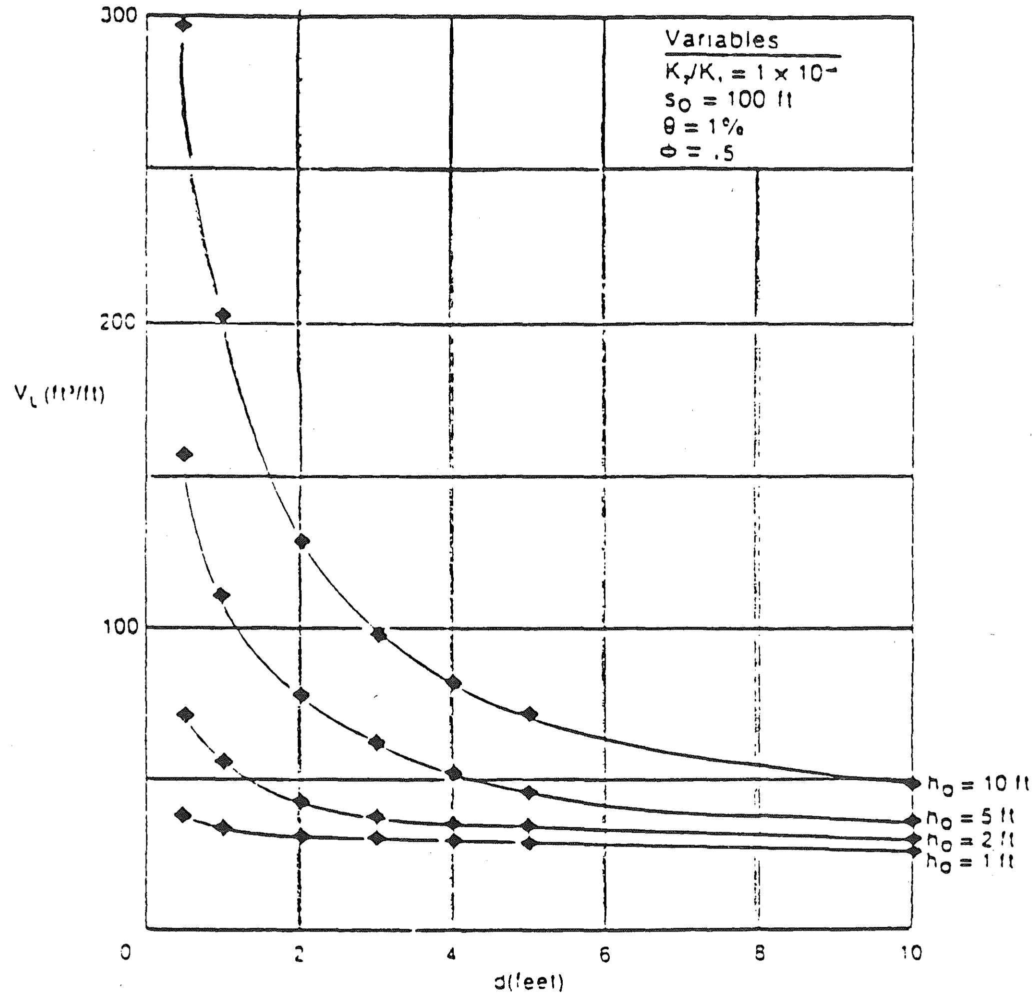


Percent leakage as a function of liner thickness for various leachate flow distances

Two feet of a natural-soil barrier liner is required as a backup to all synthetic membrane liners. Synthetic membranes are a cost-effective choice for barrier liners only when sufficient amounts of clay soil are not present on site or nearby. Since clay has the best attenuation capacity of all soils, little natural protection will be available to treat any leachate migrating through the synthetic membrane. Thus, the addition of a soil-based barrier liner under the membrane assures some treatment of the leachate. Two feet is the minimum thickness needed to ensure collection efficiency and permeability standards are met.

As indicated earlier, the depth of the drainage layer is 12 inches. The drainage layer serves two functions. The first and most important function is enhancement of horizontal flow of leachate generated in the fill area. The second function is protection of the barrier liner from disruption due to the placement of waste or driving on the barrier liner. Twelve inches was chosen as the design standard for the drainage layer because it is the minimum thickness needed to control the maximum head permitted on a barrier liner. If the drainage layer is to adequately encourage horizontal flow of leachate to collection pipes, the leachate must be contained within the drainage layer. Because of the efficiency standards proposed in this subpart, it is necessary to have a collection system capable of maintaining the leachate head at or below 12 inches to maximize horizontal flow versus vertical flow. The following graphic illustration shows the effect of leachate head on the collection efficiency. Thus, establishing a thickness for the drainage layer that is capable of containing the maximum head permitted achieves optimum collection efficiency. Additionally, it is important to protect the barrier liner from direct contact with the waste or with equipment working in the fill area. The thickness requirement ensures that some protection is provided for the integrity of the barrier liner.

Graph 2
Leachate Head Comparison



Total volume of leakage as a function of
liner thickness for various initial heads

A factor often overlooked in selecting and designing a drainage layer is the filtering effect the drainage layer has on leachate flowing through it. A drainage layer will filter settleable solids out of the leachate as the leachate moves through the layer to the collection system. By having at least 12 inches of drainage material over the barrier liner, the filtering ability of the drainage blanket will not decrease its drainage efficiency. Including the 12-inch standard for the drainage blanket provides horizontal flow control of leachate movement, protects the barrier liner, and serves as a filter medium for the leachate. Reference 78.

Item F establishes the permeability requirements for the barrier liner and drainage layer. The barrier liner must have a permeability no greater than 1×10^{-7} centimeters per second and the drainage layer no less than 1×10^{-3} centimeters per second. These permeabilities are proposed in this item to establish a specified difference in permeability between the barrier liner and the drainage layer. The efficiency of a barrier liner is dependent on its ability to impede the downward movement of leachate. By creating a significant change in permeabilities between the barrier liner and the drainage liner, horizontal flow over the surface of the barrier liner is maximized. Liquids will follow the path of least resistance. If it is easier for liquids to flow through the drainage layer because of increased pore size, leachate will move through this layer rather than vertically through the barrier liner. As the difference in the permeabilities increases the collection efficiency increases. The permeability ratio represented by the standards proposed in this item results in an efficiency ratio of only 25 percent leakage. Because many factors go into the ultimate design for the liner, the Agency believes minimum design standards controlling the permeability for the barrier liner and drainage layer are reasonable. The performance standards will achieve the more restrictive efficiency standard needed to minimize the release of pollutants. This gives facility owners and operators flexibility in altering the design to achieve the required facility performance standard.

Item G requires the base of the liner to be graded to a slope between 2 and 10 percent with side slopes no greater than 25 percent. The slope of the liner improves the performance of the barrier liner and leachate collection system. By increasing the slope, a facility owner or operator may increase the efficiency of the leachate collection system. Although the slope is not the most sensitive factor in controlling the performance of a liner system, it is important that some control must be considered in the design of the barrier liner. The slopes proposed in this item will control the rate of leachate flow in the fill area while providing flexibility in the design to meet the facility owners' and operators' needs regarding site-specific conditions. The maximum slope of 25 percent on the side slopes has been established to minimize the erosion potential of the drainage layer during precipitation. Additionally, the slumping slope of sand is 28 percent. This means that slopes greater than this will cause sliding of most sands under normal stress conditions. Therefore, the design requirement provides some assurance that the barrier liner will be protected by the drainage layer while encouraging control on the liner efficiency. This item provides a set of design criteria that ensures the basic performance by the liner system without undue restriction of the facility owners' and operators' design and risk management options.

Item H requires the barrier liner to be constructed in compacted layers of 8 inches or less. Compaction of the barrier liner must be determined based on specific soil conditions. However, standard construction procedures dictate that thin layers of loose soil be compacted near the optimum moisture content to achieve maximum compaction. Normal recommended depths of the loose lift are between 6 and 12 inches, dependent on the type of equipment available for compacting the material. By establishing a minimum standard of 8 inches, the Agency permits facility owners and operators to achieve compaction needs without the expense of buying or renting special equipment. The compaction achieved by passing equipment over the lifts and comparing this to permeabilities established by practice runs determines construction quality control measures. By compacting the barrier liner in thin lifts and following proper quality control measures, the facility owner or operator will be able to meet the design standards proposed in item F. The proposed standard imposes no undue burden on facility owners and operators while ensuring good compaction.

Item I requires the drainage layer to be placed over the entire barrier liner including the side slopes. The drainage layer functions not only as a means of leachate transport to the collection system, but also serves as a protection material for the barrier liner. The drainage layer prevents equipment used in the fill area from coming into direct contact with the barrier liner, disrupting the integrity of the barrier liner. The drainage layer also prevent desiccation of the barrier liner. In the situation where a synthetic membrane is used, the drainage layer protects the membrane from attack by ultraviolet light and cold weather conditions that break down the polymers that give strength to the membrane. Requiring that the drainage layer be placed over the entire barrier liner ensures physical protection and good drainage over the entire fill area.

Item J establishes a performance standard for the design and construction of the barrier liner. This standard is used in conjunction with the final cover performance standard and the overall site efficiency standard to minimize the potential for leachate migration out of the fill area into the surrounding area.

The efficiency standard for the barrier liner is 95 percent of the precipitation falling on the fill area. This standard establishes a leachate leakage rate from the barrier liner during the active operating time of the fill area. The efficiency standard proposed in this item establishes the minimum conditions a land disposal facility design must meet. The standard also allows ample flexibility in how the performance standard is met or exceeded. By establishing this performance standard, the Agency informs facility owners and operators what level of protection the Agency expects to be achieved by facility designs. The facility owner or operator is then responsible for assessing the risk associated with a particular site, facility operation, or facility design and incorporating the final barrier liner design into the facility risk management program. The proposed performance standard provides a reasonable approach for controlling leachate migration out of a fill area and guiding the facility owners and operators to acceptable designs.

Along with the proposed performance standard, this item contains the design components that must be considered during the efficiency calculation for the barrier liner. These components include the barrier liner thickness, side and base slopes, saturated hydraulic conductivity of the barrier liner and drainage layer, drainage layer thickness, porosity of the drainage layer, flow distance to collection pipes, and the amount of leachate to be generated and collected based on annual precipitation and ground water inflow. The design components listed are those most critical to determining the efficiency of a liner system. No one specific efficiency model is proposed to be required for use by facility owners and operators because more than one model exists and new or improved models may be developed in the future. By listing the design components that must be addressed in the efficiency calculation, the Agency ensures that consistent evaluations are made both by the facility owners and operators and by Agency staff. It is important that sufficient information be supplied by the facility owner or operator to the Agency for review and approval of a particular design. Additionally, facility owners and operators need to understand what is expected of them in order to comply with the proposed rules and minimize risks associated with a facility through good design and operation. This provision establishes a reasonable standard for obtaining detailed consideration of the critical elements of a barrier liner design while allowing flexibility in the use of these elements in the design. By including these elements in rule, the Agency has not increased the burden on facility owners and operators, yet has provided the basis for consistency between the design and approval processes.

Item K allows for alternative designs for liner systems upon approval by the Commissioner. The Commissioner's approval will be based on the ability of the liner system design to control leachate migration, meet performance standards, and protect human health and the environment. The rule provides facility owners and operators the opportunity to alter the design standards proposed in this subpart based on site conditions and facility operations. By providing this opportunity in rule, the Agency eliminates the need for a facility owner or operator to request a variance for such minor design changes as slope alterations to achieve a particular design efficiency. In many cases, the facility owner or operator may wish to exceed the minimum performance standard included in the proposed rules but would be unable to make changes without the variance procedure. By including this option in rule, the Agency encourages the use of best available technology capable of ensuring that the risk associated with a particular facility does not exceed the acceptable risk established by the performance and design standards included in the proposed rules. The Agency believes that the facility owner or operator is responsible for managing the land disposal facility to minimize the risks associated with that facility. If this requires a change in design from the minimum standards included in the proposed rules, the Agency should provide the facility owner or operator the opportunity to accomplish this task with a minimum increase in administrative burden. In order for the facility owner or operator to utilize a design different from the proposed rules, the facility owner or operator must meet performance standards with adequate leachate control mechanisms. A basic design and construction quality must be maintained under the alternative liner system designs.

Item L contains the requirements for an engineer's report to be submitted along with the design plans for the liner system. The engineer's report documents how the design was derived, including assumptions and calculations needed to show design efficiencies and the reasonableness of the proposed design. By reviewing the engineer's report the Agency staff gains an understanding of how the facility owner or operator intends to coordinate the design, construction, and operation of the facility to minimize risks to human health and the environment. An engineering report included with the design establishes a common basis for discussion between the Agency and facility owner and operator. The inclusion of an engineer's report excludes lengthy debates over a particular design because all the necessary information will be collected in one organized report.

Subitem (1) requires the engineering report to address the source and quantity of natural soils capable of meeting the requirements of this subpart. A design is only as good as the material used and the construction procedures followed. If the liner is to be constructed of clay soils, it is imperative that the source be found prior to receiving approval for construction. By addressing the location and amount of soil in the engineer's design report, the facility owner or operator assures the Agency of the quality of soil to be used and may plan appropriately for the costs to be incurred using the soil. Planning for the construction of a particular design feature is as critical as developing a scheme that on paper indicates all standards will be met. For example, the use of natural soils may not be feasible or cost effective if the soils are located some distance from the proposed facility location. This provision does not increase the responsibility of the facility owner or operator and provides the Agency with information on the availability of suitable construction materials.

Subitem (2) requires the facility owner or operator to address the likelihood and consequences of barrier liner failures caused by puncture, tear, creep, freeze-thaw, thermal stress, abrasion, swelling, extraction, oxidative degradation, ultraviolet radiation, acid conditions, organics, pressure, gases, rodents, microbes and root penetration. An important factor in selecting barrier liner material is matching its intended service life with the particular exposure conditions. In order to estimate the service life, it is necessary to understand how a barrier liner might fail. By understanding the potential failures of a barrier liner, design and construction techniques can be devised to reduce the potential for these failures. Additionally, the barrier liner is the main control for protecting the environment surrounding the facility from severe impacts. In order to provide for proper corrective actions in the event of a failure, it is necessary to understand the potential failure mechanisms provide sufficient financial reserves for the facility, and be prepared with the necessary equipment to correct the situation.

Three major categories of liner failure are used to discuss this area of concern. The categories are chemical, physical and biological failures. The importance of the potential modes of failure will differ for synthetic membranes and natural soil liners. In choosing one liner material over another, the facility owner or operator must consider not only the cost of the material but also how reliable it is in meeting performance standards over a period of time. Because of the cost associated with correcting environmental degradation caused by the failure of design systems, the rule requires the facility owner or operator to address why a particular liner material should be used in constructing a facility. Reference 80.

Subitem (3) requires the facility owner or operator to address in the engineering report the composition of the soils used for the drainage layer and the barrier liner, including at least the soil gradations, percent fines, mineral composition, and solubility under acidic conditions, and performance when in contact with solvents. The physical and chemical properties of the soils used in constructing a barrier liner and drainage layer are critical to the performance and long-term integrity of these systems. Leachate generated at a mixed municipal solid waste land disposal facility is typically slightly acidic. If soils used in the barrier liner and drainage layer are highly susceptible to these conditions, the performance of these systems will not be as good as designed. In the case of drainage layers, the material should be free of fine particles that could clog the system, preventing good flow conditions. The drainage layer may be more effective if the material is a combination of very coarse to coarse gradations so it functions as a flow-through filter medium. On the other hand, barrier liners are best when larger particles are not present and the material consists of very fine soil particles. This provision requires the facility owner or operator to carefully analyze the facility design and construction materials to ensure they are compatible and will guarantee, to the extent possible, that minimal risks will be associated with operating the facility. The required information allows the facility owner or operator to consider the expense of purchasing additional lands to obtain suitable materials based on construction needs. Obtaining this information is good risk management and necessary for the construction of the facility. Reference 82.

Subitem (4) requires the facility owner or operator to address the calculations and assumptions used in choosing a particular design for the facility. Because assumptions made during the course of evaluating the suitability of a particular design can impact or determine the outcome of any review, the Agency must have an understanding of the thought processes that went into the selection of a particular design. Additionally, calculating errors are possible and by including the calculations made in determining liner efficiency or amount of material needed, the Agency's review process can include mathematical verification. In brief, the facility owner or operator must submit all assumptions and calculations because they constitute the technical background to the design decisions made by the facility owner or operator. Reference 83.

Item M requires the facility owner or operator to protect the liner system from damage during operation of the facility. The protection method chosen by the facility owner or operator must be approved by the Commissioner. This item ensures the liner system of a land disposal facility will not be disrupted during operations, yet it provides the facility owner or operator flexibility in designing the protection. Protecting the barrier liner may be accomplished through the use of solid waste loosely placed over the drainage layer, increasing the thickness of the drainage layer, synthetic membranes, a combination of these options, or another option. Allowing the facility owner or operator to investigate the potential use of a particular method of protection allows for the integration of this requirement into the general operations at the facility. Requiring the submittal of a protection plan assures the Agency that the liner system's integrity will be maintained.

Item N requires the facility owner or operator to install or ensure installation of the liner system in compliance with the construction specifications proposed elsewhere in the proposed rules. Without good construction techniques and quality control, the design of any facility can become unimportant. The construction of a design feature is critical to performance of that feature and the facility in general. Because it is good business practice to ensure quality workmanship on such an expensive project as a land disposal facility and due to the costly actions needed to repair a damaged facility or environment, the facility owners and operators of all land disposal systems must exercise strict control over construction projects.

Subpart 8. Cover and liner evaluation. This subpart requires the soils intended for use as cover or liner material to be evaluated for certain properties, as appropriate. As discussed earlier, the ability of a cover or liner system to perform satisfactorily is highly dependent on the quality of material used in the construction. This subpart lists the evaluation techniques the Agency considers suitable to determine the quality of the material being investigated for use at the facility. By including a list of specific evaluation techniques in rule, the Agency ensures the same methods are used consistently by all facility owners and operators. This eliminates any complaints of unfair treatment of any facility owner or operator. Additionally, by listing the acceptable techniques in rule, the Agency provides the facility owner or operator with sufficient information to avoid using unacceptable techniques. The list also provides potential service organizations with information needed to ensure they have proper equipment and procedures needed to complete the evaluation. These tests are nationally recognized as acceptable.

Item A requires the facility owner or operator to conduct particle size distribution analyses in accordance with the American Society of Testing and Materials (ASTM) standards D421, D422, and D2217. The ASTM tests are standard procedures used to evaluate soils for construction efforts. These tests are regularly used in the industry for evaluating soils and are relatively inexpensive. The particle size distribution analysis provides the user with information on how coarse or fine the soil is. This information is used to classify the soil for use as liner material (fine-particle soils) or drainage material (coarse soils). The distribution curve is used to see how well the particular soil is sorted before use. In this way, compaction needs, workability and other physical characteristics of the soil can be determined. Reference 53.

Item B requires the percent fines to be determined for the soils intended for use as cover or liner material. The standard testing protocol to be used for this determination is found in ASTM D1140. The percent fines provides insight as to the suitability of a particular soil material for use as a cover material to control vectors, provide low permeability, or generate dust; or use as a liner material to impede migration of leachate out of the fill area; or use as a drainage layer if few fines exist, decreasing the potential for clogging. Requiring the facility owner or operator to collect information regarding the percent fines in a particular soil provides an understanding of the possible function the soil may serve or the problems it may create. Reference 53.

Item C requires the facility owner or operator to determine the Atterberg limits for the soils. The standard protocols for these tests are found in ASTM D423, ASTM D424, and ASTM D427. The Atterberg limits are standardized indices of water content used to define the states of consistency for fine soils. These indices are used to assess the mechanical behavior of the soil. The Atterberg limits are defined as the liquid limit, plastic limit, and the shrinkage limit. These limits are most important when evaluating the suitability for a soil as a liner material. The liquid limit is the water content at which two halves of a slot in the soil will close under the impact of 25 blows. The blows and separation distance are all standardized in the appropriate test protocol. The liquid limit is presented as a percentage of the dry weight. At the liquid limit, soil behavior is a blend of plastic deformation (deformation ceases upon stress removal) and liquid flow (deforms freely after stress removal). The recommended liquid limit for soils used as barrier materials is between 35 and 60 percent. Reference 53.

The plastic limit is the water content at which the soil begins to crumble when rolled into a thread 1/8 inch in diameter. This limit represents the boundary between plastic and semisolid conditions. Though the plastic limit generates information on mechanical behavior, it can also provide information on chemical properties of the soil. Normally, the plastic limit is determined using distilled water, but higher electrolyte solutions can be used to reflect the more aggressive behavior of leachate on a liner. This is particularly the case if the soil is suspected of being chemically sensitive, containing 20 percent or more of montmorillonite clay. The information collected from this test is critical to decisions on the design of a liner or cover.

The shrinkage limit is the water content at which further removal of moisture will not decrease the soil volume. This represents the boundary between semisolid and solid conditions. Forcing a soil beyond this point will cause cracking. Again, this information is necessary in deciding on the suitability of a particular soil for use as a cover or liner. The information is easily obtained while collecting information on the liquid and plastic limit.

The Atterberg limit tests are easily accomplished, routinely done by all soil laboratories, and inexpensive. When using different liquids with different soils, valuable information is obtained regarding the soils buffering capacity, i.e., its ability to resist physico-chemical alterations and mechanical changes. Reference 73.

Item D requires the specific gravity of the soil material be determined using ASTM D854. The determination of the specific gravity of a particular soil is a standard practice used in determining the moisture content of a soil. It is necessary to have this information to determine other important soil conditions and characteristics. Reference 53.

Item E requires the facility owner or operator to obtain a soil description in accordance with ASTM D2488. This method of describing the type of soil present at the site or intended for use as borrow source allows the soil to be classified by visual and manual inspection without extensive laboratory testing. The Agency proposes a soil description method based on field inspection because laboratory analyses are needed to determine the soil's suitability for use as a cover or liner material, making an exact classification of soil type unnecessary for preliminary efforts. By completing a specific gravity analysis, mineralogy analysis, and determining Atterberg limits, the facility owner or operator will better understand the type of soil present. This visual classification is done as a preliminary determination according to specific procedures. Facility owners and operators should use this method of soil determination until detailed analyses are needed. Reference 53.

Item F requires a soil classification be completed in accordance with ASTM D2487. Although most soil classification is done by the visual method discussed in item E, laboratory classifications are routinely done on representative soil samples that are to be extensively tested for shear strength, compressibility, and permeability. The tests are also used as a quality control check on the field descriptions. It is important that soils used as barrier liners be accurately defined as to soil characteristics in order to ensure the performance of liner. By requiring some laboratory verification of soil classifications, the Agency provides for consistency in soil classification and application of analytical data for the decision making process by all facility owners and operators. This information provides a verification of field classification of soils and ensures similar soils are being correctly classified. Reference 53.

Item G requires the facility owner or operator to define the water content of the soils used as final cover and liner material. The water content is defined as the ratio, expressed as a percentage, of the weight of water in a given soil mass to the weight of the soil particles. The water content is a fundamental property of any soil. The water content ratio is used with density analyses to determine the optimum conditions for compaction of a particular soil. Placement under optimum conditions maximizes the ability of the soil to meet performance standards. By comparing the natural water content to the needed water content for maximum compaction, the facility owner or operator will be able to determine the amount of water that must be added or removed to achieve optimum conditions. This information is critical to the quality of construction accomplished because the water content of a soil is dependent not only on the inherent soil properties but also climatic conditions (e.g., immediately after a rainfall).

Item H requires compaction analysis to be completed in compliance with ASTM D698 or ASTM DM1557. These standard analyses are determined by the rapid acceleration of mechanical force to a soil to increase its density, decreasing the permeability. The compaction analyses are used with the water content results to determine optimum conditions needed to achieve the desired compaction. For liners, the most important effect of compaction is upon the permeability of the soil. Therefore, it is necessary that this information be obtained before construction begins in order that the proper construction quality control procedures can be developed. This information is easily obtained and is critical to the construction of the facility. Reference 53.

Item I requires a consolidation test be completed in accordance with ASTM D2435. Consolidation means adjustment of a soil to the application of a load. When a soil structure has come to equilibrium after an applied load is in place, the soil is said to have been consolidated. The primary cause in delaying consolidation is the movement of water out of a saturated soil. Consolidation behavior is insignificant in cover soil but can be important in the liner and solid waste. If soil material drains slowly, pore pressure may rise under new loading conditions and lead to slope instability or bearing capacity problems. It is important to understand these structural properties of soils proposed for use as liners in order to be confident that side slopes in the fill area will maintain their strength during site operations after precipitation events. The integrity of facility design features is basic to the performance of the facility. The tests provide the information necessary to ensure this integrity. Reference 53.

Item J requires a permeability test to be conducted in accordance with ASTM D2434. Soil permeability is a numerical measure of the ability of a soil to transmit fluid. The laboratory permeability tests are used to predict performance of a natural soil liner in the field. The permeability achieved in the laboratory and in the field are dependent on the liquid passing through the soil, the moisture content of the soil, the soil structure and density, and many other factors. Thus, there can be a discrepancy between results achieved in the laboratory and those received in the field. However, the laboratory test results do indicate the potential for a particular soil to be used as a liner. The information generated from this analysis can be used to obtain an overall picture of the quality of the soil in terms of structure, compactability and performance. This information establishes the foundation for the constructive quality control and assurance plan discussed elsewhere. Reference 53.

Item K requires the facility owner or operator to obtain a breakdown of the soil mineralogy according to ASTM and the American Society of Agronomy. Soil mineralogy is defined by its elemental background, e.g., calcium, magnesium, sodium, and the shape and bonds used to hold these elements together. The soil mineralogy is useful background information for use in site investigations and facility designs. An x-ray diffraction analysis in combination with a particle size distribution analysis reveals much of the engineering behavior of soil. However, the mineralogy can be complicated by interlayered combinations of the basic minerals. Sufficient mineralogical background already exists on many soils and the new analysis can be unnecessary. This information is important to the overall engineering design of the facility and can be obtained for some soils without the expense of actually laying out the test protocol.

Item L requires an unconfined compression analysis to be completed on the various soil types to be used in constructing the land disposal facility. The procedure to be followed is found in ASTM D2166. This analysis is used to determine the quantitative changes in strength. This test measures changes in the sample as though it were a free standing body with no opportunity for continuous drainage. The strength tests are needed to determine the support provided to the sloping side of a fill area and for predicting soil performance under traffic at the site. This analysis is necessary to predict a soil's performance at the land disposal facility, is standard practice with construction projects, and is readily available at soil laboratories.

Item M requires the facility owner or operator to complete a triaxial compression test on the soils using ASTM D2850. The triaxial compression test is used to measure shear strength of a soil under controlled drainage conditions. In general, three specimens are each tested under a different confining pressure, to establish the relation between shear strength and normal stress. The procedure is selected to closely approximate field conditions. The strength of a soil is an important factor in determining its ability to function as designed. For instance, soils used to construct the liner on the slope of the fill area must be capable of withstanding the forces placed on it that could exceed the soil's shear capacity. If this capacity is exceeded, the soil will slump away from the side walls disrupting the soils function as a liner. This provision in the proposed rules ensures that the facility owner or operator will consider all engineering principles and determine the weak points of a particular facility in time to correct and operate a facility with maximum protection.

Item N requires the completion of a cation exchange capacity analysis. This test is to be done in accordance with the "Methods of Soil Analysis, Agronomy Monograph No. 9," C. A. Black, editor, as published in Madison, Wisconsin, 1965. The cation exchange capacity analyses evaluate a soil's ability to adsorb pollutants and prevent their migration into surface water or ground water. Since the performance standards of the proposed rules are based on the premise that future land disposal facilities will be located in areas of natural protection, it is important to understand from an analytical context how much of a contribution to that natural protection can be attributed to the soils. The cation exchange capacity can impact the engineering behavior of a soil by causing the basic structure of the soil to change as pollutants are adsorbed. The cation exchange capacity of a soil impacts not only the engineering characteristics of a soil but also its treatment capabilities.

Item O requires the facility owner or operator to obtain the basic nutrient content, pH value, and percent organic matter value for those soils intended for use as a growing medium for vegetation. No specific analyses are required under this item because these are routine procedures with little deviation experienced. This information is inexpensively obtained, is routinely done before seeding large areas, and provides valuable data on the optimum conditions for vegetative growth.

The last paragraph of this subpart allows for the facility owner or operator to choose analyses other than the particular protocol included in the items under this subpart. The facility owner or operator must receive the Commissioner's approval prior to utilizing an alternative analysis. Because there are many options for analyzing soils, the Agency has chosen to provide a list of analyses that are to be completed and the most common procedure for analyzing soils. The Agency believes it is reasonable to provide the facility owner or operator with an option to use other analyses that will provide the information in the same detail as the tests referenced in this subpart. By providing this option in rule, the Agency allows the facility owner or operator to use locally available methods to analyze the soil and ensures some basic level of quality of assurance.

Subpart 9. Leachate collection and treatment system. This subpart establishes the design and performance standards for the leachate collection and treatment system. The design for a mixed municipal solid waste land disposal facility must include a leachate detection, collection, and on-site or off-site treatment system. The detection system must monitor the level of leachate build-up in the fill area and the effectiveness of the liner system. The collection and treatment system must collect the leachate for proper treatment. The facility owner or operator must provide any pretreatment needed for proper treatment to occur at an off-site treatment facility. These general performance standards are proposed for inclusion in the rules because they govern the design of the leachate collection and treatment system. In order to be effective, the leachate collection and treatment system must function jointly with the liner system and not as a completely separate component. By indicating how the leachate detection and collection systems interact with each other and with the liner system, the Agency has emphasized their importance to the performance of the land disposal facility.

The leachate detection system is critical in determining how well the liner system and the leachate collection system are performing. The liner system is designed and constructed to impede the downward migration of leachate out of the facility and encourage horizontal movement to the leachate collection system. The leachate collection system, in turn, is designed and constructed to move the leachate out of the fill area for treatment and disposal. If either of these systems is not properly functioning, the overall performance of the facility will be affected and the environment and human health put at a greater risk.

The leachate detection system is designed into the facility as a check on the operating performance of these very critical design components. The detection system must monitor leachate migrating through the barrier liner and leachate building up on the liner. Migration through the barrier liner can indicate liner failure; therefore, the detection system must be located at points where failures are most likely to occur. These areas would include points where the collection system enters or leaves the fill area, seams between sheets of synthetic membrane, and low points in the system where leachate build-up may be greatest. Leachate build-up on the liner system may indicate a failure in the collection system. As discussed in item D, the collection system must be designed to maintain less than one foot of free liquid standing on the liner. If the detection system indicates free liquid at a depth greater than one foot or leachate migration out of the fill area exceeding design specifications, actions may be necessary to correct existing conditions or modify the facility design. It is reasonable to require a leachate detection system at all land disposal facilities because of the importance of the design components it monitors. References 82, 83 and 84.

The difficulty with establishing performance standards for mixed municipal solid waste land disposal facilities is detecting minor failures before large impacts occur. The detection system is one method of minimizing this risk. By monitoring the performance of the liner and collection system as it is operating, changes in the amount of leakage or build-up can be used to evaluate the performance of the facility and early corrective actions can be initiated. A leachate detection system is a reasonable method of evaluating facility performance because it functions by monitoring certain points within the fill area and under the liner. This is much less expensive than requiring a complete second liner/leachate collection system that may be completely unnecessary under the primary system.

Leachate collection and treatment are necessary to complete the cycle of proper disposal of mixed municipal solid waste. To build a facility with barrier liners to control the downward migration of pollutants and not also include a system to collect and properly treat the leachate contained within the fill area would be neglecting a critical portion of the facility design. Because of the release of pollutants from the waste into water migrating through the waste, leachate has the highest potential of all land disposal facility by-products for polluting the environment. It is reasonable to establish a general performance standard to ensure leachate is collected and properly treated because of its high potential for negative impacts on human health and the environment.

The more detailed design and performance standards for the leachate collection and treatment system are found in items A to K. Each of these items will be discussed in greater detail as to its need and reasonableness.

Item A specifies minimum design standards and locations for the leachate detection system. The leachate detection system must be installed at the lowest elevation of the fill area and throughout the fill area, as necessary to monitor leachate build-up. The detection system must also be capable of being used as part of the collection system. For instance, standpipes used to detect build-up must be capable of being used as pump-out wells in cases where leachate is building up on the liner at a rate faster than it can be removed with the existing collection system. Thus, 2-inch standpipes would not be considered acceptable for use throughout the entire detection system. The portion of the detection system placed under the liner must enable any leachate collected in this area to be removed for treatment and disposal. It is reasonable that the detection system be designed for use as part of the leachate collection system when originally installed because it allows for faster responses to leachate build-up and allows the facility owner or operator to install these systems as filling occurs rather than retrofitting at a later date and potentially damaging the facility. Drilling through the waste after placement is not only difficult but can be a safety hazard. If decomposition has begun, pockets of explosive gases may exist within the fill area, and drilling into these areas may cause an explosion or fire. The potential for puncturing the liner also exists.

The detection system must consist of collection lysimeters and standpipes capable of monitoring, detecting, and collecting leachate movement through the liner. Standpipes are used to evaluate the amount of leachate building on the liner and the collection lysimeter. If leachate is being impeded from moving through the liner, little, if any, leachate will be found in the collection lysimeter and some will be found on the liner system until it moves off the liner system to the collection system. It is reasonable to use collection lysimeters to monitor the effectiveness of the barrier liner because they measure a two-dimensional area under the liner rather than just a point. The function of the detection system is to evaluate the performance of the facility's liner system. If monitoring only occurs at single points below the liner the probability of detecting small failures is minimal because fluid movement is not in a direct line from the leakage point downward. In using collection lysimeters, a wider area is monitored and the leachate can be collected for removal and treatment rather than allowing it to migrate even further from the fill area. Such a system decreases the potential impacts on the environment from a disposal facility and is less expensive than corrective actions completed after major impacts have occurred.

The detection system must be constructed of materials compatible with the leachate generated in the fill area. Compatability means that the detection system materials are resistant to chemical and biological breakdown from contact with leachate. Maintaining the integrity of the detection system is the key to its performance. If the detection system cannot withstand the chemical and physical stresses leachate may place upon it, the detection system will not function as an accurate monitor of site conditions. Additionally, because the detection system functions as a back-up leachate collection system, it is reasonable to require the detection system to be capable of functioning in the presence of leachate. Standpipes placed within the fill area for monitoring leachate build-up on the barrier liner must be capable of maintaining their integrity over an extended period of time. If the standpipes are damaged by the leachate, their performance will be diminished. In such instances, the facility owner or operator would experience considerable costs in replacing the standpipes on a routine basis. By establishing a performance standard rather than a specific construction or material standard, the Agency permits the facility owner or operator sufficient flexibility to compare costs associated with various materials and their performance over time when in contact with leachate.

The Commissioner may approve, under this item, a detection system without a collection lysimeter or standpipes. This approval will be based on information supplied by the facility owner or operator regarding the liner design, subsurface soil conditions, ground water and surface water flow patterns, depth to ground water, and a projection of the amount leachate generated. There may be situations where lysimeter collection systems are unnecessary because the depth to ground water or subsurface soil conditions allows for early detection and collection of pollutants leaving the fill area. Additionally, the facility owner or operator may elect to use another option to monitor the liner performance such as electrical monitoring of liquids being released from the facility. It is reasonable to provide such options by rule rather than requiring variance proceedings because of the rapid advancement of technology in this area and because the detection system is a part of the overall facility design the owner or operator must consider in evaluating risk management at the site. If modifications are acceptable only when approved by the Commissioner, environmental protection is maintained. Reference 80.

The last provision of this item refers to monitoring the performance of the leachate storage area. Unless direct piping to a treatment facility is designed into the facility, leachate will be collected at a point for removal and transportation to the treatment facility. The storage period of leachate varies in length dependent on the storage capacity and leachate generation rate. Because of the concentration of leachate and, consequently, pollutants in one area over a period of time, it is important that the storage system not become a source of pollutant migration into the surrounding area. By closely monitoring the storage area, failures within the storage area can be found before major impacts occur. For instance, monitoring the amount of leachate in a storage tank can be used to determine if the tank is leaking. This provision provides a reasonable method to ensure that leachate storage areas do not become sources of pollution yet allows facility owners and operators flexibility in how they intend to monitor the performance.

Item B requires the facility owner or operator to construct a clean-out system to clean the entire length of the collection system. Clean-out structures must be spaced no more than 500 feet apart. Standard design practices for designing flow-through pipes is to obtain a cleaning velocity within the pipe. The cleaning velocity provides sufficient movement within the pipe to prevent settling of solids within the pipe. By establishing self-cleaning velocities, clogging of pipes is minimized. Because of the variability in leachate flow and the high solid content of leachate, it is impractical for all facility designs to obtain cleaning velocities within the leachate collection systems in order to maintain optimum performance. The 500-foot maximum spacing for clean-out structures is based upon the limitation of available equipment. Most pipe cleaning equipment has been designed for sanitary sewer lines. This equipment rarely has the capacity to clean more than 500 feet of pipe at one time. It is expected that facility owners and operators will rent cleaning equipment rather than purchase equipment for use. It is reasonable to establish standards that reflect the equipment available for use.

Item C establishes the specific design requirements to be followed in sizing a leachate collection system. As with most operational systems, performance standards alone are insufficient. If the performance of the various components were more easily monitored; if the controlling mechanisms of the reactions within a fill area were better understood; or, if the subsurface conditions surrounding a facility could be more accurately defined, the use of performance standards without establishing design controls might be reasonable. The Agency is charged with the responsibility of evaluating a particular facility's potential adverse impact on the environment. The proposed rules have been established to ensure that basic safeguards are in place at all land disposal facilities to prevent one area of the State of Minnesota from being protected by the utilization of ample risk management techniques while another area is at risk due to a wait-and-see-if-something-happens attitude. The design standards propose reasonable criteria by which these safeguards may be put into place at all facilities.

Subitem (1) requires the facility owner or operator to complete a water balance analysis based on the facility design. The water balance analysis is used to determine overall site efficiency in collecting or promoting run-off and to facilitate designing the leachate collection and treatment system for the facility. It is important that all facility owners and operators complete the water balance in a consistent manner. This subitem contains the variables to be included in each water balance calculation. These variables include precipitation, evapotranspiration, surface run-off, soil and waste moisture storage, root zone depth, surface slope, subsurface lateral drainage, and average monthly temperature. These parameters, in varying degrees, impact the amount of moisture entering a fill area and in turn the amount of leachate generated. The Agency believes it is reasonable to provide facility owners and operators with the variables to be considered in calculating a water balance rather than requiring a specific procedure to be followed. No specific methodology is addressed in the proposed rules because the variables considered in the determination control their use in the water balance calculation. Additionally, the methodologies consistently undergo updating to better define the calculations. This appropriately allows the facility owner or operator to investigate site conditions and utilize a model or analytical method that best represents actual site conditions.

The facility owner or operator must derive the leachate generation rate from the amount of water that percolates through the cover each month using actual data from an average weather year and a year when the precipitation exceeds the average precipitation by at least 20 percent. Many models contain default data, which is data included from one or two reporting stations that may or may not be in the proximity of the proposed land disposal facility. By using actual data generated from reporting stations near the proposed facility, a more accurate picture of site conditions will be obtained. Also, the design parameters used in calculating the size of leachate collection, storage and treatment systems will more closely reflect actual conditions. Using a precipitation event greater than the average precipitation allows for an understanding of how the various facility components will react under such conditions and provides opportunity for alterations to the facility design before a storm event occurs and disrupts operations. It is reasonable to use average precipitation data because of the moisture storage capacity within the cover materials and the mixed municipal solid waste in-place at the facility. Because this storage capacity exists, moisture will not be released at a fast rate that may overload the collection system. In fact, the moisture storage capacity will act as an equalizer for moisture release in the fill area. The use of data reflecting a 20-percent increase in precipitation above the average approximates how the leachate collection system will function during times of extra moisture. This analysis will provide data for use in designing storage capacity within the fill area or the planned storage tank or pond to be used before delivery to the treatment facility. Storage to be handled in the fill area must be taken into consideration when designing the liner and leachate collection system. A 20-percent increase over average precipitation considers events above the expected value without causing unnecessary alarm that an underdesigned collection and storage system exists. This provision ensures that the system will not fail because of its inability to handle leachate, thus minimizing potential environmental impacts. The extra capacity designed into the facility's leachate collection and treatment system based on these figures should not create an unnecessary financial burden on facility owners and operators.

The engineering design report must contain all calculations and assumptions made during the water balance calculation. The engineering design report presents the facility owner's or operator's reasoning behind a chosen facility design. The Agency is charged with the responsibility of reviewing facility designs to ensure they minimize potential impacts to the environment. Therefore, the Agency should have at its disposal all information used in making the design decisions. Additionally, the inclusion of this information in the engineering design report requires no additional work on the part of the facility owner or operator. It is needed to complete the design work and the proposed requirements are only a reporting requirement.

Subitem (2) requires the sizing of collection pipes and the storage area based on the size of the fill area and the characteristics of the piping materials and liner materials. Logic dictates that in designing component parts of a total system, the entire system design must be considered. The area draining into the storage area or a particular portion of the collection system has a direct bearing on the volume of leachate that will be handled.

Subitem (3) requires that the volume of leachate generated under the scenario presented in subitem (1) be considered in determining the size of the leachate collection system. The required site efficiency as calculated in subpart 7 must also be used in determining the proper design for the collection system. In order to emphasize the importance of the water balance calculations, the Agency believes it is necessary to include in the proposed rules a provision that mandates the use of this information in the design efforts for the facility. The water balance calculations are not a planning tool for use in estimating if leachate will be generated and when, but rather an analytical tool used to estimate as accurately as possible the volume of leachate generated for design purposes. The water balance calculations are used for determining storage capacity needs, determining treatment capacity, calculating site efficiency capabilities, and designing the collection system. Because it affects so many facility components, it is imperative that the water balance be completed as accurately as possible. By including this provision in the proposed rules, the Agency again provides facility owners and operators with information that must be used in developing facility design specifics that will be reviewed in the approval process. Because this information is used in standard design practice, the proposed provision adds no additional burden on the facility owners or operators.

Subitem (4) establishes the design parameters that must be considered when sizing sump pumps to remove leachate from the fill area. It is expected that in most situations the leachate collection system will be designed to provide removal by gravity drainage. A gravity-controlled collection system will require the least amount of maintenance, require no external energy source to operate, and represent the least cost alternative in most situations. However, some situations will require the leachate to be moved to a higher elevation than the collection system. In these cases, sump pumps will be needed to lift the leachate to the higher elevation. It is, therefore, important to consider the components that will impact the size and performance of the pumps. Under this subitem, the following items must be considered in sizing the sump pumps: the storage capacity in the waste and collection system, the volume of leachate anticipated, and the amount of leachate moving out by way of gravity drains. The pumps must also be compatible with the leachate, i.e., the structural and operational integrity of the pumps must not be affected by the leachate. The proper sizing of the pumps is critical to the removal of leachate from the fill area, which in turn affects the overall performance of the liner and collection system. Standard design practices for sizing pumps call for the need to understand the volume of liquid to be pumped, the flow rate anticipated, and the elevation difference to be pumped. This provision does not require additional work to be completed.

Subitem (5) addresses the design efforts to be expended regarding the leachate storage area. The storage area is used to hold leachate prior to delivery to a treatment facility. Because of the potential for pollutant release in large quantities from a storage area, it is important that proper safeguards be used in designing, constructing, and operating the storage area. Subitem (5) requires the storage area to be designed and constructed to drain the system back into the overall leachate collection system to minimize the potential for overfilling of the storage areas. Another type of design may be approved by the Commissioner if it contains a method to detect leaks, contain leaks, and minimize the need for corrective action. If a storage area is overfilled and spills, the environment is placed at risk and the facility owner or operator must employ corrective actions to minimize these risks. Therefore, it is reasonable to require design and construction techniques that minimize the potential for pollutants to escape the system.

Item D requires the design of the leachate collection system to prevent free standing liquid over the liner in the fill area to exceed one foot. The height of the liquid on a liner creates a downward pressure encouraging vertical flow to compete with horizontal flow. If the depth of the liquid becomes too large, the vertical force will become stronger and liquid will move into the surrounding subsurface environment rather than being collected and properly treated. Although other factors such as liner slopes, hydraulic conductivity and flow distances impact the amount of leakage more than the depth of standing liquid on the liner, the height of the liquid is a factor that must be minimized. If leachate is allowed to build up on the liner, the leachate collection system also will be under large hydrostatic pressure that may collapse the piping, force gas to migrate out of the piping, and permit more contact between the piping material and the chemical constituents of the leachate creating an increased potential for structural failure. Additionally, by delaying the removal of leachate from the fill area and allowing more contact time between the waste as it decomposes and the liquid percolating through the waste, a higher strength leachate may be generated. It would be more difficult to prepare the leachate for treatment and disposal. The build up of liquids within the fill area may also serve as a destabilizer for the fill area. As the mixed municipal solid waste absorbs more liquid it will lose some of its structural support capabilities causing larger problems with subsidence and settlement as well as with traffic over those areas. The Agency believes it is reasonable to establish a 1-foot maximum depth of free standing liquid over the liner. This depth has been found to be the most efficient head on a liner for collection efficiency.

Item E proposes that the maximum unintercepted leachate flow distance along the drainage layer be 100 feet. The effect of changing leachate flow distance is discussed in the paper presented by Mr. Peter Kmet, et al. and included as Appendix XIV. As one would expect, the percent leakage from a facility decreases as the flow distance decreases. Unlike other components used in evaluating the liner efficiency, no point of diminishing return is found to exist with the flow distance. This is because the change in leakage is linear with respect to flow distance for distances below 150 feet. Distances greater than 150 feet become inefficient in collecting leachate. It has been calculated that no optimal flow distance exists but that distances less than 50 feet are not practical in the field. No optimal flow distance exists because of the many factors controlling the collection efficiency, as discussed earlier. Construction equipment will need to drive directly over the collection pipes when a 50-foot flow distance is used. This increases the likelihood that damage to the pipes will occur. The standard proposed in this item has been chosen as the figure halfway between the impractical 50-foot flow distance and the lower efficiency limit of 150 feet. The other design parameters contained in the proposed rules were also taken into consideration when arriving at the 100-foot standard. As stated earlier, the minimum design standards presented in the rule were not intended to be used as a recipe for acceptable designs capable of meeting all performance standards. The design standards are intended for use as guidance for facility owners and operators to recognize the Agency's basic requirement as to the thickness of liners and covers and materials.

Some commentors have argued that the flow distance permitted along the drainage layer should be greater than 100 feet. Some stated that spacings of 500 feet between the collection pipes had been used at sites in other states and that this should be permitted in Minnesota. This spacing was used in conjunction with synthetic membrane liners. The Agency disagrees that the 100-foot maximum flow distance (200-foot centers) is too restrictive. The Agency believes that most land disposal facilities will be constructed with clay liners. Leachate flow over the surface of a clay liner is not as smooth and unobstructed as the flow over a synthetic membrane. The flow on a clay liner has a vertical component in addition to the horizontal component while a synthetic membrane, for practical purposes, has only a horizontal component. Thus, liquids on a synthetic membrane will do one of two things, flow horizontally to the leachate collection system or build up within the fill area. Liquids on a clay liner may move vertically downward, horizontally to the collection system, or build up on the liner. It is important that the vertical component on clay liners be eliminated to the extent possible. This is accomplished by using low permeability clays compacted to their maximum density, using coarse sands or gravel as a drainage medium above the liner, and by spacing collection pipes within distances of each other to collect the liquids in reasonable time frames. The Agency believes the proposed standard of 100 feet flow distances will provide a reasonable means of ensuring the liner design is efficient in controlling liquid movement out of the fill area into the surrounding subsurface environment.

Item F addresses the design requirements for the leachate collection pipes. The collection pipes must be of sufficient diameter to handle the flow and allow cleaning. Leachate flowing through collection pipes at a land disposal facility contains a large amount of solids. The flow through the collection system must be designed to achieve self-cleansing flow velocities within the pipes. If the flow is slower than necessary to generate cleaning velocity, the potential for solids settling from the leachate as it moves through the pipes is high. Therefore, it is important that the facility owner or operator design the system to allow for mechanical cleaning of the pipes. Normal cleaning equipment cannot be used in pipes with a diameter less than 4 inches. Without dictating the specific dimensions of the pipes, this provision proposes a reasonable performance standard that gives the facility owner or operator flexibility regarding the collection system design. It is standard engineering practice to design collection pipes based on the anticipated flows. The proposed requirement that this be considered is not a new design requirement.

The collection pipes must be capable of handling any loads experienced during construction and disposal of solid waste. The engineering design report must contain the buckling capacity and compressive strength of the pipe. Pipes installed at the base of a fill area can be subjected to high load pressures because of the depth of the fill area and construction techniques used to place the liner and collection system. In the analysis of the structural stability of a pipe under the imposed loading, the pipe is considered either a rigid or flexible conduit. Rigid conduits would include pipes made of concrete or cast iron. Plastic and fiberglass pipes are examples of flexible pipes. Because a land disposal environment is highly corrosive, pipe materials selected for use in leachate collection systems are generally plastic due to their relatively inert properties with respect to typical leachate. Therefore, the structural stability of flexible pipe in land disposal facility applications is of concern.

Collection pipes are installed under two basic conditions - trench or positive projections. Figures 8a and 8b show a generic installation for each of these conditions. The trench condition exists whenever the top of the pipe is located below the base surface of the liner. The load on the pipe is the waste and the trench backfill. These two components of the total vertical pressure on the pipe are computed separately and then added. This force is then determined as a force per unit length of pipe (References 78 and 85). The positive projection condition exists whenever the pipe is at or above the base surface of the liner. In this case, the load on the pipe is equal to the weight of the prism of overlying waste. Reference 85. Perforations in the pipe reduce the effective length of pipe available to carry loads and must be considered in calculating the load on the pipe to ensure suitable pipe strength is available. The capacity of a buried pipe may be limited by buckling. Estimates of vertical stresses on pipes show buckling can be a controlling factor depending on the pipe flexibility and the modules of passive soil resistance. Commentors have suggested that this information is not needed. However, the Agency believes the efficiency of the collection system is controlled by the ability of the pipes to operate properly and if the pipes collapse under the loads exerted on them, inefficient collection will occur. The same is true for the importance of compressive strength of the pipe. The information required under this item is routinely calculated in the design of pipe installation. The Agency is responsible for approving the design to ensure it will operate in a manner that minimizes the potential for pollutant release from the land disposal facility. The Agency will obtain all information necessary to do a proper review of the loads on the collection pipes and the performance expected under these conditions.

February 23, 1988

FIGURE 8a

COLLECTION PIPE INSTALLATION SCHEMATICS:
Trench Installation

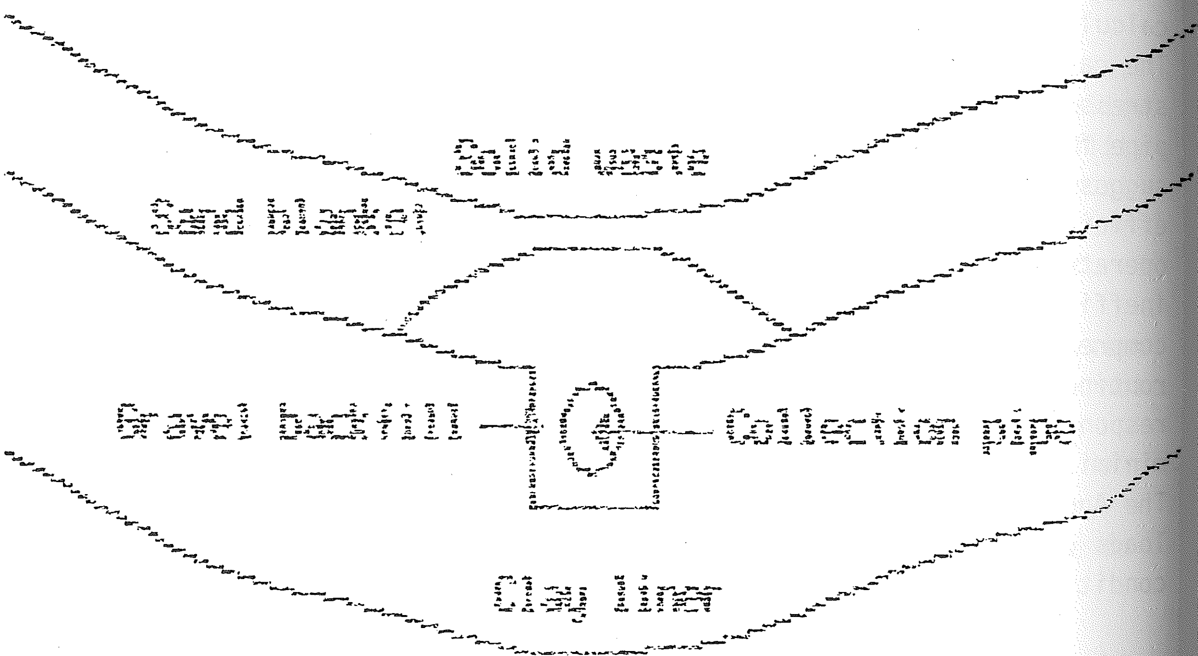
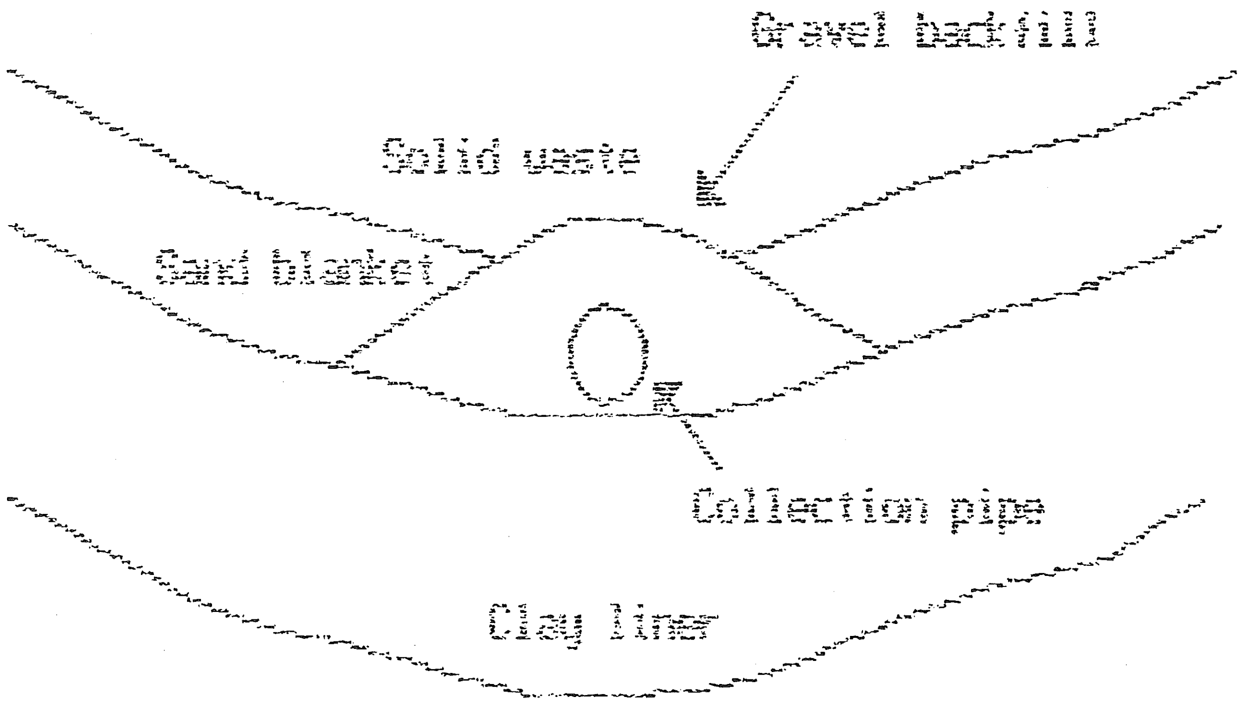


FIGURE 6b

COLLECTION PIPE INSTALLATION SCHEMATICS:
Positive Projection Installation



A pipe correctly designed to withstand loading from the waste can fail from loading received during construction. Although only a fraction of a stationary wheel or tracked vehicle load applied at the ground surface over a trench is transmitted to a pipe through the trench backfill, the percentage increases rapidly as the vertical distance between the loaded surface and the top of the pipe decreases. In addition, moving loads cause impact loading generally considered to have a 1.5 to 2.0 multiplier effect over stationary loading. In general, equipment should not be moved over collection trenches installed with shallow cover or in positive projections. Thus, it is reasonable to require that construction loads be considered in the design of the collection system and the calculations reported in the engineering design report.

The leachate collection pipes placed in lined trenches and covered with a suitable filter material or geotextile membrane must be designed and constructed to encourage flow to the pipe and prevent infiltration of fine-grained soils. A geotextile membrane is a synthetic membrane that functions as a filter. The geotextile membrane must not be placed in contact with the collection pipes. As discussed elsewhere, leachate contains large amounts of settleable solids. It is important to remove as many of the solids as possible before the leachate reaches the collection pipes to minimize the potential for clogging in the pipes and hindering routine maintenance cleaning of the collection pipes. By using a graded drainage blanket above the barrier liner, solids can be filtered out of the leachate providing a more free flowing liquid. Geotextile membranes can be designed for the same purpose and may in some cases be a cheaper alternative. Therefore, it is important that the collection pipe not be wrapped with the membrane. A membrane wrapped around collection pipes can become clogged and result in excessive head pressures on the liner because the liquid can not move into the pipe. The basic result of this situation is increased depth of liquid on the liner and an increase in the vertical movement of leachate into the subsurface soils. Care is needed to ensure proper installation and operation.

Item G requires that there be the same thickness of liner below the collection pipes as exists elsewhere or that the pipes be constructed under positive projection. Although these are the designs most expected when reviewing leachate collection systems, the Agency believes it is necessary to expressly indicate that pipes laid on the top of a barrier liner in a lower elevation and not in a trench are unacceptable and that the barrier liner must be the same thickness under the collection pipes as elsewhere. This item eliminates any confusion as to what type of design will be acceptable without directing particular design standards. This item provides the facility owners and operators a reasonable opportunity to design any collection system that meets these standards.

Item H requires the facility owner or operator to use only pipes resistant to chemical and biological breakdown resulting from contact with the leachate. As with the barrier liner, the long-term integrity of the leachate collection system has a direct influence on the overall performance of the facility. To expend large amounts of money on the design and construction of a facility but neglect the material composition of the design components would be a serious oversight. The use of concrete pipes in the acidic environment of a land disposal facility would only result in disintegration of the pipe due to chemical attack and result in a nonfunctioning collection system. By establishing performance standards rather than a specific design criteria, the Agency provides the facility owner or operator a reasonable opportunity to evaluate the cost and benefit of particular pipe materials. This provision merely states the common practice used in designing any facility and does not increase the burden on a facility owner or operator.

Item I requires the design and construction of the collection system to be coordinated with the planned phase development for the site and the amount and timing of leachate generation. Although this may be seen as a statement of the obvious, the most basic ideas are not always put into practice. The Agency believes it is necessary to remind the regulated community that the entire facility design must be considered when the various components are being reviewed. The timing of construction can be critical to the continued operation of a facility. If a particular phase is intended to be filled by December of a particular year, the facility owner or operator cannot wait until December to put the next segment of the collection system into place. The weather in Minnesota typically would not permit quality construction during this time. Additionally, for operational concerns filling in the subsequent phase may be needed as a particular phase is nearing completion. Coordination between the construction of the leachate collection system and the phase development for the facility provides for a systematic progression of the facility and ensures proper site preparation for filling and preparation for the collection of pollutants.

Item J requires the facility owner or operator to design the collection system in a way that allows the collection of leachate samples for chemical analysis. The chemical analysis of leachate generated at a particular facility is used to determine the treatment needs for the leachate and the potential for pollutant releases to have detrimental effects on the environment. By analyzing the leachate, a determination can be made as to the need for continued treatment of leachate and continued monitoring after the facility has been closed. The routine analysis of leachate will provide a pattern on the composition and concentration of pollutants indicating the amount of waste stabilization that has occurred at the facility.

Item K sets out the standards for leachate treatment and disposal. Because the discharge of potential pollutants to surface waters or the land application of the pollutants is regulated under water quality rules and standards established by the Water Quality Division of the Agency, this item contains references to the applicable standards. This item provides a performance standard to be complied with at all facilities. The proper treatment and disposal of leachate is the final step in minimizing the risk associated with the operation of a mixed municipal solid waste land disposal facility. To control the movement of pollutants out of a land disposal facility through the use of barrier liners and collections systems yet neglect the treatment and disposal of the leachate would be irresponsible.

This item requires the facility owner or operator to design and construct the leachate collection system to transport leachate to a holding area for testing and, as needed, treatment prior to disposal. The holding area or treatment system must be compatible with the leachate and prevent the release of pollutants to the environment. In many cases, the local or regional land disposal facility is located some distance from an existing wastewater treatment facility. In these cases, the leachate must be transported to the treatment facility by truck or treated on-site. Treatment on-site is not routinely financially viable or logistically feasible. Leachate treatment requires a large space commitment due to the volumes and composition of leachate requiring treatment. Many existing land disposal facilities do not have space available, nor are there discharge options. Operating wastewater treatment facilities are usually the preferred alternative for leachate treatment. Trained operators are present who understand the intricate balance that must be maintained between volume of water to be treated, concentration of pollutants, and the biological, chemical, and physical processes used to treat the water. Because of the need to maintain this balance, it is important to have the capabilities to store leachate prior to treatment for incorporation into the wastewater treatment process at a level that will not disrupt facility operation; in some cases this includes testing of the leachate prior to treatment. Upsetting the balance of the processes involved at a wastewater treatment facility would only serve to create an additional source of environmental degradation. References 83, 86 and 87.

No specific design standards were provided under this item regarding holding facilities or treatment facilities for a number of reasons. These reasons include the variety of designs that will adequately address the performance requirements, the site-specific conditions that must be taken into consideration with the design, and the need to allow flexibility in designing treatment programs compatible with the overall land disposal facility operations and the potential leachate treatment facilities. In some cases, pretreatment of leachate at the land disposal facility may be necessary, while other cases may permit the direct piping of leachate to a wastewater treatment facility. The proposed rules must provide ample flexibility in designing specific components while ensuring proper protection measures are included in all designs.

The treatment and disposal of leachate must comply with parts 7001.0010 to 7001.0210 and 7001.1000 to 7001.1100. The design and construction of a leachate treatment and disposal system must be completed in accordance with a feasibility study conducted by the facility owner or operator and approved by the Commissioner. The references made in this portion of the item refer to the existing Agency rules that regulate point discharges to surface waters or the land application of liquids needing treatment. The cross-references provide the facility owners and operators with easy access to the governing factors concerning treatment and disposal of wastewater without adding complicated language to this set of proposed rules. To include the language found in these references would only increase the size of these proposed rules without adding any information. Therefore, the cross-referencing of appropriate rules is reasonable. A feasibility study provides a systematic approach to evaluating the treatment and disposal options available for the leachate generated at a land disposal facility. The feasibility study will address such items as treatment capacity, treatment needs, facility design, facility operation and disposal. Improper facility design and disposal cause environmental impacts and impose additional costs on the facility owner or operator for cleanup actions. Therefore, the treatment and disposal of leachate must be carefully planned for and approved by the Commissioner in accordance with the water quality standards.

Subpart 10. Water monitoring systems. Subpart 10 contains the requirements for design, installation, and maintenance of water monitoring systems at mixed municipal solid waste land disposal facilities.

A water monitoring system measures ground water and surface water quality to determine whether the facility containment is adequate. The functions of the water monitoring system are to allow early identification of impacts on water quality and to determine whether the facility's impacts on water quality are within an acceptable range. Subpart 10 requires the facility owner or operator to provide a water monitoring system that is designed, installed, and maintained to serve these important functions.

Subpart 10 relates to three other subparts in part 7035.2815. The sampling and analysis of water from the water monitoring system is covered in subpart 14. Subpart 3, item H, requires that the design and construction of the monitoring system be developed as the third phase of the hydrogeologic evaluation, after determining the hydrogeologic conditions at the site and submitting a work plan describing the proposed monitoring system. Finally, subpart 9, item A, requires a leachate detection system, which may include collection lysimeters placed in the unsaturated zone immediately beneath the liner. This detection system can provide a measure of the effectiveness of the liner before leachate travels to the ground water. Because such installations can detect leakage beneath only a small portion of the total facility area, ground water monitoring is necessary.

Item A requires the facility owner or operator to install a water monitoring system. Even the smallest land disposal facilities have been shown to adversely impact water quality and even well-designed facilities do not ensure total containment. The monitoring system is needed to assure that the facility performs as intended. More than ninety percent of Minnesota's permitted mixed municipal solid waste land disposal facilities already have some type of water monitoring system.

Item A lists five outcomes that a water monitoring system must achieve through the design, construction, and operation. Subitem (1) requires the samples to be representative of the actual quality of the ground water or surface water being sampled. Improper design, construction and use of a monitoring system can provide a false picture of the water chemistry in a variety of ways. If the samples obtained are not representative of the actual water quality, the wrong follow-up actions may be required--corrective actions may be triggered falsely or may not be triggered when they should. Accomplishing this purpose will be more protective of the environment and public health, less expensive, and more timely.

Subitem (2) requires that the water monitoring system must be able to distinguish the facility's impacts from background water quality. This condition is needed because water quality effects can be attributed to the facility only if they can be compared with, and shown to be different from, the quality of water unaffected by the facility. Background water quality can be determined by comparing water quality data collected before the facility is constructed with subsequent data, or by comparing upgradient and downgradient ground water quality or upstream and downstream surface water quality.

Subitem (3) requires early detection of the release of pollutants. This provision is needed to avoid monitoring system designs that allow identification of a problem only after it has become widespread or severe. The cost and difficulty of corrective action, the damage to the resource, and the risk to water users normally increase over time.

Subitem (4) requires that the water monitoring system contain sufficient monitoring points to allow for definition of a polluted zone. This condition is needed because the concentrations and the areal and vertical extent of pollution must be understood before risk and corrective actions can be finalized.

Finally, under subitem (5), the monitoring system must allow for sampling to determine whether the facility complies with the ground water performance standards of subpart 4. This provision ensures that the monitoring system will allow water quality to be measured at the compliance boundaries.

Subitems (4) and (5) are not meant to require all water monitoring systems to be extensive compliance monitoring systems. As explained in item C, the first aim of a monitoring system should be to detect a problem. Once pollutants are detected, the expense of adding monitoring points to define the polluted zone and to assure compliance with the performance standards is justified.

Item B requires the facility owner or operator to demonstrate that the water monitoring system is adequate to detect pollution. This information is needed for the Agency to assess the suitability of the monitoring system.

Item B requires that the monitoring system be designed based on three factors: an evaluation of potential sources of leachate releases (subitem (1)), an evaluation of the hydrogeologic conditions at the site (subitem (2)), and points where water resources or water users are potentially impacted (subitem (3)). The monitoring system design is site- and facility-specific. No two sites are similar enough to allow for a simple formulation of a uniform system design, such as a minimum spacing distance between monitoring points. The design of monitoring systems includes positioning monitoring points in relation to the locations where pollutants leave the facility, the routes by which they will migrate, and the resources and users needing protection.

The evaluation of potential sources of leachate releases, required in subitem (1), reflects that with lined facilities leachate is more likely to be released in certain areas. Leachate will flow across the liner to specific collection areas, and will build up to differing heights above the liner. The liner will be constructed in phases, each phase having been built under different weather conditions. Leachate collection and transmission pipes will extend through the liner to tanks, holding ponds, or treatment facilities, creating possible weak points in the liner and adding potential release points outside the fill area itself. The facility owner or operator is required to conduct a failure analysis in support of the contingency action plan and the cost estimates for corrective actions. While this evaluation cannot predict failure points with certainty, the evaluation will help to locate monitoring points.

The second design factor that the monitoring system design must be based on is the hydrogeologic evaluation required under subitem (2). The rationale for linking the monitoring system design to the hydrogeologic conditions has been discussed under subpart 3. This linkage is fundamental to the success of the monitoring system, as the sampling interval of the monitoring points must be determined based on a knowledge of the hydrogeologic characteristics and the anticipated behavior of the leachate constituents. As noted in the discussion of subpart 3, item G, subitem (7), separate attention to soluble and low-solubility constituents of leachate is needed. This is reasonable because soluble constituents move with the ground water, while constituents that do not dissolve in water will tend to rise or sink through the ground water and may go undetected in improperly designed monitoring systems. If low-solubility constituents are abundant or are identified as a concern, the monitoring system may need to include separate monitoring points positioned at the water table or at the base of the aquifer.

Finally, under subitem (3), the monitoring system must be designed after considering the locations of potentially affected water supply wells, other points where water is being used, and any surface waters where biological communities may be affected. The facility owner or operator must consider the need for monitoring points, and the Commissioner may require monitoring points, positioned directly along the flow path between the facility and the potentially affected locations. This provision is needed because the potential impacts listed are of great concern. If a monitoring system complies with subitems (1) and (2), it may already comply with subitem (3), unless pollution has already spread to the outermost monitoring points. In that case, the need to monitor ground water moving toward water supplies and other potentially impacted areas is apparent.

Item C lists six requirements concerning placement of monitoring points. Under subitem (1), monitoring points must be installed both upgradient and downgradient from the facility. Any aquifer that has downgradient monitoring points must also have one or more upgradient monitoring points because water quality downgradient from a facility must be compared to concentrations present at locations unaffected by the facility in order to identify any impact from the facility. Points upgradient from the facility are the most logical locations to obtain this data. Upgradient monitoring is especially important when upgradient concentrations are elevated due to natural conditions or pollutant sources other than the facility. If background data are not available from upgradient monitoring points, impacts may be incorrectly attributed to the facility. This results in costly and unnecessary follow-up actions. Background data must be from the same aquifer to provide a valid comparison as quality may vary between aquifers.

Subitem (2) requires the monitoring system to function as a detection monitoring system. The monitoring system must be designed to assure early detection of pollutants originating from the portions of the facility that have been identified as potential points of releases under item B, subitem (1). Pollutants entering ground water or surface water must be detected as early as possible. Pollutant migration increases the risks of affecting water users or violating performance standards. Subitem (2) allows the facility owner or operator to avoid installing a compliance monitoring system until it is needed. Subitem (2) effectively prohibits monitoring systems whose only monitoring points are located so far from the facility that it is questionable whether they are in the path of the water movement.

The application of subitem (2) is important in other ways also. First, the Commissioner must use discretion in applying subitem (2) if pollutants have already migrated from a facility. The focus of monitoring at that point is defining the pollutant plume or determining the effectiveness of corrective actions. The detection monitoring close to the waste boundary is less important than monitoring near the end of the plume. Second, the specific methods used to assure early detection may vary. In some cases, the appropriate system may be a line of closely-spaced monitoring wells or sampling points along the downgradient edge of the fill. In other cases, the preferred monitoring system may include additional wells, offset farther from the facility, which serve as a second line of defense in detecting discrete plumes migrating between wells in the first line. Finally, in cases where water pollution has not been detected, subitem (2) does not prevent the Commissioner from requiring monitoring points on the compliance boundaries or in other locations more remote from the facility. Hydrogeologic conditions, water use, or other factors may justify more extensive monitoring at a facility, although detecting pollutant releases is the first objective.

Subitem (3) requires that once pollutants are detected and attributed to the facility, the monitoring system must be expanded to define the polluted zone and to measure compliance with the water quality performance standards. Appropriate follow-up actions can be developed only after defining the extent and severity of the pollution. The monitoring points in detection monitoring systems normally are not sufficient or appropriately located to determine the extent and severity of the polluted zone. An alternative to the phased monitoring system described by subitems (2) and (3) is a system that tries to accomplish both objectives from the outset. This alternative does not meet the test of reasonableness because compliance monitoring is unnecessary and may be ineffective when pollutants have not yet been detected. Until pollutants are detected, the appropriate monitoring points for determining the extent of the plume or the effectiveness of the corrective actions cannot be established.

Subitem (4) requires that monitoring points be installed within aquitards, confining units, and aquifers, as needed, to comply with the provisions of subpart 10. Aquitards are soil or rock units with permeabilities that permit only very slow ground water movement. Confining units are aquitards that restrict ground water movement so that ground water above and below the confining unit may be under different pressure or hydraulic head. Monitoring only within aquifers is often insufficient. While aquifers constitute the most valuable ground water resource because they can yield useable quantities of water to wells, aquitards control the movement of pollutants to those aquifers. Aquitards may control whether pollutants reach an aquifer, how fast they get there, and the paths they travel. Aquitards can so influence pollutant pathways that it may be impossible to predict where to position monitoring points without tracking pollutant movement through the lower-permeability materials. Therefore, it is necessary to monitor aquitards as well as aquifers.

Subitem (5) requires water quality monitoring beneath an aquifer or aquitard already affected by leachate, unless the deeper ground water is not at risk. This provision ensures that monitoring stays ahead of a pollutant plume. The limits of the polluted zone can be known only if monitoring extends far enough to determine its extent. The requirement to monitor lower aquifers or aquitards provides for determinations that ground water is at low risk when protected by very low-permeability clays or upward ground water movement, or when a plume is being collected and removed or is shrinking in size.

Subitem (6) requires changes in the monitoring system when changes in land use, water use or other factors alter ground water flow. The monitoring system must be adjusted in response to changes in ground water flow. An example would be the installation of a high-rate irrigation well that has sufficient capacity to alter ground water flow. It may be necessary to add additional monitoring wells in the new direction of ground water flow. Including this provision in the proposed rules alerts facility owners and operators to the need for monitoring systems that reflect potential pollutant movements.

Item D requires the use of nonconventional monitoring methods when monitoring wells do not work or do not provide the necessary information. Special designs may be called for in low-permeability soils to facilitate ground water flow into the well or to minimize the time lag between fluctuations in water level inside the well and hydraulic head outside the well. Special designs may be needed to accommodate continuous monitoring devices where a greater frequency of monitoring is warranted. In cases where the geology is complicated and difficult to predict, or where a critical water supply is at risk, conventional monitoring alone may leave too much uncertainty about pollutant routes. Indirect methods such as surface resistivity or soil vapor analysis may be necessary adjuncts to monitoring wells. Nonconventional installations are required only when the information they provide is needed to ensure the facility meets performance standards established to protect human health and the environment.

Item D also allows the Commissioner to require additional monitoring points, as needed, to monitor conditions other than ground water quality. These include hydraulic head, ground water or surface water flow, leachate quality, and leachate movement in the unsaturated zone. Monitoring wells may not be designed to allow hydraulic head or direction of flow to be measured accurately. The unsaturated zone cannot be monitored with wells in the saturated zone. Methods to monitor these conditions are widely used and available at a reasonable cost. This monitoring will be required only when necessary. Separate monitoring points to measure ground water flow and hydraulic head will be required when the ground water flow conditions are not thoroughly known or are subject to change due to seasonal or other fluctuations. Monitoring in the unsaturated zone may be required when saturated zone monitoring cannot reliably detect pollutant migration. An example is where a variably-permeable unsaturated zone may cause lateral movement above the water table. It should be noted that, under subpart 9, detection monitoring may be required immediately beneath the liner to measure liner performance, regardless of the reliability of ground water monitoring.

Item E requires the Commissioner's review and approval before constructing, sealing, reconstructing or redeveloping a monitoring point. If these activities are done improperly, they can affect the quality of the samples and even the quality of the ground water. The Commissioner's prior review of well construction and abandonment has been standard practice for several years. Prior approval by the Commissioner is not required for minor repairs, such as replacement of well caps and straightening bent casings.

Item E requires Minnesota Department of Health (MDH) approval to construct a monitoring well that extends into any aquifer below the aquifer nearest the ground surface. Monitoring wells that interconnect aquifers could provide an artificial pathway for spreading pollutants to otherwise unaffected aquifers. MDH's review is to ensure that the monitoring well is designed and constructed to prevent cross-contamination.

Item F requires that monitoring wells and piezometers be designed, constructed, maintained, and sealed in compliance with subpart 10 and with the MDH Water Well Construction Code (Well Code). The Well Code governs all water wells, including monitoring wells and piezometers. The Well Code provides controls on wells to ensure well construction by qualified personnel; prevent pollutant movement along the well and borehole; protect and maintain the well; and record well construction.

Item G requires that monitoring wells be designed and constructed to be durable, to prevent ground water or pollutant movement vertically along the well, and to prevent leakage at casing joints. Well design and construction must avoid opening new avenues for the spread of pollutants, or erroneous sampling results due to pollutant movement through casing joints located above the sampling interval.

Subitem (1) requires monitoring wells to be constructed with materials that are not attacked or degraded by exposure to the chemical environment of polluted water. Materials such as black iron pipe commonly corrode and deteriorate. Stainless steel resists chemical attack under a variety of conditions and is often recommended as the material of choice for monitoring purposes (References 88, 89 and 90). Inexpensive materials, such as polyvinyl chloride (PVC), can be used in some applications. However, PVC is permeable and subject to degradation by some organic solvents.

Subitem (2) requires that the casing and screen be centered in the drill hole. This requirement ensures that the filter pack and seal materials, such as cement grout or bentonite, are placed completely around the well casing to achieve a secure continuous seal. Centering is accomplished by attaching centering guides to the well casing and screen, or by placing the well casing through a hollow-stem auger. Requiring centering and a secure seal prevents pollutant migration along the well casing.

Subitem (3) requires that any granular filter pack placed around well screens be insoluble, nonreactive, and washed and blended for use in filter packs. Silica sand is required for filter pack except where this is infeasible and approval is granted by the Commissioner to use other materials. A filter pack prevents sediment movement into the well, enlarges the effective radius of the well, and enhances the hydraulic connection to the earth materials surrounding the well. The filter pack also extends the long-term integrity of the well by preventing clogging and slowed water movement into the well. Historically it has been common practice to use either a few standard blends of sand and gravel, or pit-run gravels depending on what is cheap and available nearby. This often results in a well that produces sediment or a filter pack that deteriorates over time and impedes flow into the well. Silica sand is recommended for use in filter packs because it resists chemical change (Reference 88, p. 65). Silica sand is available and commonly used for monitoring wells. Requiring its use in monitoring wells was recommended by monitoring consultants. The provision to allow alternate materials is reasonable because silica sand could be impractical in some cases, such as in a fractured or cavernous bedrock, where very large quantities of filter materials may be needed to fill voids.

Item H contains provisions designed to minimize introduction into a well of foreign substances that may interfere with water quality analyses. It is recognized that oils, solvents, and other contaminants may be present in or on casing and screen materials, in drilling fluids and additives, in well seal materials, and on drilling equipment or personnel. Contaminants may show up in sampling, which can result in expensive and unnecessary follow-up actions. Some well and filter pack materials may also attenuate selected pollutants, causing sample quality to be better than actual ground water quality. It is reasonable to avoid these conditions because the Agency and the facility owner or operator want ground water samples to accurately represent ground water conditions.

Subitem (1) requires the Commissioner's approval to use drilling additives and water from other sources when installing a monitoring well. These additives are potential contaminant sources that cannot be fully removed from the drillhole. Drilling muds are widely used with rotary drilling methods. Muds are used largely to prevent collapse or caving of noncohesive soils. There may be no alternatives to using drilling muds in some instances. The rule reasonably allows the Commissioner to review each case and to require removal of the drilling additives, if they will interfere with water quality analyses. The rule also allows the use of additives if they will not compromise subsequent analyses or if alternative methods are not feasible.

Subitem (2) reasonably requires clean well materials and drilling equipment. Drilling cables are specifically mentioned in response to a comment cautioning that limiting the use of drilling muds might encourage more use of cable-tool drilling methods. Drillers not sensitive to the demands of monitoring well construction may use greased cables. This may result in contamination of the water quality samples. Requiring the use of clean equipment prevents contamination of water quality samples.

Subitem (3) requires cleaning of contaminated equipment to avoid introducing contaminants to unaffected areas. This requirement compels well construction methods that protect the quality of water samples.

Item I allows the Commissioner to authorize the use of well materials that cause analytical interferences if the facility owner or operator provides another monitoring point that allows sampling to detect those substances. An example would be the use of plastic pipe that might interfere with analyses for organic compounds but is suitable for inorganic analyses, along with a separate monitoring point constructed of steel for monitoring organics. This provides an option that a facility owner or operator may prefer to the use of more expensive inert materials.

Item J requires that the monitoring well design be based on the hydrogeologic and hydraulic characteristics of the site. Wells cannot be designed properly without considering the soils and ground water conditions of the site. Improperly designed wells fail to perform in various ways. For example, they may produce sediment or may mix water from different depths and fail to detect pollutants. The practices used in designing wells should fit the site conditions.

Subitem (1) requires written justification for using a sampling interval longer than five feet, or ten feet for water table wells. Longer intake intervals result in blending of waters from different depths. This results in dilution of the highest pollutant concentrations. This dilution creates a false picture of the actual water quality and could cause pollutant concentrations to fall below the limits of analytical detectability. The provision allows the Commissioner to permit a longer screen when the facility owner or operator provides a rationale and supporting information. Long screens are sometimes appropriate when the objective is to detect but not quantify ground water pollution.

Subitem (2) requires monitoring wells to be designed, constructed, and developed to allow ground water to flow into the well and to exclude sediment. Installation practices and the use of narrow screen openings often result in a poor connection between the well and the formation, especially in lower-permeability soils. In these cases, the well may take a much longer time to refill after bailing. The excessive time for recovery can result in a change in sample chemistry due to exposure to air. A well's hydraulic connection to the aquifer can be improved by proper sizing of screen openings and well diameter, using filter packs, removing drilling muds and natural fines, and development after installation. Measures to reduce flow velocities through the screen are commonly recommended for water supply wells to reduce the build-up of encrusting deposits that may eventually plug the screen openings (Reference 91, pp. 450-453). Monitoring wells are pumped much less often than water supply wells. However, the requirement is also appropriate for monitoring wells. The facility owner or operator meeting this requirement avoids possible changes in sample water chemistry due to pressure changes during rapid flow through constricted screen openings. This problem is easily avoided by using screens that have enough total open area to minimize intake velocities. Sediment entry into the well must be minimized because sediment can alter sample water chemistry, interfere with analysis, and gradually fill in the well screen. Again, properly-sized screen openings, filter packs, low intake velocities, clean installation techniques, and proper development can minimize or eliminate sediment entry into the well.

Item K requires monitoring wells to be clearly and permanently marked with a Minnesota Unique Well Number (Unique Number) and with the well's common identification if different from the Unique Number. A Unique Number is a six-digit number used by well drillers, the Minnesota Department of Health and the Minnesota Geological Survey to uniquely link the well log, location, initial water quality sample, and other information to that well. This requirement enables sampling personnel, surveyors, Agency staff, drillers and maintenance personnel to distinguish between wells. The requirement to use both the Unique Number and any common name is justified because successive wells are often referred to by the same or similar common names, so the Unique Number is needed. In practice, those who use the well routinely prefer a convenient and easily remembered name. Familiar designations such as "Well 4" or "S-2" should also be shown.

Item L requires monitoring wells to be protected from damage and unauthorized access as required in the Well Code. Wells must be fitted with a locked metal cap for additional security. This condition protects monitoring wells from damage by site activity. Compliance will ensure that sample water quality is not affected by vandalism, sabotage, or other tampering. Monitoring wells are targets for vandals. A locking cap provides added security and will show evidence of tampering. A variety of locking caps are available from drilling equipment suppliers and are standard features at regulated waste facilities.

Item M requires development of monitoring wells. Development is the process of removing sediment from within and around the well screen after the well is installed. This is accomplished by a variety of techniques. Under different soil conditions, development may require minutes to hours before the well yields sediment-free water. Development is needed to clean the well, filter pack, and the soil or bedrock formation around the screen before the well is sampled, so that the well produces sediment-free water. The reasons for avoiding sediment were discussed under item J above. Even in low-yielding soils not suited to aggressive development techniques, gentle development can produce cleaner samples more representative of actual ground water quality.

Item M further requires a suspended solids analysis after development. This is needed and reasonable because it enables evaluation of well development and the residual sediment yield after development. The depth measurement required after development is needed and reasonable to verify that sediment drawn into the well during development has been removed. Removed sediment cannot plug the screen or interfere with sampling. The provision authorizing the Commissioner to require additional measures to remedy a sediment problem is needed because sediment may interfere with water quality analyses. The Agency recognizes that in some silts and silty sands, it may be very difficult to eliminate sediment. In most cases, a combination of proper screen and filter pack sizing, development, and sampling technique can result in a well that yields acceptable analytical results by controlling sediment.

Item N requires the facility owner or operator to conduct a simple field test to determine how much water must be removed from the well before water samples can be taken. Stagnant water inside the well is in contact with air. This water has a different chemical composition than the water surrounding the well. This water must be removed and replaced by water fresh from the formation before a representative sample can be collected. The technical literature commonly recommends conducting a stabilization test, recovery rate test, or other evaluation for each well (References 88, pp. 111-112; 89, pp. 102-104; 90, pp. 29-30; 92, pp. 43-53, 59; 93, pp. 7-10). The stabilization test is a series of chemical or physical measurements taken during the evacuation of a well. Stabilized readings indicate that the necessary amount of water has been withdrawn. The recovery rate test is used in low-permeability soils. This test measures the rate at which the water level recovers after the well is drawn down. These tests are recommended each time a sample is collected. The test results indicate when the sample can be drawn. The requirement to conduct an initial test provides a reasonable reference point to plan future sampling equipment and time needs.

Item O is the first of three items requiring records to be kept of monitoring point construction. Item O requires accurate records of the soil or bedrock types encountered during construction. This provision acknowledges that sampling results can be understood only in relation to the hydrogeologic setting from which the samples were obtained. Features such as clay layers and sand lenses may greatly influence pollutant movement. These features must be identified during drilling and recorded to permit accurate interpretations and predictions about pollutant migration. The soils records must be those required for soil borings in subpart 3, item F, unless the Commissioner approves otherwise. These requirements include classification and laboratory examination. Undisturbed samples must be obtained during construction of a monitoring point. Accurate hydrogeologic evaluations require high quality soil samples. Common drilling practices can provide suitable samples.

Item O allows the Commissioner to approve alternative drilling or logging procedures if the requirements are unnecessary or infeasible. Examples include use of the rotary method when alternative methods are not feasible and the use of a soil log from an adjacent monitoring point. The rule requires the facility owner or operator and the driller to report an unanticipated change in drilling method after completing the drilling. This prevents expensive down time while the Commissioner reviews the change of plans. However, the facility owner or operator accepts the risk that the change will not be acceptable.

Item P requires a well record to be submitted within 30 days after installing or sealing a monitoring point. This requirement compels the facility owner or operator to provide the information needed to interpret results obtained from the well and to evaluate the adequacy of the procedures used. The requirement provides time for the driller and the facility owner or operator to assemble and submit the well record. The 30 days is the same period required by existing Minn. Rules pt. 4725.6800 for submittal of water well records to the Minnesota Commissioner of Health.

Subitems (1) and (2) pertain to well construction and well abandonment, respectively. Subitem (1) requires the well construction record to include several components. A detailed log of the soils encountered and well construction is required as discussed regarding item Q below. The Minnesota Unique Well Number is required for the reasons discussed under item K above. A copy of the Department of Health log is required as a check on the accuracy of the log developed for the Agency under item Q.

Submittal of geophysical logs is required because they can provide additional information about soils and ground water conditions. For example, geophysical logs can provide more accurate elevations of contacts between soils and the water table, and more insight into the degree of soils layering or variation than is possible through periodic samples. Well development and suspended solids data are needed for the reasons discussed under item M above. Stabilization or recovery rate testing are needed for the reasons given under item N. Submittal of the results of other measurements and tests is reasonable because these tests yield information about the hydrogeologic conditions that is important to understand ground water flow and pollutant migration.

Finally, the dated and revised plan sheet showing the location of the monitoring well enables all users and inspectors of the facility to locate all wells. If ground water pollution is detected, many new monitoring points may be installed, causing plan sheets to become obsolete. The requirement that locations be surveyed to the nearest foot is needed because monitoring wells commonly have been destroyed and buried by construction equipment. The wells must be located so that they can be rebuilt or properly sealed. If the wells are not rebuilt or properly sealed, they become transport routes for pollutants. Surveying techniques easily achieve the stated degree of accuracy.

Subitem (2) contains the requirements for a well sealing (abandonment) record. The information required is needed to evaluate whether the sealing procedures were adequate to prevent pollutant movement along the abandoned well and to connect the record (by name, Unique Number, and surveyed location) to the construction log for the well. A surveyed location enables locating sealed wells in the future, if they come into question as a possible avenue for pollutant migration. The rule avoids duplication by allowing a copy of the report required by the MDH to suffice, if it contains the required information.

Subitem (3) requires that the accuracy and completeness of the records submitted be verified by the person who actually constructed or sealed the well. Under Minn. Stat. § 156A.03, this person must be a licensed water well contractor or a professional engineer registered with the MDH under the provisions of the Well Code. This provides further assurance, based on the need to comply with the law in order to maintain a license or registration, that the well log is accurate.

Item Q contains the information requirements for the soils and well construction log. This is the central component of the monitoring point record required in item P. The log consists of a graphic depiction of the way the well was constructed. The log also depicts the soils or bedrock conditions surrounding the well. The log is fundamental to understanding where the water entering the well is coming from, and for describing and correlating soils on the site. Because of the amount of information the log must convey, the common practice of displaying this information is a vertical cross-section drawing.

Some of the information required in subitems (1) to (10) goes beyond what is identified on MDH's standardized Water Well Record form required under Minn. Rules pt. 4725.6700 (Reference 94). The additional information reflects a difference in the responsibilities and concerns of MDH and the Agency. Under Minn. Stat. ch. 156A, MDH is charged with regulating well construction to protect the health of well water consumers and to ensure that well construction practices do not create pathways for possible pollutant migration between aquifers. The Agency must assure that samples obtained from a well are representative of ground water quality within a discrete, known position in the three-dimensional ground water flow system.

Subitem (1) requires a description of the well casing as required by MDH. The influence of casing material on sample chemistry has been discussed under item H above. Casing diameter controls the size of the sampling and evacuation devices that can be inserted. Casing diameter also affects the width of the annular space around the casing available for seal materials and filter packs, and the volume of water in the well. The casing schedule number, standard dimension ratio, and wall thickness are measures of the casing strength. Requirements for casing strength are given in the Well Code.

Subitem (2) requires information about the well screen. As with the casing, some screen material can interact with the water and potentially alter the water quality. A variety of screen material is available. Each is suited for monitoring different contaminants. Identification of the screen material, product name, and description is a reasonable method for determining the strength of the screen, the potential for undesirable electrochemical (galvanic) reactions between the screen and casing, and the total area of the openings available for water movement into the well. The Agency and the well driller must know the opening width to determine the size of particles that can pass into the well, the well driller's ability to agitate the soil or filter pack during well development, and the ease of water movement into the screen.

The only information in subitem (2) that is not also required on the MDH Water Well Record form is the type and direction of alignment of openings and the type of screen bottom. The type of openings, including factory milled slots, continuous wire wound, and hand-sawed slots, can affect the chemical interaction with the water, the total open area of the screen, screen strength, and the uniformity of the slot widths. Hand-sawed slots are not recommended. Openings are normally horizontal, but may need to be vertical if devices for measuring ground water flow direction are to be used. Finally, the Agency must know whether the well has a bottom cap to exclude sediment, or whether there is another section of casing below the screen serving as a sump for collection of water, sediment, or dense insoluble organic pollutants.

Subitem (3) requires reporting the methods and materials used to join the component pieces of the casing and screen. This information identifies the strength and security of the couplings, the likelihood of leakage through the joints, and the possibility that any solvents, adhesives, gaskets, greases, welding fluxes, or other materials applied to the joints may contaminate water samples.

Subitem (4) requires information on the granular filter pack installed in the annular space surrounding the well screen, if a filter pack was used. The reasonableness of requiring this information has been discussed under item G, subitem (3) above. Information on the quantity of filter pack can be used to verify whether the pack covers the entire screen or leaves part of the screen exposed to finer-grained formation and backfill material, grout, bentonite, or other annular seal materials.

Subitem (5) requires details on the annular seal material. The information provided is used by the Agency and the facility owner or operator to assess the strength and security of the seal; the likelihood of cracking or shrinkage; the susceptibility of the material to penetration by pollutants; and the possibility that the seal material will act as a source of pollutants. For example, some monitoring wells at Minnesota land disposal facilities have yielded high pH measurements long after installation. This condition could be attributed to ground water pollution when a cement grout is the actual source of the alkalinity.

Subitem (6) requires the elevation of the top of each casing, surveyed to the nearest 0.01 foot. This degree of accuracy is needed to determine ground water flow direction at sites with very slight hydraulic gradients. Gradients are determined based on the hydraulic head difference between two points. If this difference is very small, the flow direction (gradient) cannot be determined without the accuracy required in this subitem. Standard surveying practices yield elevations accurate to 0.01 foot. The provision for surveying the top of each casing is needed and reasonable because wells normally contain both an inner and outer casing. Both elevations are needed to ensure the accuracy of water level measurements because the top of either casing might be used as the reference elevation.

Subitem (7) requires elevations of other components of the monitoring well. Each of these will assist in judging the overall performance of the well. The elevations in subitem (7) can be determined by direct measurement of the casing or screen, drill string, or depth, then subtracting this length or depth measurement from the surveyed elevation required under subitem (6). The accuracy of elevations in subitem (7) will not be required to the nearest 0.01 foot. These elevations yield information on the length of the screen; the separation between the top of the screen and the bottom of the annular seal; the locations of casing diameter changes; and other features that may affect geophysical logging, well development, the insertion of sampling devices, or other observations, and the length of any drilled interval below the bottom of the screen. This information makes all details available if future work needs to be done on the well.

Subitem (8) requires information on the drilling and installation procedures. Knowing the type of drilling rig used may yield insights about grout placement, the quality of cutting materials removed from the hole, or other procedures followed. This information might not be otherwise obvious from the well construction details. Knowing how the well, filter packs, and grout were installed will help in judging whether they will effectively perform their functions. Drilling fluids are potential sources of certain pollutants that may be found in the analysis of samples. Cleaning procedures vary in effectiveness. Inadequately cleaned materials or equipment may yield contaminated samples. The information required under this subitem improves the Agency's and facility owners' or operators' abilities to evaluate water quality results.

Subitem (9) requires noting pertinent observations during drilling and well installation. This is normal practice. Such observations are indicative of conditions that may affect the performance of the well or may help in defining the soil conditions. Typical observations include the loss of drilling fluids, which may reveal the presence and locations of voids; cave-ins, which may indicate a change in soil material type, structure, or degree of saturation; and changes in the ease of drilling, which define the elevation of changes in soil type between soil samples.

Finally, subitem (10) requires information on any pump, sampling device, or measuring device permanently installed in the well. The pump type, model number, capacity, and other information indicate the rate at which the well can be evacuated and sampled. The methods and materials used to suspend or secure the device must be documented. The device dimensions determine the amount of free space available between the device and the well casing. The placement of the intake area indicates how much available drawdown there is and whether the pump could expose the screen to air or cause undesirably high inflow rates through the screen openings. This information is necessary to evaluate whether the device or its installation may be the source of trace-level pollutants. Finally, the type and location of the power source is needed to evaluate equipment needed to sample the well.

Item R specifies the requirements for piezometers. Piezometers are used only to measure water levels and are not required to meet the standards of a monitoring well. Therefore, it is reasonable to exempt piezometers from the requirements of items H, I, N, and S. Items H and I are requirements to protect water samples from pollutants introduced during the construction of wells. Item N addresses the preparatory steps to obtaining a water sample. Item S addresses requirements for surface water monitoring points. These requirements are unnecessary for piezometers since they are not intended for use as sampling points. Piezometers must accurately measure hydraulic head and whether water levels change synchronously with the changes in hydraulic head in the formation. Time lags in water level can be appreciable in low permeability soils. These lags can lead to inaccurate interpretation of permeability test data and of ground water flow directions. Piezometers can be designed to give accurate data by adjusting variables such as the diameter of the intake area and riser pipe or tube. Under extremely low permeability conditions, the rule authorizes the Commissioner to require alternative designs, such as pressure transducers, to obtain information on hydraulic head.

Item S contains three requirements for surface water monitoring. Surface water monitoring requirements will be determined based on site-specific conditions because of the differences in water quality and flow rates among rivers, streams and lakes.

Subitem (1) requires a permanent marker adjacent to the sampling location. This condition ensures successive samples are taken from the same location. This consistency makes it easier to compare data from one sampling to the next. Subitem (1) reasonably allows alternative measures when the sampling locations are off the facility owner's or operator's property.

Subitem (2) makes the general requirement of item A, subitem (2), more specific for stream sampling. To enable comparison of potentially affected water to unaffected water, subitem (2) reasonably requires monitoring upstream; downstream, where mixing and dilution have had their effect; and in the area where the potential impacts would be greatest, namely, where the ground water pollutants discharge into the stream at the highest concentrations. The area where the maximum probable pollutant concentrations in ground water discharge to the surface water usually can be estimated based on the hydrogeologic conditions, the distance to the stream, and the stream configuration.

Subitem (3) requires notification and revision of plans within 30 days after establishing a surface water monitoring station. This condition is needed for the same reasons discussed under item P.

Item T establishes requirements for inspection and maintenance of monitoring points and markers. These installations must be inspected by sampling personnel when they sample or measure the well. Annual inspections must be done by the facility owner or operator. This ensures that a person with direct responsibility for the monitoring points checks their condition regularly. Damage or other conditions that may interfere with the use of the monitoring point must be repaired within 72 hours. Otherwise, the monitoring point must be properly sealed within seven days. The Well Code requires these prompt response times to prevent pollutant migration into the well and to restore the usefulness of the monitoring point. Immediate resurveying will ensure the facility owner's or operator's ability to measure water elevations accurately without delays. Finally, a reasonable time period of 30 days is allowed to submit revisions of the well log and facility plans to reflect the current elevations. These revisions are needed to prevent erroneous water level measurements. Maintaining the date of the change and the previous top-of-casing elevation on the plans ensures that depth-to-water measurements made before change in top-of-casing elevation can be converted to accurate water elevations.

Subpart 11. Gas monitoring, collection, and treatment system. The decomposition of mixed municipal solid waste produces gases. Of these, methane gas becomes the dominant component when decomposition occurs in the absence of oxygen. Methane gas is explosive and presents a safety concern as well as an environmental concern at land disposal facilities. Methane gas moves through subsurface soils much in the same way liquids travel through soil, that is, it follows the path offering the least resistance. The path is one containing large pore openings compared to the gas molecule and does not contain liquids or some other medium plugging the pore openings. The ability of methane gas to move for great distances at a fairly quick rate compared to ground water makes it essential to institute safeguards at land disposal facilities to protect on-site structures and nearby off-site structures. Equally as important is the protection of vegetation on and off the facility property.

The existing solid waste rules prohibit the migration of explosive gases from the land disposal facility. However, no specific guidelines are given on acceptable gas concentrations at the facility or on the type of monitoring that should be provided to ensure gas migration is not a problem. In 1979, the EPA promulgated the "Criteria for Classification of Solid Waste Disposal Facilities and Practices," 40 CFR Part 257, regulating the concentration of explosive gases in facility structures and at the facility property boundary. Specifically, sections 257.3 to 257.8 require that the concentration of the explosive gases not exceed 25 percent of the lower explosive limit (LEL) in facility structures and not exceed the LEL at the property boundary. The Agency proposes to include this performance standard in the revised solid waste rules with a slight addition. The Agency believes that exceeding 25 percent of the LEL should be prohibited in facility structures. The Agency also believes the 25 percent LEL level should not be exceeded around facility structures within any on-site monitoring point, and has expressed this in the rule language. Reference 47.

The Agency believes the proposed performance standards for explosive gas concentrations to be reasonable. Without proper monitoring and control of the build up of explosive gases, life-threatening situations may arise on and off the site. The inclusion of barrier liners under the waste fill area has increased the potential for increased pressure due to gas retention in the fill area. This may cause eventual blow-outs to release the pressure from the fill. Facility owners and operators are required by federal law to meet these performance standards. By including the standards in the proposed rules, the Agency alerts facility owners and operators of these requirements without an increase in effort.

Item A contains the monitoring requirement for land disposal facilities. The gas monitoring system must be capable of monitoring gas build-up in a facility structure and at the property boundary. This standard is consistent with the federal criteria in effect for solid waste management facilities. Including this provision in the proposed rules advises facility owners and operators of the federal criteria and the Agency's intent to enforce the standards. It is important to monitor on-site structures for gas build-up because of the explosive nature of methane. Monitoring at the property boundary is needed to ensure the explosive gases are not migrating away from the fill area to nearby homes, endangering the residents of these homes. Monitoring provides a quantitative check on visual indications that gas is migrating out of the fill area and placing human health and the environment at risk. Visual indications of gas migration include vegetative stress, the bubbling of liquids out of the fill area, and cracks in the final cover. Monitoring for explosive gases is a reasonable requirement to ensure the safety of human health on and off the land disposal facility. Uncontrolled gas migration will result in increased erosion (sedimentation loss) and increased leachate generation through the increase in moisture in the fill from the loss of cover and cracks in the cover. Monitoring permits corrective actions to be taken before these problems occur.

The Commissioner will establish the monitoring requirements for each facility. The monitoring requirements will include water quality parameters that indicate gas migration as well as direct measurement of gas concentrations. The monitoring requirements will be established in the permit, closure document, order, stipulation agreement or other enforcement document governing facility operations. Monitoring is intended to ensure the compliance with performance standards. The Agency considered specifying monitoring type and frequency in the proposed rules, but determined that this would be too stringent and would not allow for site-specific characteristics. The proposed requirements allow for determining the type and frequency of monitoring on a case-by-case basis. Factors that need to be considered in establishing a monitoring program are soil conditions, hydrogeologic conditions, location of facility structures, and the property boundary. These factors control the rate and extent of gas migration. Because of the variability in site conditions, monitoring requirements are established for each facility in the document regulating facility operations.

The monitoring system must include field inspection to detect odors and signs of vegetative stress, and portable or inplace monitoring probes to monitor explosive gases. Although methane does not have an odor, many other gases, usually present in lesser amounts, have very distinctive odors. Thus, the presence of these odors may indicate the release of gases from the fill area and the potential for methane gas to be present at dangerous concentrations.

Gases generated at land disposal facilities can be harmful to vegetation growing at the facility. The gases collect around the plant roots in the pores of subsurface soils. The presence of the gases inhibits the movement of water to the plant through the roots because the pore space is filled by gases. Vegetation will show signs of stress if gases are present by turning yellow and withering.

If monitoring probes are to be effective, they must be maintained. It is important that a regular schedule for checking these probes be established. Field inspections are a reliable method to determine the migration of gas and the condition of the monitoring system. Therefore, field inspections are included in the monitoring program for each facility.

Item B discusses the placement of gas monitoring probes at a land disposal facility. The probes must be placed between the disposal site and on-site structures or property lines. The probes must be placed no closer to the property lines than the compliance boundary. The Agency believes it is important to discover the migration of explosive gases before they put human health or the environment at risk. Therefore, the Agency proposes that monitoring probes be placed at locations between the fill area and the potential area of concern. By monitoring away from facility structures or the property lines, the facility owner or operator has time to institute corrective actions before performance standards are violated and human health or the environment is placed in jeopardy.

The Agency decided to limit the placement of monitoring probes to no closer to the property line than the compliance boundary for two reasons. First, the hydrogeologic conditions are best defined at the compliance boundary. In most cases, ground water monitoring wells will be placed at the compliance boundary to determine compliance with the performance standards for the release of pollutants to the ground water. By understanding the hydrogeologic conditions, the facility owner or operator will be able to establish gas monitoring probes at the most likely location and depth that first signs of gas migration will occur. The second reason for establishing the compliance boundary as the gas monitoring location deals with maintenance of the monitoring probes. Because ground water monitoring wells will also be located along this boundary, the areas will be well-marked and protected to ensure facility operations do not destroy the monitoring points. Thus, the Agency believes this requirement ensures early warning of potential gas migration hazards.

If the facility owner or operator believes that monitoring probes are unnecessary or infeasible, the owner or operator must submit reasons and evidence to justify this conclusion. If the Commissioner concurs with the submittal, monitoring probes will not be required at the facility. The Commissioner's decision will be based on the waste characteristics, fill size, surrounding soils, the water table depth, and the proximity to occupied buildings. The facility owner or operator must show how existing site conditions and facility operations will prevent the migration of explosive gases. Facility owners and operators should have the option to utilize methods other than permanent monitoring probes to provide the same assurances that human health and the environment are not at risk. By allowing this flexibility in rule rather than through a variance request, the Agency provides a reasonable approach to permit and operate land disposal facilities based on site-specific conditions rather than design standards that may not be applicable in all situations.

Item C requires probe depths and locations to be based on the soils, site geology, depth of fill, water table, and depth of frost. As discussed earlier, these conditions greatly influence the amount and extent of gas migration at a facility and must be considered in the design of the monitoring system.

Item D establishes the minimum requirements for gas control mechanisms at mixed municipal solid waste land disposal facilities. The proposed design requirements included in subparts 6 through 9 contain provisions to control the migration of pollutants contained in leachate out of the fill area. The very facility components that minimize the amount of leachate generated at a disposal facility and the movement of leachate out of the fill area cause the build up of explosive gases within the fill area. Allowed to continue, the build up of gases within the fill area greatly increases the potential for fires and explosions. In order to minimize these risks, preventive measures must be designed into the fill area. At a minimum, under the proposed rules, each facility must be designed and constructed with gas vents. The number and placement of the gas vents must release gas pressure in the fill area to prevent ruptures of the cover system and to encourage vertical gas migration. Encouraging vertical migration of gases out of the fill area decreases the potential for disruption of the cover system and for the migration of gas out of the fill area through the leachate collection system. Encouraging vertical migration of gases from the fill area by means of vents through the cover system provides a reasonable approach to controlling gas migration avoiding expensive forced aeration systems that include gas treatment. Passive ventilation as a minimum design standard provides facility owners or operators the opportunity to use a less sophisticated method of controlling migration.

Item E requires gas control systems to be located near the fill area and to extend to the water table or to a subsurface soil capable of impeding gas movement. Water acts as a natural barrier to the movement of gas because the gases generated at land disposal facilities are not soluble in water. Low permeability soils, which have small pore openings, or rock formations, also serve as barriers to the movement of gases. Gas control systems should be located near the fill area to collect gas before it has an opportunity to impact large areas and to minimize the effort needed to control the gas. The control system must be located at a depth capable of impeding gas movement and must increase the probability that the maximum amount of gas is contained. By using existing site conditions in controlling gas movement, the facility owner or operator will minimize the cost and type of control systems for the facility.

Item F establishes the minimum criteria that the Agency will use to evaluate the design of gas collection systems used at land disposal facilities. The size of the gas collection system must be based on the volume and type of waste received at the facility. The decomposition of mixed municipal solid waste in an environment without oxygen generates methane as the primary gas. Theoretical values on the amount of gas generated per pound of waste being decomposed range from 1 to 8 cubic feet per pound of waste decomposed. Reference 83. Using these numbers, the facility owner or operator can design the size of a gas collection system. It is reasonable that the size of gas collection systems be based on numbers generated from the waste deposited at the facility because that process acknowledges the importance of understanding the fundamental processes at work at a land disposal facility. The more organic wastes included, e.g., food wastes and paper, the higher the values for methane generation that must be used. Sorted mixed municipal solid waste can result in less gas generation because of the lack of carbon for methane formation.

The facility owner or operator must determine the need for a gas collection system and discuss in the engineering report how the need for the facility was determined. The Commissioner will review the facility owner's or operator's determination during the permit review process and again at closure. The Agency acknowledges that gas collection systems may not be necessary at some land disposal facilities. Therefore, the Agency allows facility owners and operators to review the site-specific conditions associated with a facility and evaluate whether a gas collection system is needed or feasible. Experts working on designing and installing gas collection systems have indicated that facilities of sizes less than one million tons in-place and less than 50 feet deep are not large enough to generate sufficient volumes of gas on a continuing basis to make collection, treatment, and utilization of the gas cost effective. It is reasonable to allow the facility owners and operators to conduct this evaluation rather than mandating gas collection systems at all land disposal facilities, thus forcing the facility owners and operators to request variances from the requirement when necessary.

Approval of a gas monitoring system will not limit future requirements for gas collection and treatment determined necessary by the Commissioner based on the volume of gas generated at the facility, the proximity to residential or business property, or problems experienced at the facility in maintaining vegetative growth or accumulation of gas in site structures. This rule informs facility owners and operators that a determination at permit issuance that a gas collection system is not required does not close the issue forever. This is particularly true for smaller, more remote facilities. It is possible that these facilities originally will be considered to be of such a size and location that a gas collection system is unnecessary only later to find that the final cover for the facility cannot be established due to gas problems. Additionally, the Agency cannot control the location of residences near a land disposal facility. This is a zoning issue outside the Agency authority. If new residences are built near the facility, it may become necessary to install a gas collection system to control the migration of gas. This provision in the proposed rules informs facility owners and operators that this specific facility component may be needed at a later date. The amount of gas generated is highly dependent on actual fill conditions, which can vary considerably from facility to facility. Thus, gas collection systems may need to be installed after original data indicated they would be unnecessary.

Item G establishes the minimum components of a gas monitoring system for land disposal facilities. The sampling and analysis of gas generated at the facility must address the amount and type of gas generated. This becomes particularly important at facilities where gas collection systems are employed. The amount and type of gas generated at the facility determine the proper treatment needed and operation of the gas collection system. The type of gas being generated also indicates the condition of the waste deposited in the fill area. For instance, carbon dioxide is the main component of the gas being generated in the early stages of decomposition. Carbon dioxide is highly soluble in water and will move with the leachate forming carbonic acid. Little methane gas will be recovered during this time. As decomposition continues and oxygen is depleted, methane gas is generated. Methane is not soluble in water and will be found in the gas monitoring system. To correctly operate the gas collection or control systems, it is necessary to understand what stage of decomposition is occurring. Because of this need to understand the amount and type of gas being generated at a fill area, the gas monitoring system provide for the required sampling and analysis.

The monitoring program must be included in the operations manual for the facility. The program must consider variation in gas generation and migration due to climatic conditions, variations in the amount of waste deposited, and the length of time the waste has been in place. The operations manual must include the techniques to be used to monitor gas. Monitoring is the means used to determine compliance with performance standards. If the monitoring is not completed correctly or in a timely fashion, the results may not be just a violation of performance standards but also a loss of life or fires due to explosions. All facility personnel must be made aware of the procedures to be followed for monitoring gas build-up and migration and the scheduled times for monitoring. The operations manual contains all information facility personnel must know about operating a particular facility and is used as a training guide.

Gas generation and movement is highly dependent on conditions in the fill area. These factors often vary with the climatic conditions, thus it is important to understand and consider the effects of climate on monitoring.

Monitoring should be conducted when the soil surface is wet or frozen as the potential for horizontal migration is increased under these conditions. If an extremely wet period was experienced before closure of a phase, gas generation rates may be higher and earlier than expected under drier conditions. Under times of low atmospheric pressure, vertical migration will tend to increase because the pressure in the fill area is sufficient to overcome the downward forces being exerted by the atmospheric pressure. Under periods of high atmospheric pressure, less vertical migration will occur, thus placing structures and vegetative growth located horizontally from the fill at risk. A monitoring program must be established that considers the factors that can influence the results. Without considering these factors erroneous or misleading results may be obtained leading to disastrous results.

Subpart 12. Construction requirements. The existing solid waste rules require facility owners and operators to certify construction on the facility before operations begin or any component of the facility is placed into operation. The rules provide little guidance on what is to be included in the construction certification or what the minimum requirements are for constructing a land disposal facility. Part 7035.2610 of the proposed rules discusses the construction certification procedures applicable to all solid waste facilities. The Agency believes the construction certification program required under part 7035.2610 should be expanded to alert facility owners and operators to the requirements the Agency believes must be included in even the most basic of construction programs. The construction requirements proposed in this subpart address not only the elements needed to ensure compliance with design and construction requirements contained elsewhere in the proposed rules. They also address those elements used on a continuing basis to ensure quality construction is completed and maintained. Addressing these elements in rule provides facility owners and operators guidance on the Agency's basic acceptance criteria as no facility or facility component may be put into operation without the Agency's approval of the completed construction work. Reference 95.

Item A requires the facility owner or operator to notify the Commissioner at least seven days before the day construction is expected to begin on major design features. The Agency must determine that the construction completed at a facility complies with approved permits and plans. This conclusion is reached by Agency staff reviewing the construction certification and by completing on-site inspections during actual construction. In order for the Agency staff to schedule people to be at the site during construction, notification is needed in advance of construction. Notification by the facility owners or operators does not overly burden them as they must schedule work efforts to coordinate material arrivals and allows for a smooth transition from one construction phase to another. Agency staff will be able to schedule visits to the site during construction so that no hold-ups will occur. Seven days provides a reasonable time within which facility owners and operators and Agency staff may coordinate inspection needs. Seven days allows sufficient time for Agency staff to schedule inspections.

Currently, the facility owner or operator makes a phone call to the Agency staff member responsible for the project and provides a tentative schedule for construction to be finalized at a date nearer the anticipated date. Approximately one week prior to construction or earlier, if known, the facility owner or operator calls the Agency staff member and reconfirms the construction date or indicates a revised date. This system has allowed Agency staff to prepare for and schedule inspections at facilities as construction proceeds and has allowed minor modifications to be approved in the field, thus keeping work efforts on schedule. This requirement provides for the continuance of a practice that has functioned under existing rules.

Item B requires the construction firm's inspector to maintain a record of all procedures completed during construction. The record must document that all design features were constructed in accordance with the proposed solid waste rules and approved design plans. The record must include pictures, field notes, and all test results. The key in evaluating the quality of construction is the inspection process used. The Agency, unfortunately, is unable to be present at a site at all times or watch all construction activities while on-site. The same is true for facility owners and operators. Therefore, the construction firm must be relied upon to complete activities as approved unless found to be infeasible during actual construction. In order for the Agency and facility owners and operators to approve the work completed in their absence, a record of the activities must be kept. Although the documentation does not guarantee final construction and performance, it does improve confidence that work was completed as authorized. The written documentation along with inspections made by the Agency is used to authorize facility operation. The better the documentation, the more confidence in the work completed. A record maintained by the construction firm's inspector provides information as to the quality of construction achieved. The construction record also adds consistency to the manner in which the need for corrections will be determined on a continual basis. The construction firm demonstrates to the facility owner or operator the quality of work done in order to receive proper payment. This provision, in effect, only requires the construction firm to duplicate the report provided the facility owner or operator, and submit it to the Agency with the construction certification. This provision does not increase the burden on a construction firm, yet it provides very necessary data regarding the construction practices followed at a facility.

Item C requires that a permanent benchmark to be placed on-site at every facility and that the location of the benchmark be shown on the as-built plans submitted with the construction certification. Considerable surveying will be needed during different construction phases and during facility operations. In order to compare the results of these activities with approved plans or work completed by other parties, a reference point is required for each facility. To expect a traverse line to be drawn from an off-site benchmark at each surveying event is unreasonable. It is preferable to establish a benchmark early during facility construction for use during the remainder of the operating life and postclosure care period. Facility owners and operators are allowed to choose the location of the benchmark based on site conditions rather than dictating a specific place or corner of the facility.

Item D indicates the laboratory and field tests that must be completed by facility owners and operators during construction of a land disposal facility. Compaction, Atterberg limits, grain size distribution, laboratory and field permeability, and field moisture-density tests, at a minimum, must be completed on all facility liners and final covers. A portion of the field-molded and field-compacted samples of liners and the final cover layers must be retained until the construction certification is complete. Since not all performance standards can be evaluated for compliance based on visual inspections, some support analysis must be used. Because particular analyses were used to determine the suitability of a soil for use in the liner or final cover, these same tests should be used in evaluating the construction results. The tests perform the same function in determining construction quality as they did in determining soil suitability. The combination of field and laboratory testing in verifying construction quality provides a quick analysis of the construction process (field tests) while providing greater accuracy on the results achieved (laboratory tests). Field tests are used because they are quick and permit work to continue while the longer more detailed analytical analysis are completed. The results obtained in the field during construction are compared to the results obtained during the suitability evaluation. The field inspector can determine if corrective actions are needed to ensure the quality of work will be completed. Since the quality of construction relates directly to the overall facility performance, it is both needed and reasonable to require analytical verification construction in the field and in the laboratory. The retention of samples during the period of analytical verification is standard procedure. By retaining samples, the analytical results may be validated by reanalyzing a particular sample.

Item E re-establishes the minimum and maximum permissible cover slopes. The minimum permissible cover slope is 3 percent; the maximum is 20 percent. These slopes can be altered as provided under subparts 5 to 9. The Agency repeats the design standards for the cover slopes here to emphasize the importance of achieving these slopes during construction. If 3 percent slopes are not achieved, settlement of the fill area may cause the flattening of the cover or the formation of low areas that prevent drainage of water away from the fill area. Additionally, slopes less than 3 percent are difficult to achieve because the equipment used to spread and compact cover material is not easily worked with such fine tolerances. A slope greater than 20 percent encourages the rapid movement of precipitation or surface water downslope increasing the potential for erosion to occur and the ultimate destabilization of the cover.

Item F requires the liner of a newly constructed horizontal fill area to be joined to the existing liner. The purpose of a liner system is to impede downward flow of leachate out of the land disposal facility and into the subsurface environment. In most cases, fill practices will dictate the need to construct the liner in phases coinciding with the fill sequence developed for the facility. Maintenance of a large, lined area is difficult. The potential problems include physical and biological attacks on the liner (ultraviolet radiation on synthetic liners, unwanted vegetative growth on soil liners). Another problem is the logistics of operating in a fill area without disrupting the liner in the next working area. If liners are constructed in segments and not joined to each other, a potential for widespread pollution exists due to the volume of leachate that could be released through the opening between liner segments. Because of the critical function a liner plays in controlling the release of pollutants from the fill area to the surrounding environment, that all sections, if a liner is constructed in sections, should be joined to each other to ensure no leaking occurs along these seams.

Item G requires flexible membranes to be installed only under dry weather conditions. Wet weather can impact the quality of seams achieved during installation because the heat is conducted away from the joint area and the moisture may interfere with the adhesives used to join the membrane panels. Moisture under the flexible membrane may raise the membrane creating a condition that may stretch the membrane, cause buckling of the membrane as the moisture moves away, or make the membrane more susceptible to puncture or tearing because of the stress conditions. Secure seams in flexible membranes are needed to contain leachate generated in the fill area.

The seams joining membrane panels must be inspected as construction proceeds, and air testing of seams and field seam tensile testing must be completed. As part of a construction quality assurance program, seam testing is critical to the performance of a flexible membrane. Quality control mechanisms are followed at the factory in manufacturing the membrane and in forming some seams before shipment to the facility. As the membrane is placed in the field, membranes are inspected to ensure seaming and placement activity maximizes the probability that no flaws exist in the seam.

Nondestructive testing of seams is conducted to determine continuity. Continuity indicates the seam was made but does not indicate strength. Air testing is the most frequently used nondestructive method to determine seam continuity. Destructive testing is required to determine seam integrity. Destructive testing must be used only in a systematic sampling scheme because of the damage placed on the liner when taking the sample and repairing the work. In most situations, the sample is taken to a laboratory for strength analyses but some field testing must be conducted also to indicate the quality of work performed. The tensile test is a destructive strength test suitable for use in the field. Field testing of flexible membrane seams for quality of installation is standard practice. This provision merely indicates nondestructive and destructive test methods that must be completed as part of a quality construction check. Since the field seaming of membrane panels is, perhaps, the weakest point in the construction, it is important that the construction techniques used during installation result in high quality seams. This provision provides a set of minimum criteria by which the quality of installation will be evaluated.

All flexible membranes must be protected after placement. After placement, the quality of flexible membranes can be impaired by exposure to various weather conditions, equipment and vandalism. Thus, it is important to protect the membrane after placement and it has been placed and determined acceptable. The protective cover is usually soil free of rocks, sticks, and other items that could damage the membrane. In some cases, a geotextile membrane is used to protect the sythetic liner before placement of the protective layer and to add drainage capabilities to the collection system. The cost and work effort required to install synthetic membranes dictates protection of the integrity of the membrane after installation. This provision ensures the protection of the membrane but allows the facility owner or operator to consider the options available and utilize a protective means suitable to the specific site.

The natural layer above and below the synthetic membrane must be free of roots, sharp objects, rocks, or other items that might puncture the liner. As discussed earlier, the integrity of the membrane is susceptible to breakdown due to punctures or tears from sharp objects or vegetative growth. The natural layers are the foundation and protective covering to maintain the quality of a flexible membrane to ensure performance during facility operation. Facility owners and operators must maintain quality control on these layers to minimize the risk to the liner's integrity. The level of quality control required under this provision is reasonable considering the cost and work associated with installing a flexible membrane and the consequences if failure occurs.

Item H requires that barrier liners constructed of in situ soils be constructed by scarifying and recompacting the soils to the proper depth. The barrier liner is designed to impede the downward movement of leachate out of the fill area. This is accomplished by compacting soils or installing flexible membranes to obtain a low permeability barrier. In situ soils do not have the same permeability characteristics as remolded or recompacted soils. Naturally existing cracks or seams may exist in less permeable soils resulting in a permeability exceeding the standards established in the proposed rules. Recompaction of these soils also provides improved structural strength, uniformity of the subgrade, and creates a smooth layer on which the liner and leachate collection system may be completed. It is reasonable that in situ soils be scarified and recompacted to ensure the integrity of the barrier liner as this is the main impediment to leachate movement into the subsurface environment. Detrimental effects on ground water quality could result if a less permeable, cracked, fissured soil seam is encountered by the leachate providing rapid flowage out of the fill area.

Item I requires that all pipe used in the leachate collection system be tested for deformations. The allowable pipe deflection is 5 percent. No in-place method to test the quality of pipe construction after manufacturing is available without destruction of the pipe. Although the manufacturer runs quality control checks on the pipe quality, unexpected loadings or bad installation techniques could create potential weak areas in the pipe under excessive stress resulting in pipe collapse. The standard procedure for evaluating the construction quality of pipe installations is deformation testing. Pipe deformations are usually evaluated by pulling a mandrel ball through the pipe to determine clearance. The mandrel is equal to the size of the maximum pipe deformation allowed. A 5 percent maximum deflection standard is presently the industry standard used for the installation sanitary sewer pipes. This standard for leachate collection systems is used because the construction techniques and materials are similar.

If leachate draining through the collection pipe cannot travel to the removal point, the efficiency of the collection system will decrease accordingly. Leachate will build up within the collection trench until it can move to another pipe area to move out of the fill area or move downward through the liner into the subsurface environment. A collapse in one portion of pipe will also prevent cleaning the collection system at a later date, further decreasing the performance efficiency. Repair efforts are much easier prior to filling the area above the collection system. Therefore, pipe deflections should be analyzed immediately after construction to ensure proper performance and allow for repair. The deflection testing program provides an easy, quick method to check installation quality and the equipment is readily available.

Item J requires that all pipes exiting the liner be fitted with antiseep collars. Gravity flow is used to drain leachate off the liner and remove it for treatment and disposal. Gravity flow is the cheapest and most effective method considering the design, operation and corrosive environment of a land disposal facility. Utilizing gravity flow to control leachate drainage and collection allows some build up to occur at the exit points before pipes leave the fill area. In order to minimize the potential for release of leachate into the environment, it is necessary to install some form of preventive measures. One method that may be utilized is the continual removal of leachate from the system, minimizing the build up that would occur in the exit area.

Another method is the use of design components like antiseep collars. These collars serve as an additional barrier at the point the pipe leaves the fill area through the liner. The Agency believes that, at a minimum, antiseep collars should be used at all exit points to prevent the release of leachate in these areas. Antiseep collars are one of the minimum design and construction methods needed to ensure efficient performance at land disposal facilities.

Item K requires the facility owner or operator to prevent vegetative growth on liners. The roots from vegetation can puncture flexible membranes or grow into the natural soil barrier liner or drainage blanket resulting in the release of leachate. Prevention of unwanted vegetation can be accomplished by removing the layer containing the vegetation or applying herbicides or both. It is necessary to choose environmentally-sound formulations of herbicides to prevent these from becoming a source of pollution.

Item L requires facility owners and operators to survey and stake the liner and cover system during placement. The ability of an equipment operator to obtain proper slope and thickness in constructing liners and covers will depend on the experience of the operator, the size of the equipment, the depth to be achieved, and the configuration of the working area. When working with large equipment, depressions and depth are difficult to assess. Surveying and staking the working areas gives the equipment operator a visual control on the construction progress. Surveying is needed after each component is completed to ensure that it is constructed as designed and that no depressions remain that could encourage the ponding of water. Surveying and staking construction projects is common practice and provides construction quality control at a relatively low cost. The facility owner or operator should include this work in the construction program because of the benefits resulting from controlling the quality of work.

Item M requires all facility owners and operators to submit quality control/quality assurance programs for construction projects to be completed at the land disposal facilities. The programs must include tests to be completed during construction for analyzing the quality of work being completed. The program must also establish the frequency of inspection and testing, the accuracy and precision of tests, procedures to be followed during inspections and sample collection, and the method of documentation for all field notes including testing, pictures, and observations.

Construction quality control consists of inspections necessary to evaluate the quality of the constructed or installed component of the facility. These activities are independent of quality assurance measures but are a necessary first step in managing construction quality. The quality control measures for flexible membrane and pipe fabrication are completed at the manufacturing facility. The facility owner's or operator's inspector should obtain a copy of the manufacturer's quality control program. Review of this program should include plant visits and discussions with the manufacturer regarding areas of concern. The quality of the completed product should be confirmed by field personnel regarding thickness, tensile properties, destruction resistance, density, percent swell, percent carbon black, flexibility and all other characteristics necessary to ensure the membrane meets the performance qualifications. Testing these characteristics must be done to verify the manufacturer's data and the results must be included in the construction certification. For natural soil liners and cover materials, quality control measures include testing of soil sources to ensure the requirements regarding soil types and characteristics are met. The materials used to construct the facility components are as critical to the ultimate performance of the facility as are the construction techniques and effort. Requiring facility owners and operators to establish construction quality control programs maximizes the use of only quality products in the construction of a facility.

The construction quality assurance program includes inspections, verifications, audits, and evaluations of material necessary to determine and document the quality of the constructed facility. This program includes a detailed description of all quality assurance activities. The program documents the facility owner's or operator's approach and is tailored to the specific facility to be constructed. Although the overall content of the quality assurance program will depend on site-specific conditions, several key elements are needed in each program. These elements include identification of the responsibility and authority of key organizations and personnel, qualifications of inspection personnel, inspection activities, sampling strategies, and documentation. Regardless of the relationships of the organizations involved in permitting, designing and constructing the facility, good communication must be established to facilitate an effective decisionmaking process during construction. It is also important that the party responsible for conducting the quality assurance checks operate independently of the organization responsible for construction. By establishing in the quality assurance plan the responsibilities of the people involved, maximum efficiency will be provided in completing the construction in an approved manner. Including this information in the plan requires little, if any, additional work on the part of the facility owner or operator. Reference 95.

The overall responsibility of the personnel involved in the construction quality assurance program is to perform the activities specified in the quality assurance/quality control plan. The plan should describe the responsibility of these individuals and their qualifications for reviewing design plans, conducting a sampling program, interpreting data, and verifying the construction contractor's quality control plan. The inspection personnel must implement the quality assurance activities in a manner that ensures the proper evaluation of work performed. The plan should address the qualifications of these individuals in order that the reliability of inspections completed can be verified.

The inspection program contained in the construction quality assurance plan describes the activities, observations and testing that will be performed. The inspection program consists of preconstruction, construction, and postconstruction activities unique to each component of the facility. Specific test methods necessary to verify construction activities must be addressed separately with the discussion relating to specific components.

Preconstruction activities involve the review of design plans, site-specific conditions, and incoming construction materials. Construction activities involve the detailed inspection of materials and components after placement, including field and laboratory analysis. This portion of the inspection program is the most rigorous and time consuming as it involves the on-site checking, rechecking, and correcting of construction activities. Detailed reports and notes must be maintained as to visual inspection results, sampling locations, test results, construction techniques, weather conditions, etc. The precision and diligence with which these activities are conducted will have a direct impact on the assurances given regarding the quality of work completed. Postconstruction activities involve collecting test results, notes, pictures, etc. and writing up a report on the quality of work completed at the facility. As a third party, the quality assurance inspector will be relied upon by all the responsible organizations to provide a detailed and accurate accounting of the construction activities.

Performance of the facility will be based heavily on the documentation submitted by the quality assurance inspector. Establishing an inspection program prior to actual construction will give the facility owners and operators time to confer with the Agency to understand the Agency's needs and requirements regarding the approval of the plan and the approval of construction activities. Inspections form the foundation for approval of the construction and are the information source for responsible organizations.

The proposed standards in this item address the minimum elements in the inspection program without providing specific requirements regarding the number of samples to be collected and analyzed. The Agency believes that the sampling and analytical program is best established on a facility-specific basis due to the variation in designs and construction materials. An inspection program, including sampling and analytical details, must be tailored to the facility design and construction techniques. Permitting the facility owners and operators to develop their own sampling and analysis program in a more flexible process allows giving more attention to the details of facility components rather than merely highlighting components that are to be present in every facility. A single rule could not address all provisions that must be evaluated in each of the possible facility designs. A guidance manual written by the Agency will provide the facility owners and operators some insight on how to develop a comprehensive inspection program that includes a systematic sampling program and sufficient analytical work. By providing a basic list of key elements to be addressed in the inspection program, the Agency provides a reasonable approach to obtain quality assurance plans with detail sufficient to ensure proper construction of the facility. This information requirement gives facility owners and operators the flexibility to evaluate their needs and site-specific conditions and incorporate these factors into the program.

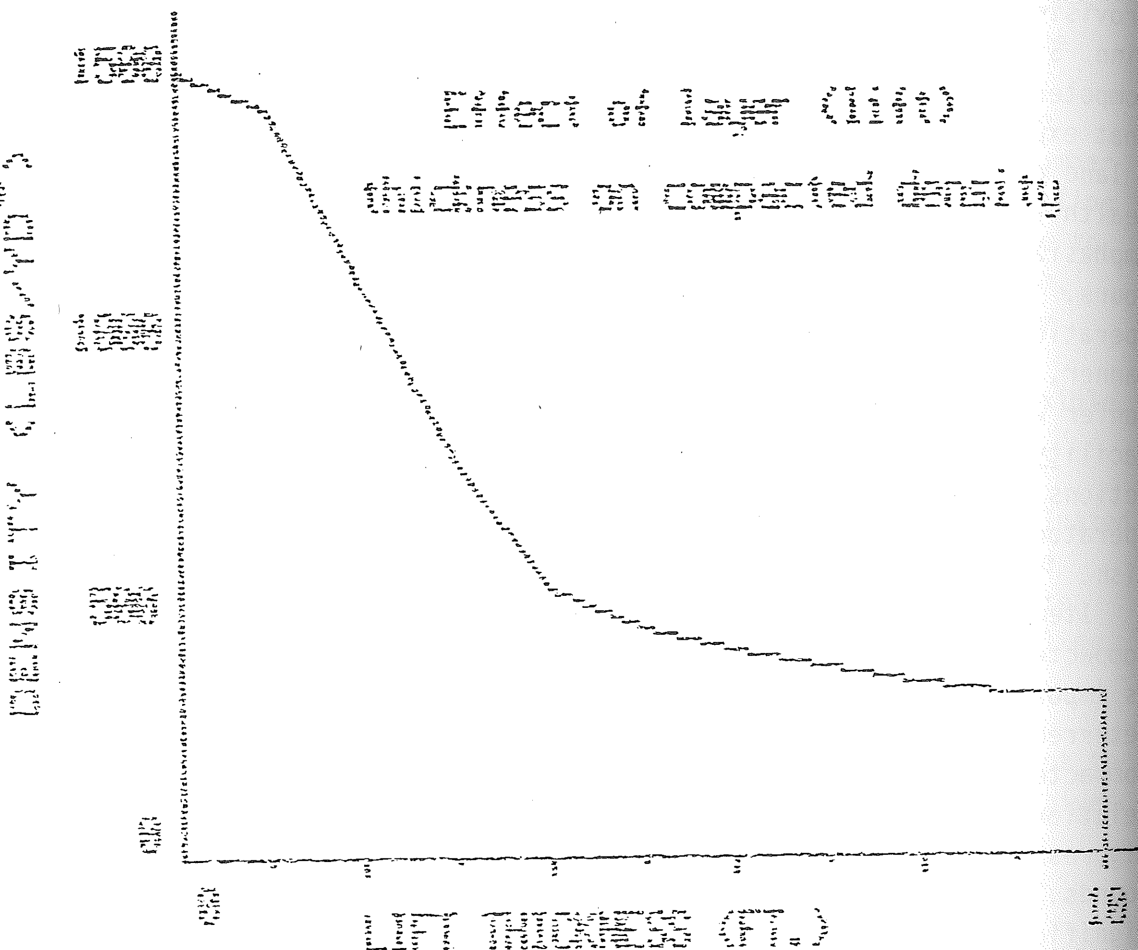
Subpart 13. Operation and maintenance requirements. The design and construction of a land disposal facility are only part of the measures needed to minimize the risks associated with the facility. Operations can enhance or impede the performance of a well designed and constructed facility. A land disposal facility is no longer merely a place to hide waste as when operational concerns were achieving the proper cover and controlling drainage of surface water. The operation of a land disposal facility requires careful planning and understanding of the total risk management program envisioned for the site. The facility owner and operator need to evaluate specific site conditions and determine how these conditions influence an operations program for the facility. The purpose of looking at these components together is to make operations easy and effective while reducing temporary structures or backtracking.

A mixed municipal solid waste land disposal facility must be operated by a certified operator. The certified operator must be present during the time the facility is open to accept waste. Existing rules, parts 7048.0100 to 7048.1300, require certified operators for land disposal facilities and contain the requirements that must be met for an operator to become certified. This provision simply reminds facility operators of the certification requirements. Minn. Stat. § 116.41, subd.2 (Supp. 1987), requires the Agency to certify competent persons to operate land disposal facilities. The legislature felt that experienced and knowledgeable persons are necessary to ensure operations at a land disposal facility are conducted in a manner that minimizes risks to human health and the environment. The Agency believes this need should be further emphasized by requiring a certified operator to be on-site during operating hours. The certified operator must understand the facility-specific design and operational needs. For facility operations to be conducted in an appropriate manner, the certified operator must be available for other facility personnel to confer with regarding issues that may arise. To operate a land disposal facility without the benefit of a certified operator on hand to ensure proper actions are conducted would serve only to waste the effort expended by the operator to become certified and place facility performance at an unnecessary risk.

Item A requires solid waste at the land disposal facility to be spread and compacted in layers of two feet or less. Compaction of waste in the fill area is important for many reasons, including volume reduction, vermin and rodent deterrence, surface water drainage, and settlement control. Waste is best compacted when it is spread in thin layers on a flat slope. Figure 10 shows the relationship between the number of passes made and the density achieved. These figures are based on a compactor having steel cleated wheels and weighing 50,000 pounds. Figure 9 shows that layer depths greater than 2 feet demonstrate a significant decrease in compaction density and more than four passes does not increase the achieved compaction density significantly. Reference 83.

Compaction efficiency decreases with greater lift thickness for two main reasons - bridging and cushioning effects. Bridging occurs when large materials in the waste become entangled with each other. This entanglement forms small structures that are well supported and difficult to crush under the load of the compaction equipment. Cushioning results from the upper layer of waste being compressed against the soft lower layers. Rather than forming a firm surface to compress the waste on, the lower layer acts like a soft mattress that springs back after the equipment load is released. This results in a lower density. Cushioning and bridging effects can be reduced by utilizing thin layers. This prevents wastes from becoming entangled and eliminates the soft under layers.

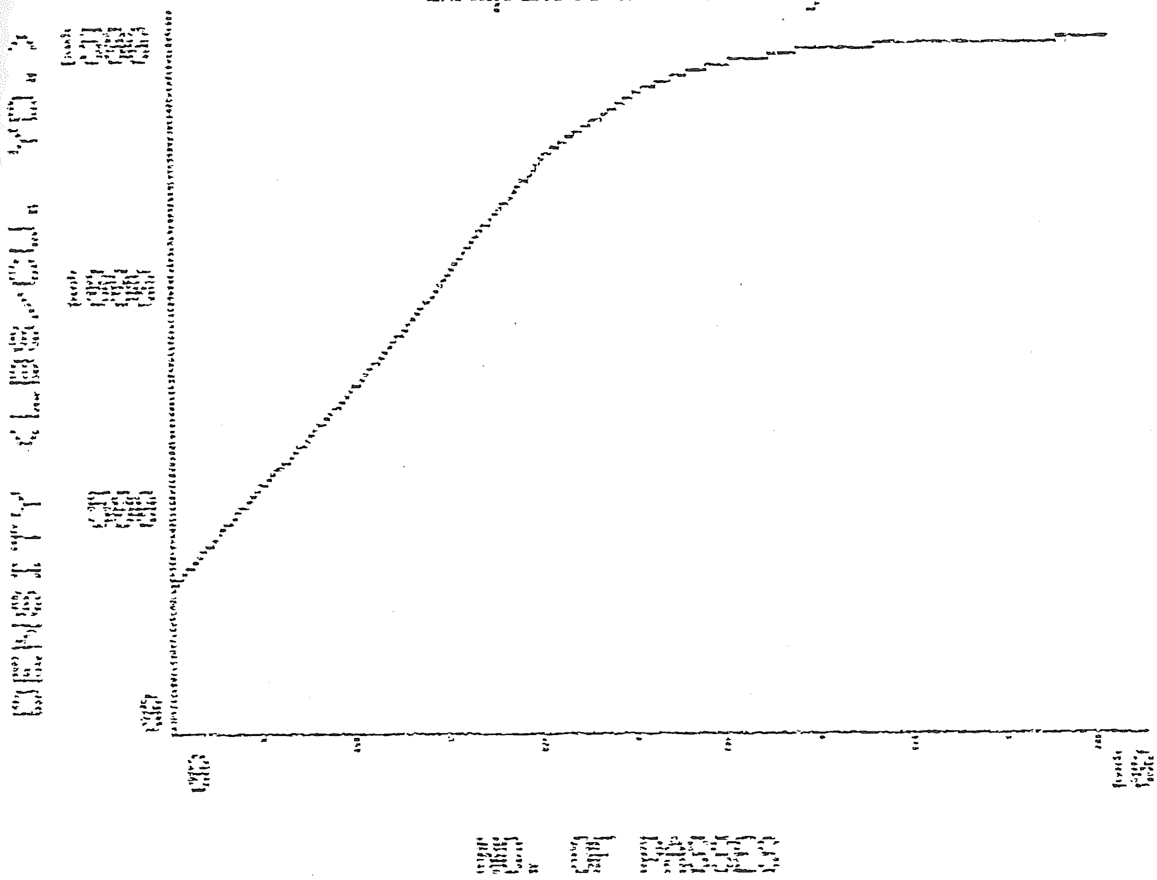
FIGURE 9


Effect of layer (lift)
thickness on compacted density
1500
DENSITY (LBS/YD3)
LIFT THICKNESS (FT.)

February 23, 1988

FIGURE 10

Relationship, number of passes, and compacted density



Item B requires that all mixed municipal solid waste must be sloped to promote drainage off the fill area. One of the main goals of the design, construction and operation of a land disposal facility is to minimize the amount of water percolating through the waste and forming leachate. Decreasing the amount of leachate generated reduces both treatment costs and the potential for pollutant releases from the fill area. Several design components under subparts 5 to 9 address accomplishing this goal. Operational methods can also be used to further minimize the percolation of water into the waste. One method is good compaction of the waste to form a firm surface that encourages horizontal flow rather than vertical flow of the water. Another method is constructing a fill area with slopes to encourage horizontal flow of water off the waste. This provision requires some slope to be incorporated into the fill area as filling progresses. No specific slope is required. By including this provision as a performance standard, the Agency allows facility owners and operators to utilize their judgment on the amount of slope that will be necessary and compatible with the overall design and development plans for the facility. The Agency believes this approach ensures that steps will be taken to minimize infiltration of water yet allows flexibility for the operations to be incorporated into the planned site development activities.

Item C requires the waste to be covered in accordance with the intermittent cover system required in subpart 6. The intermittent cover system minimizes infiltration into the waste by encouraging surface water run-off, deters rodent and vermin infestation by removing natural harborages, and reduces the potential for fires. A design for a specific component of the land disposal facility is only as good as the implementation of the design. This item advises facility owners and operators of their responsibilities to ensure the intermittent cover system is properly implemented. This provision establishes the minimum performance considered acceptable by the Agency.

Item D requires intermediate cover when no additional solid waste will be placed on a fill area for 30 days or more. The intermediate cover must be spread and compacted over the waste as provided in subpart 6. The goal of minimizing infiltration into the waste fill area of a properly designed and operated facility is met by rapid vertical filling to final waste elevations in anticipation of final cover placement. If an inactive area is allowed to remain open without some form of a cover system, infiltration will be maximized rather than minimized. The Agency recognizes that fill operations require horizontal movement to proceed vertically and that in some cases an area may not be used as an active fill area for some time. The Agency believes, however, that protective measures to encourage water to run off the area and not infiltrate into the waste are warranted in these situations. Of most concern would be a significant weather change from dry to wet weather or extremely warm weather. Wet weather increases moisture in the fill area and warm weather increases the potential for fires. To minimize the effects of such weather changes, the Agency has proposed that a particular cover design be developed and implemented. Subpart 6 requires the intermediate cover be designed and constructed in a particular manner. This item requires implementation of the subpart 6 requirements.

Item E requires facility owners and operators to implement the final cover design approved under subpart 6, items C or D. The final cover must be placed on each fill phase as it reaches final permitted waste elevations. In order to minimize infiltration into the waste, it is important to seal the surface of the fill area with a low permeability barrier and encourage the run-off of water coming into contact with the barrier. The final cover design established under subpart 6 is intended to maximize the efficiency of the barrier in retarding the infiltration of water into the fill area. The design cannot accomplish this task without implementation by the facility owner or operator.

Item F requires that each fill phase be outlined with grade stakes and approved by the Commissioner in accordance with subpart 12 before any waste is placed in the fill area. Past history of land disposal has shown that poor fill operations have occurred for two main reasons - the design plans were not understood or simply ignored and operators could not tell their location with respect to boundaries. When constructing the land disposal facilities, it is critical that design plans be followed as accurately as possible to avoid operational problems such as filling outside property boundaries or destroying monitoring wells. The construction work and material needs are developed based on the design plans. If these plans are not followed, the performance goals cannot be met. To ensure the location, slope, and depth of the fill area is completed in accordance with the design plans, grade stakes are needed. Past historical problems associated with fill locations support the need to closely coordinate phase development for the site.

Item G requires that any resource recovery operations conducted at the facility be confined to designated areas approved in the facility permit. Storage areas must be kept as small as practical, must be marked with signs, and must not interfere with normal disposal operations. The main function at facilities regulated under this part is the proper land disposal of mixed municipal solid waste. Other operations conducted at the facility must take into account the disposal operations and provide proper safeguards to prevent the operations from conflicting with each other, causing hazards to human health and the environment.

The Agency believes a total solid waste management approach is the most efficient method of minimizing the risks associated with solid waste. Therefore, some land disposal facilities will incorporate resource recovery operations at the same location to save on transportation and land acquisition costs. Additionally, storage may be necessary to generate sufficient volumes of recyclable goods for cost-effective transportation to a reuse or recycling operation. This area of the land disposal facility will be open to the general public. With this in mind, it is important that these areas be clearly marked and controlled in size to prevent them from becoming mistaken for refuse drop-off.

Item H alerts facility owners and operators to the waste tire standards contained in Minn. Stat. §§ 115A.90 to 115A.914. These sections prohibit the storage of more than 10,000 waste tires or the processing of more than 500 waste tires at a land disposal facility unless a waste tire facility permit has been obtained. The Agency seeks, by including this provision in the operating standards, to alert facility owners and operators to their responsibilities under state law. This information in the rule indicates to facility owners and operators the importance of the matter.

Item I addresses items that should be included, at a minimum, in the facility inspection program. The operation and maintenance of a land disposal facility involves more than covering and compacting incoming waste and completing monitoring efforts. The various design components must be maintained in proper operating condition for the facility to perform as designed. The inspection program must establish an inspection schedule to be approved by the Commissioner for at least the following items: uncontrolled vegetative growth, erosion control on slopes and completed areas, vandalism, rodents and burrowing animals, malfunctions in the leachate and gas detection and collection systems, and settlement in completed areas.

Each of these factors has a direct impact on the ability of the facility to meet performance standards and prevent the release of pollutants to the subsurface soils and surrounding areas resulting in impacts to human health and the environment. If the concerns listed above occur, the cover will be unable to minimize infiltration into the fill area, the liner and leachate collection system will fail to remove the appropriate amount of leachate, and the integrity of the liner will be in jeopardy. Controlling unwanted vegetative growth and burrowing animals assists the facility owner or operator in maintaining the barrier layers in the cover and liner systems. If ruptures occur within these components of the facility, leachate generation will increase and the collection efficiency of the liner will be breached. The inspection of a land disposal facility for these areas of concern will not impose a significant burden on the facility owner or operator. The inspection can be conducted during normal facility operations.

In developing a risk management program for a land disposal facility, the facility owner or operator will wish to ensure the various components comprising the facility are in working order. To expend enormous amounts of capital and effort to design and construct an efficient system capable of controlling pollutants, but ignore the maintenance of these components would simply be an exercise in futility. A risk management program is only as good as the implementation and operation of the facility components. The failure to provide basic routine maintenance will result in additional risk of pollutant releases occurring and impacting human health and the environment. The proposed standard alerts facility owners and operators to the basic areas of concern when operating and maintaining disposal facilities. This provision permits facility owners and operators to review the specific needs of their facility and address them in the inspection program.

Item J requires the facility owner or operator to sample and analyze leachate generated at the land disposal facility in accordance with subparts 9 and 14. Treatment of the leachate is dependent on the characteristics of the leachate, regarding pollutant concentrations and biological strength. The original determination of treatment options is based on typical leachate values developed from existing facility testing programs. However, every leachate is different, since the characteristics are dependent on the waste placed in the fill area and the amount of water percolating through the waste. Thus, it is important that, as leachate is generated, it is sampled and analyzed to determine if adjustments to the treatment system are necessary to achieve the proper quality in the discharge water. After closure, leachate treatment is required through the postclosure care period. Only through routine sampling and analysis can an adequate data base be established to show that a consistently improved leachate is being generated during the postclosure care period and that treatment ultimately is no longer necessary or that a less costly option may be used.

Leachate, along with the gas generated from decomposition in the fill area, represents the greatest risk to human health and the environment from the operation of a land disposal facility. It contains high concentrations of biodegradable compounds and toxic metals dissolved from the waste as water filters through the waste. The percolating water also picks up considerable amounts of dissolved and settleable solids as it filters through the waste. The proper treatment of this material is as important as any design component in the facility owner's or operator's risk management program. This provision establishes a process under which information regarding a particular facility's leachate will be collected in a systematic process. The inclusion of this provision also provides consistency in monitoring leachate at all facilities.

Item K requires the leachate collection system to be cleaned annually. Leachate contains high amounts of settleable solids. This means that soil particles and other small solid particles will settle out of leachate if allowed to stand. For treatment purposes, this is a desirable characteristic. Treatment is more efficient on the liquid portion of the leachate. However, if settlement occurs within the collection system, clogging of the system may impair overall facility performance. Most land disposal facilities are designed with gravity leachate collection systems. In order to get liquids to flow in a pipe, slopes as flat as 0.5 percent are sufficient. Pipe designs for wastewater transport dictate that at least a 2 foot per second velocity be attained in pipes to obtain self-cleaning velocities in all pipes. This would require slopes greater than 0.5 percent. Wastewater collection is compared with leachate collection because both liquids have a high solids content. Cleaning velocities are not usually attained in leachate collection systems due to the depth of the system, the short distance under which the velocity must be attained, and the inability to adequately determine the leachate flow through the collection system until construction is completed and waste is in place.

The Agency believes a reasonable approach to preventing the clogging of leachate collection systems is routine cleaning of the system rather than designing the systems to attain self-cleansing velocities. Almost every municipality has at its disposal pipe cleaning equipment to handle sanitary sewer cleaning. The Agency believes that local agreements can be developed to make this equipment available to land disposal facility owners and operators on an annual basis. This requirement provides a cost-effective mechanism for the facility owner or operator to maintain the leachate collection system in good operating conditions. The operation of the collection system is a critical component to the performance of the facility. Normal operating activities include proper maintenance of the system such as cleaning of it.

Annual cleaning is reasonable because during the early years of filling when leachate generation is low the velocity in the pipe is much slower and allows for settling to occur. As leachate generation increases with time the concentration of solids also increases resulting in more total solids settling out. By completing maintenance activities on an annual basis, the facility owner or operator will be able to diagnose potential problems before they happen or before they result in large impacts on human health or the environment. Requiring annual maintenance establishes cleaning activities on a regular basis rather than waiting until a problem arises, which was the only other alternative suggested by commentors on the rules. No regular schedule of maintenance could be agreed upon other than an annual cleaning and waiting until the system has failed. It is cost effective in a risk management program to take the proper steps to prevent problems rather than repairing the situation at a later date.

Item L requires the facility owner or operator to monitor and record the amount of leachate collected. This information is used in evaluating treatment needs and evaluating the performance of the facility. If leachate volumes are running at a consistent level and a sudden increase or decrease occurs, the facility owner or operator should investigate potential causes such as a collapse in the collection system, differential settlement, or a rupture in the storage system. Monitoring of leachate levels in storage tanks and amounts removed for treatment are the only reasonable methods available to facility owners and operators for checking on the design values that project leachate collection, storage, and treatment needs. If leachate generation occurs at a slower rate or at a volume less than anticipated, the extra capacity in the system should not present any concerns and, in fact, will lower the costs associated with managing the leachate. Receiving large quantities at an earlier rate than anticipated may create the need for modifications to the facility design and new construction to provide extra treatment and storage capabilities. The sooner these modifications can be incorporated into the facility design, the less disruption in total facility operations should be experienced.

Item M requires facility owners and operators to implement corrective actions to repair any conditions not in compliance. Part 7035.2615 requires all facility owners and operators to develop a contingency action plan. This plan contains an analysis of the events that might occur at a facility and methods for correcting the situations. The plan is further used to develop cost estimates for financial assurance instruments and time frames for completing the corrective actions. The proposed provision indicates when implementation of the contingency action plan is required and recognizes that corrective actions are standard operating procedures.

Corrective actions include items not considered routine repair needed to operate and maintain the facility in a manner that will meet performance standards. These items may include repairing berms disrupted by heavy precipitation, unwanted vegetative growth or animal intrusion, repairing the facility after a fire in the fill area, or a sudden collapse of the collection system. Because the continued existence of problem situations can severely impact the quality of the environment around a facility or human health, facility owners and operators must implement corrective actions as they are detected in order to minimize the problem and prevent the condition from worsening.

Item N requires disposal of dead animals at land disposal facilities in accordance with Minn. Stat. ch. 35. Chapter 35 addresses livestock sanitation.

The Agency believes it is a reasonable approach to notify facility owners and operators that a statute like chapter 35 can have a direct impact on facility operations. Chapter 35 requires that carcasses be immediately covered when brought to a facility. Regulation under chapter 35 should remain with the appropriate regulatory agency, Minnesota Department of Agriculture.

Item O provides for the deposition of demolition debris and construction waste in an area separate from the mixed municipal solid waste. Demolition debris and construction waste often contains large, bulky wastes that are relatively inert. The potential environmental problems associated with demolition debris and construction waste are considered to be minimal because this waste generally contains concrete debris, ferrous wastes, untreated wood products and other relatively inert wastes. The facility owner or operator developing a mixed municipal solid waste land disposal facility expends considerable time, effort and money in designing and constructing a liner and leachate collection system capable of controlling the flow of leachate out of the fill area. Demolition debris and construction waste present a hazard to the integrity of this system by placing unexpected loads on collection systems and puncturing the liner system. Therefore, the facility owner or operator must utilize another area on the facility site for disposal of demolition debris and construction waste or utilize controlled operational practices that will protect the integrity of the liner and leachate collection system.

Item P requires the facility owner or operator to sample and analyze ground water in accordance with subparts 10 and 14. This item states the Agency position that ground water sampling and analysis is a component of normal facility operations and that the facility owner or operator must address it as such in the facility operations program.

Item Q requires facility owners and operators to conduct gas monitoring in accordance with subpart 11. Routine monitoring for gas needs to be conducted for safety as well as environmental considerations. A pocket of gas may build up in a confined area between daily operations and present a fire and explosive hazard as facility personnel perform daily functions. The Agency believes that gas monitoring must be conducted as a part of daily operations to prevent a fire and explosion hazard.

Item R requires facility owners and operators to develop procedures for operations during wet weather conditions, particularly to protect liners, covers, and other design features that might be disrupted by additional loads in a saturated condition. Extra precipitation can result in operating problems at a land disposal facility such as correcting incidents of severe erosion, inability to operate in a specific fill area due to surface water ponding, or inability to adequately control surface water drainage. Protection of critical design features such as liners and covers must be incorporated into the design and operation of the facility or the repair efforts could match original construction efforts in both time and money. If a liner is not adequately protected from operations during wet weather, the movement of equipment in loading or unloading waste or compacting the waste can result in sliding of the liner materials disrupting its ability to retard leachate movement. Facility owners and operators must address the operation of facility components under periods of stress in order to develop appropriate tools to maintain the facility's integrity.

Item S requires the fill area to be surveyed each year by November 1 by a land surveyor registered in Minnesota. An updated conditions plan must be submitted with the annual report. The plan must show the elevations of completed fill areas, areas partially filled, and all design features that changed in elevation due to facility operations or settlement. The remaining fill capacity must be calculated and shown on the plan. Operations at land disposal facilities have, in the past, been sporadic fill operations. No consistent documentation was obtained on the depth or area filled. Thus, in some cases, the fill areas encroached on property lines and hodgepodge operations made it impossible for facility operators to control litter or properly cover the fill. The performance standards proposed under these rules make it imperative that the depth, area and exact location of facility components be known. The gradual settlement of closed areas can be imperceptible to the human eye, particularly if it had only a three or four percent slope initially. Surveying the site is the best method to determine how much settlement has occurred. As the fill area is used, additional space must be opened. The new area must be lined and installed with a leachate collection system. These construction activities must be fastened to the existing liner and leachate collection system. In order to achieve the right depth of trenching and liner placement, surveying is used to sight the vertical depth. Surveying to determine the annual progression of the fill operations allows for proper timing of construction needs, whether for liners or covers.

This item proposes that survey work be completed by November 1 of each year. There are two basic reasons why survey work should be completed by November. The most important reason is the need to complete survey work before snow cover interferes with determining the base points or finding particular design components. The second reason for completing survey work by November is the incorporation of this information in the annual report submitted in January of the following year. Completing the survey work by November enables the facility owner or operator to draw the updated existing conditions plan and make one submittal of the year's activities in January rather than scattered reports being submitted and reviewed by the Agency before the next construction season begins. By completing the review during the winter months, the Agency will be able to notify the facility owner or operator of activities that are needed at the facility and proper procedures can be set into action to prepare for spring construction.

The existing conditions plan drawn from the survey work must show all design components that have changed in elevation during the year. These items would include monitoring points, completed fill areas and partially completed areas. The information regarding the elevation of these components is needed to evaluate facility performance. For instance, if the elevation of the monitoring well casing changes due to frost heaving or settlement and this casing is used to determine the depth to the water table, the direction of ground water flow may be falsely interpreted. If flattened slopes are not promptly detected, surface water drainage may be impaired and precipitation may pond on the surface increasing infiltration and ultimately leachate generation. Annual survey activities will turn up these changes and will provide information on adjusting site activities to correct the situations or alter interpretations of incoming data. Yearly updated existing conditions plans allow the facility owner or operator and the Agency to evaluate facility activities during each year and make minor adjustments as needed.

The Waste Management Act requires the issuance of a certificate of need for mixed municipal solid waste land disposal capacity. A certificate of need is issued for the volume of mixed municipal solid waste to be disposed of in a ten-year period. The permit issued for land disposal facilities reflects this capacity. Therefore, it is necessary to have accurate records of the volume of waste received and the disposal capacity used at the facility to evaluate the effectiveness of waste reduction and recycling activities as well as other management alternatives to land disposal.

In the past, facility operators have not maintained accurate records of either incoming waste or the fill depth. This has impaired the Agency's ability to adequately enforce permitted capacities and the owner's or operator's ability to adequately plan for necessary construction activities. The Agency and the owner and operator need to understand the rate at which capacity is used to properly manage facility activities and to coordinate design and construction activities. Under this item, the facility owner or operator is required to submit calculations determining the remaining fill capacity each year. Surveying is the most accurate method for determining capacity because it takes into consideration actual compaction achieved and soils used rather than estimating a compaction rate and incoming wastes to determine fill capacity used each year. The updated conditions plan must also show where the remaining fill capacity exists on the site. Survey information is needed to ensure that fill operations remain in permitted boundaries and don't encroach on property or compliance boundaries and other design features. Obtaining this information annually provides an indication on the facility owner's or operator's compliance with permit conditions and allows for early planning activities to be initiated if fill capacity is used at a rate higher than expected.

Item T requires that all trenches or area fills be staked with permanent markers. By staking fill boundaries, the opportunity for irregular fill operations will be minimized. After closure it will be much easier to establish inspection locations and possible areas for activities that would not disrupt the closed areas. The facility owner or operator would, under normal construction and operation activities, determine the limits for fill areas in order to manage risk, control construction costs, and establish proper site operations. This item places no additional burden on the facility owner or operator, yet provides useful information after closure and controls filling during site operations.

Item U requires that at least six feet of solid waste cover all lined areas by December 31 of each year. No disposal will be permitted on areas left uncovered after December 31 unless the liner integrity has been tested and approval granted by the Commissioner. The liner system at a land disposal facility is the single most important item in controlling leachate movement from the fill area. Maintaining the integrity of the liner minimizes the risk associated with land disposal facility operations.

Liners are highly susceptible to weather conditions such as heat, rain or freezing conditions. Insulation is a proven method to protect liner integrity. In order to reduce costs, solid waste has been used as the insulating material. The frost line in Minnesota is generally considered to be 4 to 6 feet below the surface, depending on snow cover and location. A minimum 6-foot insulating layer is used as a standard to provide an adequate safety level under normal operating conditions. If the fill area is constructed late in the year and incoming waste is not sufficient to obtain the proper insulating depth, the freeze-thaw cycle in winter and spring could cause shifting in the liner, creating cracks in the liner increasing its permeability, or breaking collection liners. In some cases the cracks may be imperceptible to the human eye and only testing will indicate the problem exists. Requiring an insulating blanket over the liner by December 31 ensures coverage before the coldest winter months and provides the facility owner or operator a date for which accountability for facility operations will occur.

Again, by establishing reporting and specific facility actions to occur within the same calendar year, the Agency reduces the number of reports required and provides a systematic approach for evaluating the next year's activities. Six feet provides protection against frost action and permits the facility owner or operator to use incoming waste reducing costs associated with this activity.

Item V requires the facility owner or operator to record and maintain in the operating record all expenditures related to closure, postclosure care and contingency action. This information is useful to the Agency and facility owner or operator in numerous ways. First, by comparing actual costs to the estimated costs contained in the appropriate plans, the Agency and the facility owner or operator will be able to evaluate the funds required for financial assurances. Rate adjustments in the financial assurance payments can be made after the annual update, when these adjustments should be small, rather than after a shortfall has occurred and major rate increases must be made. Planning and monitoring facility activities are necessary to ensure facility performance and keep costs as low as possible. Under the financial assurance provisions of the proposed rules, facility owners and operators may request reimbursement from the appropriate fund after work has been completed and approved. The facility owner or operator will need an accounting of all construction activities to ensure the proper reimbursement is received.

Additionally, understanding total facility costs, of which financial assurance needs are only a part, allows the facility owner or operator to establish rates on incoming wastes. This information also allows the Agency to better understand the true cost of land disposal and provide more accurate information to perspective permittees and legislative bodies for decisionmaking activities. The recording of these costs is a normal operating procedure and places no additional work on the facility owner or operator. The information obtained from these records enables effective evaluation of financial assurance mechanisms. This provision ensures actual costs are adequately considered in reviewing land disposal operations particularly in evaluating financial assurance compliance.

Item W requires the sequence and direction of below-grade operations to be conducted to prevent surface water from entering the fill area. The filling sequence in an area can dictate the movement of surface water off the liner. By filling from the high end of the fill area to the low end, the facility owner or operator allows surface water to drain away from fill operations and minimizes the potential for ponding water to interfere with daily operations or for extra liquids to be collected and treated. Because the performance goals are to minimize the leachate generated, minimizing the intrusion of excess water into the system will decrease the potential for disrupting operations and overloading the leachate control system.

Subpart 14. Sampling and analysis. Subpart 14 establishes sampling and analysis requirements for ground water, surface water, and leachate at mixed municipal solid waste land disposal facilities. The aim of water sampling is to determine whether a facility's protective measures minimize impacts on water quality. Sampling provides the most direct means to evaluate a facility's compliance with the ground water and surface water performance standards. Together with the leachate detection monitoring required in subpart 9, item A, the subpart 14 monitoring provides direct evidence of the adequacy of the siting and design precautions. The key role of monitoring and the high cost and risk that erroneous results cause are reflected in subpart 14's detailed provisions to assure the accuracy and reliability of the monitoring data.

The relationship of this subpart to other subparts is discussed below. Subpart 3, item I, identifies water quality monitoring as the fourth phase of the hydrogeologic evaluation required of all mixed municipal solid waste land disposal facilities. It requires a work plan and report. Subpart 4 establishes the ground water performance standards that sampling results are compared against. Ground water quality must meet these standards. Subpart 10 establishes requirements for water monitoring systems and individual monitoring points.

Item A, requires facility owners or operators to monitor ground water quality in all cases, and surface water quality and leachate quality as required in permits, orders, and stipulation agreements. The need for and reasonableness of ground water monitoring at land disposal facilities has been discussed regarding subpart 10, item A. Because land disposal facilities have shown ground water quality impacts regardless of size, any requests for exemptions to the requirement for ground water monitoring should be considered only through the variance procedures, subjecting them to the increased scrutiny that process entails.

Surface water quality monitoring is not needed at all facilities. In some cases, facilities are located miles from the nearest surface water and surface water impacts are not an issue. Surface water quality should be sampled when there is a direct discharge or run-off from a facility to the surface water, or when the surface water is near a facility and the impact on surface water quality cannot be determined through ground water quality sampling. Direct discharges are subject to the requirement for a National Pollutant Discharge Elimination System permit under Minn. Rules pts. 7001.1000 to 7001.1100 (1987), administered by the Agency's Water Quality Division. The potential for surface water impacts from polluted ground water must be judged individually. This potential will depend on the extent and severity of the ground water impacts, the percentage of the plume that discharges into the surface water, the rate of discharge, and the flow rate and mixing characteristics of the surface water. Even when the potential for surface water impacts is confirmed, surface water monitoring may not be needed until ground water impacts have reached a defined level of severity. At sites where this approach poses unacceptable risks, surface water monitoring may be required along with ground water monitoring. Examples include sites where ground water moves rapidly, eliminating the advance warning provided by ground water monitoring, and sites where ground water monitoring is unreliable due to fractures or variable soils.

Leachate monitoring is needed for the reasons given in the discussion of subpart 9, item A. Few specific leachate monitoring requirements are given in either subparts 9 or 14. It is necessary and reasonable to develop the monitoring requirements on a facility-by-facility basis because leachate monitoring is directly related to the characteristics of the waste generating the leachate.

Finally, item A requires that the monitoring comply with other portions of Minn. Rules ch. 7035 and pts. 7050.0150 and 7060.0800, and the Agency-issued permit. Part 7060.0800 is in a chapter titled "Underground Waters." This rule states in part that "samples shall be collected in such manner and place and of such type, number, and frequency as may be considered satisfactory by the agency from the viewpoint of adequately reflecting the condition of the underground water and the effects of the pollutants upon the specified water uses." Part 7050.0150 falls within a chapter titled "Standards for the Protection of the Quality and Purity of the Waters of the State." This part contains similar language. The Agency requires facility owners and operators to comply with standards in those rules because the standards apply to all monitoring of pollutants regardless of the source. It is unnecessary to repeat the standards in these rules.

Items B to E specify the location and frequency of monitoring, the constituents to be tested, and other measurements that may be required. Item B requires monitoring conditions to be established on a facility-specific basis. However, at current staffing levels, it will take time for the Agency to establish individualized requirements for all facilities. Until individual requirements are established, monitoring is still needed. Item C contains monitoring requirements that apply until a facility is given specific requirements in its permit or other enforcement document.

Variable factors such as leachate composition, facility size and layout, and ground water flow rates have a bearing on the number, frequency, parameters and locations of monitoring. This will be discussed further under subitems (1) and (2) below. A facility owner or operator is required to supply information needed to determine which requirements should apply. The Commissioner must consider at least the factors given in subitems (1) and (2) in setting the monitoring requirements.

Under subitem (1), the Commissioner must consider several factors concerning the degree of impact a facility is having on water quality. These include the evidence of pollution in the sampling record, the extent and severity of any pollution, the facility's compliance with water quality standards, and the evaluation of sampling needs required under subpart 4 when an intervention limit is exceeded. The presence of pollutants in ground water often indicates the need for increased monitoring. The extent and severity of any pollution and the facility's compliance with water quality standards control the number and location of samples. This monitoring information may indicate the need to collect samples at the compliance boundary in addition to the detection monitoring points and on a more frequent basis than required in Item C or the Agency-issued permit. The evaluation of sampling needs required under subpart 4 when an intervention limit is exceeded ensures that the sampling program addresses elevated pollutant concentrations. The evaluation may simply indicate that immediate sampling is appropriate to determine the reliability of original sample results.

Under subitem (2), the Commissioner must consider specific facility and site conditions when establishing sampling requirements. Facility conditions that must be considered include the location, design and operation. An existing facility with no liner to collect leachate may require more frequent monitoring than new facilities with liners and leachate collection systems. Less frequent monitoring may be required at a new facility because leachate is contained and treated and little waste is in the fill area, minimizing the potential for pollutant migration. A facility located near residences will require more careful monitoring for impacts because of the immediate risk to nearby water users if pollutant releases occur.

The Commissioner must also consider the composition of the leachate and the waste stream when establishing the monitoring program. If the facility is used to dispose of industrial solid waste and mixed municipal solid waste, the monitoring parameters should reflect the potential pollutants from these streams. If the monitoring parameters are not representative of the waste or leachate, compliance determinations can not be made.

Specific hydrogeologic conditions and surrounding water use are important considerations for monitoring requirements. Ground water flow directions and rates and aquifer thickness, depth, and degree of natural protection are necessary considerations in determining monitoring frequency. In general, rapid ground water flow must be monitored more frequently than very slow flow. These same factors may have a bearing on the analytical requirements. For example, it may not be necessary to test for dissolved metals in deeper ground water that is overlain by soils with a high capacity to attenuate metals. High attenuation capacity is usually associated with low-permeability soils. Seasonal variations in water quality may be large enough to warrant timing the samplings to coincide with these changes. Surface water flow conditions may vary more than ground water flow conditions. For surface water, it is often important to sample during the periods of lowest flow, when contamination is least subject to mixing and dilution. The presence of sensitive aquatic communities in surface waters also affects the selection of sampling frequencies and test parameters. These nearby resources may justify more frequent sampling or additional analyses.

Item C contains interim monitoring conditions that apply until facility-specific monitoring requirements are established under item B. It will take time to establish the monitoring requirements under item B tailored to conditions unique to each site. At some facilities, the hydrogeologic information needed has not been generated. Once hydrogeologic information is obtained, it will take time to review the information and to develop the monitoring requirements. In the meantime, it is necessary and reasonable to require continued use of existing monitoring systems. For the facilities where site-specific monitoring conditions cannot yet be assigned, interim monitoring conditions are a reasonable method to protect water quality and public health.

The requirements under item C have been developed to apply under the most common conditions. The requirements are based on years of experience with water quality monitoring in Minnesota. For this reason, they may serve as a starting point for developing site-specific requirements under item B.

Item C requires sampling at least three times per year, or as specified in the Agency-issued permit or enforcement document. This requirement is a reduction in frequency from the quarterly sampling required until the early 1980's. The quarterly sampling requirement was based on two main considerations. First, ground water flow rates at most facilities are in the range of hundreds of feet per year. At these rates, sampling less frequently than quarterly could allow a contaminant plume to migrate past the monitoring system before it is detected. For instance, if the ground water flow rate is 600 feet per year and the detection monitoring is located along the waste boundary, a pollutant could move 150 feet past the monitoring point before the next quarterly sample is taken. Secondly, natural water quality varies over time. Water quality interpretations must be based on an analysis of trends in the monitoring data. In order to discern trends within variable data, a greater number of measurements is needed than an annual or semiannual sampling frequency can provide. The largest and most important water quality fluctuations normally occur over an annual/seasonal cycle. Quarterly sampling spaces the measurements over the seasonal cycle, providing some idea of the seasonal variability in natural water quality.

Despite these considerations, the Agency dropped the requirement for winter sampling for most facilities due to limited access to well sites and sampling difficulties under subfreezing conditions. This reduction in sampling frequency to three times per year is reasonable for interim monitoring requirements. Once ground water flow rates and other conditions can be estimated for a given facility, this information may indicate a need to reinstate winter sampling or monitor on a more frequent basis as provided for under item B.

The requirement that sampling times be specified in the Agency-issued permit assures that sampling is scheduled to cover seasonal variations. This approach allows the flexibility needed to adjust for differences within the State. For example, winters are longer in northern Minnesota, so the Agency allows spring sampling to take place later and fall sampling earlier.

Item C also requires specific analyses for ground water sampling. This specificity is not possible for surface waters due to the greater variation in surface water quality and the variety of water uses that surface water monitoring must be targeted to protect.

In pollutant sampling, a balance must be reached between a complete accounting of all possible pollutants and cost efficiency. As discussed under subpart 4, item F, more chemicals might find their way into facilities than can be tested. A testing strategy must narrow and target the analyses. By targeting the analyses, sufficient data is gathered to determine in a cost-efficient way if a land disposal facility is impacting water quality. For many years a common approach to this problem has been to test for a limited number of indicator substances that usually indicate a polluted condition. These tests are periodically supplemented with more complete analyses. Supplementary analyses characterize the chemical composition of water more completely and they include more substances that may threaten public health or the water resource.

This is the approach taken in item C. Three times per year the analyses, measurements, and observations under subitem (2) are required; for one of those three sampling events the tests under subitem (1) are added. The once-a-year analysis is more complete, focusing on overall major ion chemistry, toxic inorganic chemicals, and the traditional inorganic indicators, in addition to the more frequently tested organic indicators.

Item C allows reasonable variations from these lists for existing monitoring points that may be unsuitable for sampling some or all of the listed substances. As discussed under subpart 10, items H and I, some well screen and casing materials have the potential to affect pollutant concentrations.

Subitem (1), the analyses required once per year, requires analysis of 17 specific pollutants, four general parameters (alkalinity, total dissolved solids, Eh or oxidation potential, and total suspended solids), and one quality control calculation (cation-anion balance). This list has changed since 1981 to fulfill many objectives. The reasonableness of each is given below, and is summarized in Table 7a. Table 7a shows that each of the tests required once per year under subitem (1) has been selected for one or more reasons.

The listed substances are mobile and persistent in the subsurface under some or all conditions. They are also amenable to analysis by various methods and occur at elevated levels in mixed municipal solid waste land disposal facility leachate (see Table 7b). The analyses listed in subitem (1) are reasonable because they enable interpretations about water chemistry, pollutant mobility, and data reliability. The requirement to report dissolved metals rather than total metals is reasonable because such analyses better represent actual ground water quality, than metals adsorbed onto suspended sediment in the water sample. If sediment is present, it must be filtered to yield a value representative of the dissolved concentration, as discussed further under items H and K.

TABLE 7a: Principal Reasons for Including Constituents in Annual Ground Water Monitoring Requirements

	Toxicity to Public Health, Environment[1]	Aesthetic/ Public Welfare Impacts[2]	Leachate Indicator[3]	Importance Re: Overall Water Chemistry[4]	Quality Assurance Applications[5]
(a) Alkalinity			X	X	
(b) Ammonia Nitrogen		X	X	X	
(c) Arsenic	X				
(d) Cadmium	X				
(e) Calcium			X	X	
(f) Chloride		X	X	X	
(g) Chromium	X				
(h) Copper	A	X			
(i) Dissolved solids, total		X	X	X	X
(j) Eh (oxidation potential)			X	X	X
(k) Iron		X	X	X	
(l) Lead	X				
(m) Magnesium			X	X	
(n) Manganese		X	X		
(o) Mercury	X				
(p) Nitrate + Nitrite	X			X	
(q) Potassium			X	X	
(r) Sodium	X	X		X	
(s) Sulfate		X	X	X	
(t) Suspended solids, total					X
(u) Zinc	A	X	X		
(v) Cation-anion balance				X	X

A = aquatic toxicity

1. Toxicity: The listed leachate constituent is toxic to humans or aquatic life.
2. Aesthetic/public welfare: The constituent can adversely affect taste, odor, or useability.
3. Indicator of leachate: Elevated levels of these parameters indicate pollution by leachate.
4. Overall water chemistry: These parameters are important components of the water's overall chemical behavior. Major ions, total ion strength (related to concentration), and oxidation state affect the distribution and mobility of toxics and aesthetic parameters.
5. Quality control: These give some measure of the reliability of the sample or the analysis.

TABLE 7b: Reported Concentration Ranges in Mixed Municipal Solid Waste Land Disposal Facility Leachates and Drinking Water Standards

	Concentration Units	Minnesota Leachate	Illinois Leachate	Wisconsin Leachate	Minn. Dept of Health Recommended Allowable Limit	Primary Drinking Water Standard (or MCLG*)	Secondary Drinking Water Standard
(a) Alkalinity	mg/l	-	0 - 13,500	0 - 15,050	-	-	-
(b) Ammonia	mg/l as N	0.15 - 410	1.8 - 1,250	0 - 1,200	-	-	-
(c) Arsenic	ug/l	5.4 - 26	0 - 40,000	0 - 70,200	50	50	-
(d) Cadmium	ug/l	0.52 - 30	0 - 1,160	0 - 400	5	10 (5)	-
(e) Calcium	mg/l	-	23 - 3,050	200 - 2,500	-	-	-
(f) Chloride	mg/l	99 - 1,000	31 - 4,350	2 - 11,375	-	-	250
(g) Chromium	ug/l	8.3 - 110	0 - 22,500	0 - 5,600	120	50 (120)	-
(h) Copper	ug/l	26 - 160	0 - 1,100,000	0 - 4,060	-	-	1
(i) Dissolved solids	mg/l	-	990 - 594,000	-	-	-	500
(j) Eh	--	-	-	-	-	-	-
(k) Iron	mg/l	5.1 - 1,300	0.9 - 42,000	0 - 5,500	-	-	0.3
(l) Lead	ug/l	5.8 - 370	0 - 6,600	0 - 12,600	20	50 (20)	-
(m) Magnesium	mg/l	-	12 - 1,102	120 - 780	-	-	-
(n) Manganese	ug/l	2,500 - 93,000	0 - 678,000	0 - 31,000	-	-	50
(o) Mercury	ug/l	-	0 - 30	0 - 10	3	2 (3)	-
(p) Nitrate + Nitrite	mg/l as N	< 0 . 04	0 - 1.8	0 - 250	10-Nitrate 1-Nitrite	10-Nitrate 1-Nitrite	- -
(q) Potassium	mg/l	-	2 - 1,920	20 - 2,800	-	-	-
(r) Sodium	mg/l	-	15 - 8,000	12 - 6,010	-	-	-
(s) Sulfate	mg/l	17 - 350	0 - 84,000	0 - 1,850	-	-	250
(t) Suspended solids	mg/l	-	21 - 3,670	2 - 140,900	-	-	-
(u) Zinc	mg/l	0.04 - 34	0 - 250	0 - 731	-	-	5

* Maximum Contaminant Level Goals

The following discussion presents the reasonableness of individual analyses in subitem (1). Much of the discussion derives from reports generated by the states of Wisconsin and Illinois, the Minnesota Department of Health, and the U.S. Environmental Protection Agency. See Exhibit XXXVI and References 94, 96, 97, 98, 99, 100 and 128. Drinking water standards cited, unless otherwise stated, are from primary standards, i.e., Maximum Contaminant Levels; final or proposed Maximum Contaminant Level Goals; and secondary standards, i.e., Secondary Maximum Contaminant Levels. See Exhibits XXIII and XXXIX and Reference 64. Concentrations are given in micrograms per liter (ug/l) and milligrams per liter (mg/l).

Before discussing the individual analyses required in subitem (1), it is appropriate to define three of the commonly used terms to describe the drinking water standards applicable to individual parameters. These terms are from the National Primary Drinking Water Regulations and the National Secondary Drinking Water Regulations, which regulate the quality of the drinking water supplied by public water systems. The Maximum Contaminant Level Goals are non-enforceable health goals set at levels that would result in no known or anticipated adverse health effects with an adequate margin of safety. Maximum Contaminant Levels, also known as primary drinking water standards, are the enforceable standards and are set as close to the Maximum Contaminant Level Goals as feasible. Maximum Contaminant Levels are based upon treatment technologies, costs (affordability) and other feasibility factors. The Secondary Maximum Contaminant Levels, commonly called secondary drinking water standards, are federally non-enforceable goals established to protect consumers from undesirable aesthetic properties, such as tastes and odors. Pollutants with concentrations above the secondary standard can negatively impact such qualities as taste and odor to the point where people stop using the water.

Unit (a) requires the monitoring of ground water for alkalinity. Alkalinity is a measure of the capacity to neutralize acids. In leachate this capacity is due to bicarbonate, carbonate, hydroxide, and organic acids, which result from carbon dioxide generation during decomposition of organic wastes. Alkalinity is a major control on water pH and buffering capacity, which affects the mobility of metals. Alkalinity is elevated in leachate, and is used as a tracer or indicator of leachate contamination. It is readily determined by a simple acid titration test.

Unit (b) requires ground water monitoring tests for ammonia nitrogen. Organically-bound nitrogen is a major component of decaying organic matter. Under the reducing (anaerobic) conditions in a mixed municipal solid waste land disposal facility, the organic nitrogen is converted by bacteria to ammonia. Ammonia can indicate pollution and reducing conditions, which in turn affect the mobility, toxicity, and aesthetic properties of metals, sulfur-containing compounds, and other pollutants.

Unit (c) requires testing for arsenic. Arsenic is a trace inorganic substance that has been used in pesticides, pharmaceuticals, paints, and industrial applications. It is a strong poison, which has sometimes been found in leachates at concentrations greatly exceeding the primary drinking water standard of 50 ug/l.

Unit (d) lists cadmium as a parameter to be included in the monitoring program. Cadmium is a heavy metal used in a variety of products and applications, including elecroplating, paint, pigment, plastics, and batteries. Cadmium concentrations in leachate commonly exceed the primary drinking water standard of 10 ug/l and sometimes greatly exceed it. Moreover, the proposed federal Maximum Contaminant Level Goal for public drinking water supplies is 5 ug/l. See Exhibit XXIII. Cadmium is toxic to aquatic life at concentrations of 1 to 2 ug/l or less. See Exhibit XXXX.

Calcium, unit (e), is also a required monitoring parameter. Calcium is one of the most abundant naturally occurring constituents of Minnesota ground water, and is an abundant constituent of organic wastes. When dissolved in water, it forms a positively charged ion or cation. It is listed as a monitoring parameter because the major ion it forms is a major constituent of ground water and is important in the cation-anion balance quality assurance test. Secondly, calcium has an important role in controlling the aquatic toxicity of many metals. Many metals, such as cadmium, are less toxic at higher levels of water hardness (calcium plus magnesium). See Exhibit XXXX. Elevated hardness is also common in leachate and has some value as an indicator of leachate pollution.

Unit (f) requires chloride to be included in the monitoring program. Chloride is another highly mobile, naturally-occurring major ion, a negatively charged anion. Chloride's numerous uses contribute to its abundance in mixed municipal solid waste. It is commonly used as an indicator of leachate pollution when natural chloride concentrations are low. It is also needed for the cation-anion balance, and it has a secondary drinking water standard of 250 mg/l. This limit is often exceeded in leachate-polluted ground water.

Unit (g) lists chromium as a monitoring parameter. Chromium is widely used in chrome plating, rust inhibitors, paints and pigments, and many other industrial applications. It is another of the metals that can be toxic at low concentrations in water. Chromium in leachate commonly greatly exceeds the primary drinking water standard of 50 ug/l.

Unit (h) requires the ground water monitoring program to test for copper. Copper is widely used in plating, wire, pipe, paints, insecticides, and many other applications, and sometimes occurs in mixed municipal solid waste land disposal facility leachates at concentrations greater than the 1 mg/l secondary drinking water standard. Copper is more soluble under low pH conditions, which are common in leachate-impacted ground water. Copper is toxic to aquatic life at concentrations lower than 10 ug/l. See Exhibit XXXX.

Total dissolved solids (TDS) are listed in unit (i) as a ground water monitoring parameter. TDS is the total amount of solid material left as a residue when water, other liquids, and volatiles are evaporated. Total dissolved solids can be extremely high in leachate, and can contrast sharply with background concentrations. The secondary drinking water standard of 500 mg/L is routinely exceeded in ground water that is impacted by a land disposal facility. Thus, TDS can serve as an indicator of such impacts if background concentrations are low. It is an important factor in overall water chemistry and an influence on the activity or chemical availability of individual dissolved constituents. When compared against the additive total of all the individual constituent concentrations, TDS also serves as an additional check on analytical quality assurance.

Unit (j) lists the oxidation potential (Eh) of ground water as a monitoring parameter. Oxidation potential is a major control along with pH on the solubility and chemical form of many inorganics, including many metals. See Exhibit XXXXI and Reference 101. Leachate impacts often shift water quality toward reducing conditions. As a result, properties of many constituents, such as solubility, mobility, toxicity, and aesthetic character, can also change. Metals, such as iron, can shift from immobile to highly mobile in the ground water. Some compounds convert to more toxic or objectionable forms, e.g., conversion of sulfate to hydrogen sulfide. Eh is used by the Illinois Water Survey (IWS) as a routine stabilization test parameter for purging wells before sampling (Reference 102), and has been recommended for that purpose by IWS and EPA (References 88, 90 and 92). For annual testing, Eh is an important indicator of overall chemical behavior of ground water, a possible indicator of leachate impacts, and a quality assurance check. Repeating the Eh measurements in the field, then in the laboratory, indicates whether the sample's oxidation state has changed. An Eh shift can cause dissolved materials to precipitate out as insoluble species, resulting in unrepresentative monitoring results unless these precipitates are also analyzed.

Unit (k) lists iron as a monitoring parameter. Iron is most soluble in water under anaerobic, low-pH conditions, so it is not surprising that it can be extremely abundant in leachate and leachate-impacted ground water. It commonly exceeds the secondary drinking water standard of 0.3 mg/L, and serves as another indicator of facility impacts. Iron chemistry can greatly affect the measured concentrations of other metals. For example, if anaerobic water samples are allowed to become aerobic, iron precipitation can remove toxic metals from solution through coprecipitation (Reference 103).

Lead, unit (l), is a common heavy metal of high toxicity. Its primary drinking water standard is 50 ug/l and proposed Maximum Contaminant Level Goal is 20 ug/l. Lead has many common uses, and its solubility increases in acidic leachate. Lead concentrations in leachate commonly exceed drinking water standards and natural ground water concentrations.

Magnesium, unit (m), is another common cation. The rationale for including it among the annual monitoring constituents is the same as for calcium.

Manganese, unit (n), is used in alloys, paints and dry cell batteries. It has a secondary drinking water standard of 50 ug/l. Manganese commonly occurs at much higher concentrations in leachate and can serve as an indicator of land disposal facility impacts.

Unit (o) lists mercury as a monitoring parameter. Mercury is a heavy metal that is extremely toxic. Its primary drinking water standard of 2 ug/l and proposed Maximum Contaminant Level Goal of 3 ug/l are the lowest of any inorganic substance. Mercury has a tendency to accumulate in animal tissue and can adversely affect aquatic organisms and humans consuming fish at concentrations as low as 0.012 ug/l. <u>See</u> Exhibit XXXX. Leachate concentrations of mercury are sometimes elevated above the drinking water standard.

Unit (p) requires nitrate plus nitrite to be tested. Nitrate and nitrite are the oxidized forms of nitrogen. They can be toxic especially when consumed by infants. Nitrate concentrations in leachate sometimes exceed the primary drinking water standard of 10 mg/l. The proposed Maximum Contaminant Level Goal for nitrite is 1 mg/l. Nitrogen is a plant nutrient that can cause dense fungus and plant growth when discharged to surface water and can be an important component of the cation-anion balance. The substances are tested as a single unit because current analytical procedures do not commonly distinguish between the two and no primary drinking water standard is established for nitrite.

Potassium, unit (q), is one of the cations normally grouped with the major ions for purposes of characterizing overall ground water chemistry. It is an abundant constituent of organic matter of plant origin, so it is commonly found at elevated concentrations in leachate. It has been used as an indicator/tracer of leachate migration and may serve as a measure of the progress of organic decomposition within a fill. <u>See</u> Exhibit XXXVI.

Unit (r) lists sodium as a monitoring parameter. Sodium, a light metal, is another major naturally-occurring cation whose main importance as a monitoring parameter derives from its role in characterizing overall ground water composition and its use in the cation-anion balance. Because it is present in table salt, baking soda, household cleaners, and other common substances and moves rapidly with ground water, it can serve as an indicator parameter of facility impacts. It can occur in leachates at concentrations that can be hundreds of times higher than the 20 mg/L guidance level (Reference 104, p. 25725) set by the American Heart Association for persons on sodium-restricted diets.

Sulfate, unit (s), is a major anion of natural ground waters, and is a parameter used to characterize overall ground water chemistry as part of the cation-anion balance. Its concentration in leachate often exceeds the secondary drinking water standard of 250 mg/L. This limit is established because sulfate imparts a salty taste and has laxative effects above this level. Sulfate is an indicator of leachate impacts unless natural sulfate concentrations are also high, as is true in much of southwestern Minnesota's ground water.

Suspended solids, unit (t), are nondissolved particles suspended in the water sample. In ground water samples, suspended solids normally are present because of sampling techniques. The sediment usually is dislodged from around or within the well and does not represent particulate matter actually being transported through the ground water flow system. In surface waters and karst ground waters, the suspended solids are transported by the moving water. These solids may have various metals and other substances adsorbed to their surfaces. They may react with a fresh water sample by adding or removing constituents from solution. In either case, suspended solids represent a potential source of error that should be measured as a quality assurance check on the analysis.

Zinc, unit (u), is a metal with many uses, e.g., batteries and solder, whose concentration in leachate is elevated, frequently exceeding the secondary drinking water standard of 5 mg/L and almost always exceeding aquatic life criteria. Aquatic organisms are adversely affected by zinc concentrations as low as about 0.05 mg/L (Reference 105). Zinc has value as an indicator of leachate migration in cases where anaerobic, low-pH conditions maintain zinc's solubility.

Unit (v) lists the cation-anion balance in the monitoring program. The cation-anion balance is a quality assurance calculation rather than an analytical test. The calculation requires only the results from individual ion analyses and a calculator. It is probably the most commonly used method to serve as a check on the gross validity of ion analyses (References 106 and 107). Water is electrically neutral; i.e., the sum of cations in electrical equivalents should equal the sum of anions. If the calculation shows that the two are significantly different, it suggests an error in the analyses. The cation-anion balance has limitations, but its use in discovering gross errors at little or no cost makes the requirement reasonable.

In summary, each of the parameters listed in subitem (1) is a reasonable choice for annual ground water monitoring. The cost of analyzing the above list, excluding Eh, is approximately $300 per sample at the Minnesota Department of Health laboratory. The cost may be less at some commercial laboratories. This cost rises to about $425 per sample when the subitem (2) constituents are added.

Subitem (2) lists the parameters required to be analyzed three times per year. This list is shorter and costs about $120 per sample at the Minnesota Department of Health laboratory. This list is intended to indicate impacts rather than to represent a comprehensive analysis.

The parameters under subitem (2), units (a) to (e) are indicators. Indicators normally are not considered harmful pollutants themselves, but often indicate the presence of more harmful constituents. The need for and reasonableness of subitem (2), units (a) to (e), is discussed in the following paragraphs.

Unit (a) requires the appearance of samples to be noted. The specific information to be looked for is set out in Footnote (b) of this subitem. This information is needed because it enables a variety of inferences to be drawn about the water quality. Appearance is determined visually, so the only cost is for the minimal amount of the sampler's and analyst's time to write down any observations. Observations by both the sampler and analyst are required because changes in color or cloudiness may indicate a change in sample chemistry between the field and the laboratory. Furthermore, visible films or other separate phases may not be evident immediately. In each case quantitative analyses can be used to confirm the visual interpretation if necessary.

The first condition listed in Footnote (b), color, may indicate various conditions, such as whether substances in the water are in an oxidized or reduced state. The oxidation state is one of the main predictors of the mobility of some pollutants, especially metals. Most dissolved metals are more mobile under reduced conditions. Cloudiness may indicate the presence of sediment or colloidal iron oxides that may interact with dissolved constituents to alter sample chemistry. Floating films indicate the presence of oils, solvents, or other organic chemicals immiscible in water. The presence of other liquid or gas phases, observable as blobs, layers, or bubbles, indicates the presence, abundance, and possible identity of pollutants. Odors can indicate specific pollutants or conditions. An experienced analyst may even recognize the distinctive odors of certain aromatic chemicals. For example, a rotten egg odor is associated with the presence of hydrogen sulfide which indicates reducing conditions. In short, appearance can provide valuable information about water samples.

Unit (b) requires the measurement of pH. The hydrogen ion concentration or acidity of the water is represented by the term, pH. Along with the oxidation state, pH is the other preeminent control on overall sample chemistry and metals mobility. Most metals become more mobile under the low-pH (acidic) conditions typical of leachate. The measurement of pH is easy and rapid with a portable field instrument. Measurement in the field and in the laboratory is required to verify that the sample chemistry has not been altered by exposure to air or other conditions prior to analysis.

Specific conductance, unit (c), is a measure of the water's ability to conduct electricity. Conductance increases as the concentration of dissolved ions increases. Conductance serves as a replacement analysis for individual ion analyses. Elevated conductance readings in downgradient samples indicate the probable presence of chlorides, sulfates, carbonate species, metals, and other ions found in leachate. Conductance is measured easily and rapidly with a standard portable instrument. Changes in conductance between the field and laboratory are not expected. If a change is found, it may indicate formation of precipitates, contamination by extraneous substances, or other changes in sample chemistry.

Temperature, unit (d), is easily measured with a thermometer. It serves two functions. It may indicate whether the samples were adequately chilled to prevent reactions during shipment and storage. Temperature also help distinguish waters of different origin, such as leachate-contaminated water or water recently infiltrated from the surface versus ambient ground water. Ground water normally maintains a steady temperature year-round only a few feet below the water table.

Unit (e), water elevation, is measured with a tape measure, electronic or acoustic probe, or other available portable instrument. Water elevation measurements are also standard sampling practice. They allow verification that the water table or hydraulic head conditions are normal and not under the influence of pumpage or other stress that may be altering ground water flow. Water elevation measurements also provide a continuous record of hydraulic gradients and of seasonal and longer-term fluctuations in ground water flow. These records may be especially important in areas with very slight flow gradients, because short-term or seasonal recharge due to snowmelt and rainfall may cause intermittent reversals of ground water flow direction. Water elevations may be useful for other reasons, such as indicating the pressure conditions that affect the solubility of gases in the water.

Unit (f) represents the major departure from current routine monitoring practice at many facilities. Unit (f) requires analysis for volatile organic chemicals three times per year. Volatile organic chemicals are a class of organic chemicals that are common constituents of household and industrial solvents, degreasing agents, petroleum products, and other ubiquitous products. The test for volatile organic chemicals replaces six previous routine tests: chemical oxygen demand, chloride, nitrate, iron, ammonia, and sulfate. The first three have been required by the Agency since at least the mid-1970's; the last three have been required since 1982 (Reference 93). <u>See</u> Exhibit XXXIV. Since the early 1980's, monitoring for volatile organic chemicals has been written into permits because they are commonly found in ground water at land disposal facilities. The permit requirements are site-specific, however, the most common requirement is sampling on a two-year cycle. Unit (f) increases the testing frequency for volatile organic chemicals. The analyses for volatile organic chemicals will be required under the proposed rules at all land disposal facilities as routine parameters rather than the current six routine tests. The reasons for this change are discussed below.

Volatile organic chemicals are analyzed using gas chromatography (GC) or gas chromatograph-mass spectrometer (GC-MS) analytical methods. A number of similar GC and GC-MS methods are used in Minnesota, including the Minnesota Department of Health's method 465-C (Reference 108); the U.S. Environmental Protection Agency's 500 series (Reference 109), 600 series (Reference 110), and 8000 series (Reference 111) methods. Variants of these are used by individual laboratories. In these methods, volatile organic chemicals are (1) extracted (purged) from the water sample, (2) trapped in a short sorbent tube, (3) desorbed and swept into a gas chromatographic column, through which each individual chemical travels at a different rate, and (4) recorded by a detector upon exiting the column. In the GC method, this process is often repeated using a second confirmation column to allow positive identification and quantification of any chemicals that have similar retention times in the first column. The output from the test is a chromatogram in which the various chemicals present in the water sample appear on the graph as peaks, or deflections of a pen trace. Each peak represents a discrete retention time corresponding to an individual chemical. The size of each peak is a direct measure of the quantity of the chemical present. In summary, volatile organic chemicals are analyzed using a single test method, or two separate methods in the case of some of the EPA methods listed above; the list in unit (f) of 41 volatile organic chemicals does not represent 41 separate tests.

Volatile organic chemicals are better indicators of more general ground water pollution at mixed municipal solid waste land disposal facilities than the previously used parameters. The Agency has found that volatile organic chemicals are present in ground water where the traditional indicators have not yet influenced ground water quality. A 1986 Agency study showed that volatile organic chemicals were detected in ground water downgradient from 60 of the 61 permitted Minnesota facilities for which volatile organic chemicals had been tested. See Exhibit XXXXII. Although not discussed in that study, monitoring with traditional indicators had not revealed ground water impacts at some of the 60 landfills. The results were consistent with those of an earlier Agency study that noted leachates from rural facilities contained distributions of volatile organic chemicals similar to those at larger urban facilities. See Exhibit XXXXIII. As stated in the report, the Agency believes these chemicals will serve as useful indicators of pollution from mixed municipal solid waste leachate. The reasons for these findings are the ability to detect these chemicals at low levels (parts per billion concentrations); their ubiquitous nature in mixed municipal solid waste leachate; their absence in background ground water; and their mobility in ground water. In contrast, the traditional indicators normally occur as components of background ground water quality, and their concentrations must be raised by anywhere from several parts per million to several hundred parts per million in order to distinguish a polluted zone from normal background fluctuations. Thus, even if one of the older indicators is detected at a monitoring well with the volatile organic chemicals, the traditional indicator must be at a concentration perhaps 1,000 to 100,000 times higher than the concentration of the volatile organic chemicals in order to be equally distinguishable from normal conditions. Volatile organic chemicals, then, appear to be more sensitive indicators of polluted conditions. The Agency believes that their impact on ground water quality can be observed earlier than the traditional indicators.

The increasing role of volatile organic chemicals as indicators for ground water monitoring is also seen at hazardous waste sites. A 1985 study ranked the top 20 organic pollutants in ground water at 183 hazardous waste disposal sites based on the number of sites at which each contaminant was detected (Reference 112). Of the 133 organic chemicals considered, 39 were volatile; the rest were Base/Neutrals, Acid Extractables, and Pesticides. Nine of the top ten compounds and 16 of the top 20 were volatile organic chemicals. Although there are differences between hazardous waste disposal sites and solid waste disposal sites, the results reflect the abundance and mobility of volatile organic chemicals and support their use as indicators of ground water pollutants.

Many of the volatile organic chemicals have a direct health concern, in contrast to five of the six traditional indicators they replace (the exception being nitrate). See Table 8. Of the 41 volatile organic chemicals listed in subitem (2), 25 have Recommended Allowable Limits issued by the Minnesota Department of Health for long-term consumption in private drinking water supplies. Many of the Recommended Allowable Limits are at very low concentrations (Reference 57, see also Table 8, column headed "MDH RAL"). The

Recommended Allowable Lmits are established based on health criteria for individual well users. As Table 8 shows, of the 41 volatile organic chemicals listed in unit (f):

- all 41 have been detected in downgradient ground water at Minnesota mixed municipal solid waste land disposal facilities; See Exhibit XXXXII;
- 11 have federal Maximum Contaminant Levels (MCL's) for public drinking water under the National Primary Drinking Water Regulations; See Exhibits XXIV and XXXIX;
- 18 will have MCL's by 1989 (Reference 104);
- 8 have federal health-risk-based Maximum Contaminant Level Goals (MCLG's) and 10 more have proposed MCLG's; See Exhibits XXII and XXIII;
- 33 must be monitored for in public water systems; See Exhibit XXIV;
- 28 are listed as hazardous constituents in federal hazardous waste regulations under the Resource Conservation and Recovery Act (RCRA) See Exhibit XXXXIV;
- 35 are required constituents for ground water monitoring at hazardous waste land disposal units in federal regulations under RCRA; See Exhibit XXXXV;
- 38 are listed as hazardous substances in federal regulations under the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund); See Exhibit XXXXVI; and
- 26 are priority pollutants for monitoring of discharges to surface waters in regulations under the Clean Water Act; See Exhibit XXV.

TABLE 8

VOLATILE ORGANIC CHEMICALS IN ORDER OF FREQUENCY OF OCCURRENCE IN GROUND WATER AT MINNESOTA MIXED MUNICIPAL LANDFILLS

CHEMICAL	VOC'S IN GROUND WATER AT MINN. LF'S (NELSON AND BOOK,'86) SITES PRESENT	SITES TESTED	% OCCUR.	DENSITY (g/cc)	MDH RAL (ug/l)	NPDWR MCL (ug/l)	NPDWR 1989 MCL's	NPDWR MCLG (PPD. MCLG) (ug/l)	NPDWR REQ'D. VOC MONI-TORING	RCRA APPEND. VIII HAZ. CONSTIT	RCRA APPEND. IX GW MON.	CERCLA HAZ. SUBST. LIST	CWA/ NPDES PRIOR. POLLUT.
cis-1,2-Dichloroethylene	41	47	87.2(A)	1.2837	70		X	(70)	X				
trans-1,2-Dichloroethylene	41	47	87.2(A)	1.2565	70		X	(70)	X	X	X	X	X
1,1-Dichloroethane	47	59	79.7	1.1776					X	X	X	X	X
o-Xylene	28	38	73.7(B)	0.8968	440(B)		X	(440)(B)	X		X	X	
m-Xylene	28	38	73.7(B)	0.8684	440(B)		X	(440)(B)	X		X	X	
p-Xylene	28	38	73.7(B)	0.8968	440(B)		X	(440)(B)	X		X	X	
Trichloroethylene	40	58	69.0	1.462	31.2	5	X	zero	X	X	X	X	X
Tetrahydrofuran	30	49	61.2	0.888								(G)	
Benzene	35	60	58.3	0.8787	12	5	X	zero	X	X	X	X	X
1,1,1-Trichloroethane	34	59	57.6	1.3192	200	200	X	200	X	X	X	X	X
Toluene	33	60	55.0	0.8669	2000		X	(2000)	X	X	X	X	X
Dichloromethane (methylene chloride)	33	61	54.1	1.335	48		X		X	X	X	X	X
Ethyl benzene	30	57	52.6	0.8672	680			(680)	X		X	X	X
Acetone	24	48	50.0	0.7908							X	X	
Tetrachloroethylene	26	54	48.1	1.623	6.9		X		X	X	X	X	X
Methyl ethyl ketone	23	48	47.9	0.8054	172					X	X	X	
1,2-Dichloroethane	28	59	47.5	1.256	3.8	5	X	zero	X	X	X	X	X
Chloromethane	26	56	46.4	0.92					X	X	X	X	X
Ethyl ether	21	46	45.7	0.714								(G)	
Dichlorodifluoromethane	25	57	43.9	1.486					(F)	X	X	(G)	
1,2-Dichloropropane	25	58	43.1	1.1558	6		X	(6)(E)	X	X	X	X	X
Methyl isobutyl ketone	20	48	41.7	0.801							X	X	
Trichlorofluoromethane	21	57	36.8	1.494					(F)	X	X	(G)	
Chloroform	22	61	36.1	1.4916	5	100(D)			X	X	X	X	X
Chloroethane	20	56	35.7	0.9028					X	X	X	X	X

CHEMICAL	VOC'S IN GROUND WATER AT MINN. LF'S (NELSON AND BOOK, '86) SITES PRESENT	SITES TESTED	% OCCUR.	DENSITY (g/cc)	MDH RAL (ug/l)	NPDWR MCL (ug/l)	NPDWR 1989 MCL's	NPDWR MCLG (PPD. MCLG) (ug/l)	NPDWR REQ'D. VOC MONI-TORING	RCRA APPEND. VIII HAZ. CONSTIT	RCRA APPEND. IX GW MON.	CERCLA HAZ. SUBST. LIST	CWA/ NPDES PRIOR. POLLUT.
1,1-Dichloroethylene	18	59	30.5	1.218	7	7	X	7	X	X	X	X	X
Dichlorofluoromethane	13	45	28.9	1.426									
Cumene	13	48	27.1	0.864					X			(G)	
Chlorobenzene (monochlorobenzene)	13	57	22.8	1.1064	60			(60)	X	X	X	X	X
Vinyl chloride	11	58	19.0	0.9106	0.15	2	X	zero	X	X	X	X	X
Bromodichloromethane	10	58	17.2	1.98		100(D)			X		X	X	X
1,1,2-Trichloroethane	8	61	13.1	1.4405	6.11		X		X	X	X	X	X
1,1,2-Trichlorotrifluoroethane	6	47	12.8	1.5635									
Bromomethane	7	57	12.3	1.732					X	X	X	X	X
1,4-Dichlorobenzene	7	58	12.1	1.533	75(C)	75		75	X	X	X	X	X
1,1,2,2-Tetrachloroethane	5	58	8.6	1.5984	1.75				X	X	X	X	X
Allylchloride	4	48	8.3	0.9397	29.4					X	X	(G)	
Carbon tetrachloride	4	59	6.8	1.5942	2.7	5		zero	X	X	X	X	X
Bromoform	3	55	5.5	2.8899		100(D)			X	X	X	X	X
1,2-Dichlorobenzene	3	58	5.2	1.3048	620		X	(620)	X	X	X	X	X
1,3-Dichlorobenzene	3	58	5.2	1.2881					X	X	X	X	X

Footnotes:

A Occurrence data is for combined cis- plus trans-1,2-dichloroethylene.

B Numbers are for combined o- plus m- plus p-xylene.

C RAL for 1,4-dichlorobenzene revised based on EPA Maximum Contaminant Level.

D Maximum Contaminant Level is 100 ug/l for the sum of these three trihalomethanes plus chlorodibromomethane.

E Proposed Maximum Contaminant Level Goal given in 51 Federal Register, p. 4618, February 6, 1986.

F Monitoring conditionally required.

G Hazardous substances listed in federal Superfund regulations but not listed as required analytical parameters in the EPA Contract Laboratories Program, October 1984 "Information for Bidders" (Reference 127).

The following notes provide an explanation of the column headings found in Table 8.

Column Headings	Explanation
MDH RAL	Minnesota Department of Health Recommended Allowable Limit, in micrograms per liter (Appendix VI).
NPDWR MCL	National Primary Drinking Water Regulations, Maximum Contaminant Level, in micrograms per liter (Exhibits XXIV and XXXIX).
NPDWR 1989 MCL's	Compounds for which, under the 1986 reauthorization of the Safe Drinking Water Act, the U.S. Environmental Protection Agency is required to have Maximum Contaminant Levels promulgated by 1989 (Reference 104).
NPDWR MCLG (PPD. MCLG)	National Primary Drinking Water Regulations, Maximum Contaminant Level Goals (Exhibit XXII), or if parenthesized, proposed Maximum Contaminant Level Goals (Exhibit XXIII), both in micrograms per liter.
NPDWR REQ'D. VOC MONI-TORING	National Primary Drinking Water Regulations, volatile organic chemicals required for monitoring in public water systems (Exhibit XXIV).
RCRA APPEND. VIII HAZ. CONSTIT.	Hazardous constituents listed in Appendix VIII of the federal hazardous waste regulations (Exhibit XXXXIV).
RCRA APPEND. IX GW MON.	Hazardous constituents required for ground water monitoring under Appendix IX of the federal hazardous waste regulations (Exhibit XXXXV).
CERCLA HAZ. SUBST. LIST	Hazardous substances listed in regulations under federal Superfund (Exhibit XXXXVI).
CWA/ NPDES PRIOR. POLLUT.	Priority pollutants listed in regulations under the federal Clean Water Act (Exhibit XXV).

In summary, volatile organic chemicals represent a direct threat to public health, and they are useful indicators of ground water pollution.

The tests for volatile organic chemicals are more costly than for the traditional indicators, partly because of the greater need for quality control. The Agency's cost for gas chromatographic (GC) analysis at the Minnesota Department of Health laboratory ($107.70 per sample in 1987-88) is $20.00 higher than the cost of the six traditional indicators. Analysis by gas chromatograph/mass spectrometer (GC/MS) is less costly, at $87.00 per sample. Private laboratories may charge somewhat more for analysis for volatile organic chemicals than the MDH. Bids at a western Minnesota rural facility in early 1986 were in the range of $120 to $150 per sample. Prices may have become more competitive since then. A 1985 survey by the U.S. Environmental Protection Agency's Office of Drinking Water found wide ranges in the cost of volatile organic chemicals analyses at their contract laboratories. For a list of 60 chemicals, 13 responding laboratories reported a range in costs for GC analysis of $75 to $500 per sample, with a mean of $187 per sample. For GC/MS analyses, 23 responding laboratories reported lower costs, $50 to $300, but the mean cost was somewhat higher, at $197 per sample. See Exhibit XXII. Although somewhat dated, this survey illustrates that the facility owner or operator can reduce costs substantially by careful selection of testing laboratories.

The specific volatile organic chemicals listed as indicators were selected because they are found in ground water at Minnesota land disposal facilities. The 1986 Agency study cited above compiled the occurrences of 54 volatile organic chemicals in ground water at Minnesota land disposal facilities. See Exhibit XXXXI. The 54 chemicals studied were listed as analytes in Minnesota Department of Health method 465. Reference 108. These results are summarized in Table 8. Thirteen of the 54 were found at fewer than five percent of the facilities. Four of the 13 were never found. In contrast, the rate of occurrence was as high as 87 percent for combined cis- plus trans-1,2-dichloroethylene. Further examination of the raw data used for the study revealed that at each facility where one of the nine other volatile organic chemicals was found, some 12 to 35 total volatile organic chemicals were present. Furthermore, only one of the 13, 1,2-dibromoethane (EDB), has a MDH Recommended Allowable Limit, and it was not found at any of the 52 land disposal facilities where it was tested for. See Appendix XV.

In combination, these considerations indicate that it is reasonable to exclude the 13 chemicals rarely found at facilities from the list of 54 chemicals used by the Minnesota Department of Health since it does not appear that they are needed for detection monitoring. The Agency, under item B, can require testing for the 13 omitted chemicals if a more complete analysis is needed for compliance monitoring or other reasons.

The list of 41 also provides a reasonable distribution of densities. As Table 8 shows, the list includes both lighter-weight species with densities less than one gram per cubic centimeter and heavier species with densities greater than one. The density of a chemical in relation to water, which has a density of one gram per cubic centimeter, will determine at what depth the chemical will be found in the ground water.

Finally, it should be noted that a few commentors wondered whether one of the available total organic analytical methods, such as total or dissolved organic carbon (TOC and DOC, respectively) or total organic halogen (TOX) might provide a reasonable alternative to the scan for volatile organic chemicals. The two main reasons why the total organic analytical methods are less reasonable are because these methods do not identify individual chemicals, so health risk cannot be evaluated, and they are much less sensitive than the scans for volatile organic chemicals. The nominal detection limits for TOX and TOC are 25 and 1000 micrograms per liter respectively. This compares to GC detection limits of less than 1 microgram per liter for the volatile organic chemicals (Reference 112). This reference also gives additional reasons why the scans are preferable.

Item D lists other parameters the Commissioner may require to be tested in addition to those listed in item C. This provision establishes a basis for testing requirements developed pursuant to items B and C. For facilities subject to either items B or C, item D provides needed flexibility to add monitoring requirements for good cause, and reasonable constraints on what constitutes good cause. This flexibility must be preserved because, at all facilities, site-specific conditions and evolving scientific understanding of ground water monitoring invalidates standardized testing regimes. The Agency recognizes the difficulty of testing for every possible pollutant in leachate; the need to rely partly on well-chosen indicator parameters; and the need to evaluate methods carefully before adding more monitoring constituents. The types of monitoring that may be required are established in subitems (1) to (8).

Subitem (1) allows the Commissioner to require monitoring of substances of concern to public health, public safety, or the environment. These include substances with standards or alternative standards under subpart 4 or other potential pollutants. Chemical, microbiological, and radioactive substances could be future candidates for monitoring under subitem (1). The Agency must be able to require testing for all substances that may directly threaten health, safety, and biological communities.

Subitem (2) authorizes the Commissioner to require testing of pollutants that can adversely affect the taste, odor, or appearance of the water or otherwise adversely affect the public welfare. As discussed in relation to subpart 4, item H, subitem (4), some pollutants in leachate can affect taste and odor or otherwise limit use of the water at concentrations lower than concentrations that would be a health concern.

Subitem (3) allows the Commissioner to require testing of major dissolved ions. As discussed regarding item C, subitem (1), the most abundant dissolved ions influence the overall chemical behavior of the water sample. Furthermore, the quantities of major ions must be known in order to calculate the cation-anion balance. Generally, the major ions listed in item C will be sufficient. However, subitem (3) reasonably allows additions if an unlisted ion is identified as a significant constituent.

Subitem (4) authorizes the Commissioner to require monitoring for substances or properties that may be indicators of water pollution. The discussion of item C has already established the need for and reasonableness of the use of indicator substances in ground water testing. Subitem (4) allows additions of any useful indicators not listed in item C.

Subitem (5) allows the Commissioner to require monitoring for substances that may cause analytical interferences or otherwise affect water quality determinations. Some analytical methods have a limited ability to differentiate between an intended analytical substance and other substances that may cause similar instrument responses. Secondly, some methods, such as gas chromatography, may be able to detect but not identify substances. These concerns arise with mixed municipal solid waste land disposal facilities because leachate has such a diverse composition. Potential health impacts from unknown substances and the availability of other methods to positively identify them make it necessary to allow the Commissioner to require testing for possible interfering substances.

Subitem (6) authorizes the Commissioner to require monitoring of properties related to the movement of pollutants, such as potentiometric head in the saturated or unsaturated zone. The importance of understanding pollutant movement has been discussed extensively under subparts 3 and 10. Monitoring tension head in the unsaturated zone (above the water table) is one means to detect liner leakage or lateral migration of pollutants. Subitem (6) allows for continued monitoring of ground water and pollutant movement where the patterns and rates of movement are uncertain or changeable.

Subitem (7) allows the Commissioner to require monitoring of bed sediments, aquatic organisms, other media, and stream discharge rates. Pollutants are often precipitated or otherwise concentrated in bed sediments at levels that can be harmful to bottom-dwelling (benthic) or bottom-feeding organisms. Precipitation is caused by changes in chemistry from reducing (anaerobic) conditions in the ground water to oxidizing (aerobic) conditions in the near-shore surface water. These changes occur at the sediment-surface water interface (References 101 and 113). Pollutants in bed sediments can also be released into the surface water by seasonal changes in surface water chemistry or periodic streambed erosion. Where pollutant concentration in bed sediments may present a threat, the Commissioner should have the ability to require sediment testing.

The Commissioner should have the ability to require monitoring of aquatic organisms so that direct impacts on aquatic life can be evaluated. Again, the need may be infrequent, but cases may arise where impacts are best determined by surveying benthic populations to reveal deficiencies indicative of pollution, or by analyzing benthic or fish tissues, where pollutants can be concentrated by bioaccumulation.

Finally, the Commissioner should be able to require measurement of stream discharge rates because streamflows vary with weather patterns. The amount of flow available for dilution of pollutants in discharging ground water will also vary substantially. It is important to know whether a pollutant concentration was measured under low, high, or typical flow conditions in order to estimate pollutant concentrations at other times. Streamflows are commonly measured by long-term government programs using permanent gauging stations or with survey gauging procedures.

Subitem (8) authorizes the Commissioner to require monitoring of leachate composition and leachate release rates in the unsaturated zone. This information makes it possible to detect and quantify the rate of leachate loss from the leachate containment structures and to evaluate the possible impacts.

Item E requires the facility owner or operator to determine water quality in new monitoring systems and the range of seasonal variation in water quality. Subpart 3, item I requires initial sampling of monitoring points developed as part of the facility's hydrogeologic evaluation. Item E establishes more specific requirements for this initial sampling. Item E also applies to monitoring points installed at times other than during the hydrogeologic evaluation. As discussed at greater length under subpart 3, item I, initial water quality monitoring establishes base conditions against which subsequent measurements are compared. Because these base conditions are not static, it is necessary to measure seasonal variability. Future high concentrations will not be erroneously attributed to impacts from the facility, if it has been shown that background water quality can reach these levels.

Item E further requires the Commissioner to establish the sampling frequencies, analytical constituents, and other conditions for the initial water quality monitoring based on the site's ground water flow conditions and known water quality. This provision ensures that specific site conditions are reflected in the sampling program. The rationale for considering site-specific conditions is the same as was discussed above for item B.

Finally, item E requires at least quarterly background monitoring until waste disposal activity begins at new or expanded facilities. This provision provides a record adequate to analyze the variation in water quality and ensures that the record is continuous. Facility owners may find it in their interest to collect more data than is required, so that the range of background variation is clearly established. Initial monitoring should be timed to account for seasonal variations because the data will inform decisions on the frequency and timing of future sampling.

Items F through L contain requirements for sampling, sample storage and handling. Experience demonstrates the need to assure consistency, reliability, and quality assurance during sampling (References 88, 89, 90, 92, 98, 114, 115 and 116). Items F through L provide that assurance.

Item F requires the facility owner or operator to submit only samples collected by persons who have received training in sampling. Compliance with this condition will ensure consistent sampling procedures and reliable monitoring data. Sampling requires technical knowledge and procedural care. Sampling by untrained personnel may result in erroneous test results because of the mishandling of samples. It is not in the interest of the Agency, or the public, or the facility owner or operator, to have sampling errors generate false results. On-the-job training by experienced personnel, in-house procedures manuals, and formal training courses on sampling techniques are available. Item F requires that training cover procedures established under items G to L for the required classes of analytical substances. Sampling for each class of substance has unique sampling procedures, including avoiding air contact and degassing for volatile organics and adding acid sample preservatives for metals analyses.

Commentors stated that sampling by the facility owner or operator should not be allowed. They believe that sampling should be done only by a disinterested third party or, in the opinions of some, by a certified laboratory. Several commentors noted that many facility owners insist on third-party sampling to avoid any question of impropriety. Using a laboratory to collect, transport, and analyze samples brings the entire sample history under the control of one party. This increases the credibility and consistency of the sampling and analytical process.

The Agency agrees with this approach and routinely recommends that facility owners or operators contract for sampling. However, Minnesota does not have a certification process for laboratories conducting pollution analyses. Without certification there is no assurance that laboratories will always do a better job. Without a certification program the State has no regulatory control over laboratories. The Agency's regulatory authority is over the facility owner or operator through the facility permit. Therefore, the Agency has not required third-party sampling or analyses in this or any rule. Until a certification program is developed for sampling and analysis, it is reasonable to allow self-sampling.

Item G requires the facility owner or operator to develop and maintain a written monitoring protocol. The monitoring protocol will contain the procedures to be followed for sampling and analysis. Compliance will assure consistency and completeness in sampling and analysis. It assures that sampling procedures are coordinated and compatible with the analytical procedures and vice versa. The monitoring protocol is intended to be useful, up-to-date and routinely used by sampling and analytical personnel.

Subitem (1) requires that the monitoring protocol describe in detail the sampling and sample transportation procedures to be followed under items H to L and the analytical procedures to be followed under items M to O. This provision specifies the required contents of the protocol and clearly indicates that the protocol must be thorough and detailed. Each procedure or precaution required under items H to M is important to assure reliable results. Incomplete descriptions of the protocols or procedures will not supply the necessary guidance needed by sampling and analytical personnel.

Subitem (2) requires the monitoring protocol to be submitted for the Commissioner's approval and included in the operations manual required under part 7001.3475. The first of these provisions makes possible Agency review of the protocol to determine compliance with subpart 14. Currently the Agency reviews laboratory quality assurance plans, notes deficiencies, and relays recommendations to the facility owner or operator. Placing the monitoring protocol in the operations manual will help ensure that other provisions of the operations manual are coordinated with the monitoring constraints.

Subitem (3) requires immediate revision of the protocol to reflect changes in the monitoring system, field or analytical procedures, sampling personnel, or analytical laboratories. Compliance with this requirement will ensure that all personnel are following current procedures. The monitoring protocol must also be reviewed at least annually by the facility owner or operator, sampling personnel, and analytical laboratory, and revised as necessary. This provision assures a regular review to identify deficiencies and improvements needed. Annual reviews should reflect emerging technology in ground water monitoring.

Subitem (3) also requires the facility owner or operator to submit revisions of the monitoring protocol to the Commissioner upon written request or as specified in a facility enforcement document. This provision provides the Agency the current protocol, if needed. The requirement is made conditional in order to avoid the burden of another routine submittal to the Agency. Finally, the facility owner or operator must retain records of past protocol language through the postclosure period. Long-term trends in ground water quality monitoring are relied on to determine impacts from a facility. It is important in establishing the validity of monitoring results to know with confidence the sampling and analytical procedures used to generate data.

Subitem (4) allows the Commissioner to establish specific procedures and quality control requirements for monitoring, if necessary to assure confidence in the results. Compliance with this provision will ensure monitoring data reliability. Site-specific requirements can be imposed only when the monitoring data would otherwise be questionable. Confidence as used in subitem (4) has both a qualitative and a statistical meaning. In the qualitative sense, the Commissioner must establish the requirements needed to assure that the monitoring results are reliable and accurate. These requirements may combine basic precautions common to all monitoring and other provisions designed around a particular facility's monitoring program. The needs may change over time.

Statistical confidence is a technical measure of the accuracy of statistical findings. A finding is said to be associated with a specified level of confidence. For example, assume that a survey finds that 45 percent of the people in a sample intend to vote for a particular candidate and that this result is valid at the 95 percent level of confidence. The measure of statistical confidence means that repeated sampling of the same universe will yield the same result 95 percent of the time. Five percent of the time normal random error will cause the survey to yield different findings. The accuracy of findings increases with higher levels of statistical confidence.

Analysts who make statistical interpretation of ground water monitoring data may develop new methods or standards. Therefore, it does not seem prudent to specify closely the level of confidence needed in the rules. Different statistical levels of confidence are appropriate under different circumstances, e.g., proving a violation of standards versus long-term tracking of a facility that seems to be having no impact on water quality. Subitem (4) identifies appropriate requirements to assure confidence in the monitoring results.

Unit (a) allows the Commissioner to set limits for precision, accuracy, and other measures of the reliability of field procedures and analytical results. Precision is a measure of whether results from a test method are reproducible. Accuracy is the measure of how close a test method comes to the true value. Each is a standard determination in analytical laboratories. This provision allows the Commissioner to establish acceptable limits for the quality control measures if the limits improve confidence in monitoring data.

Unit (b) allows the Commissioner to specify the conditions for and frequencies of quality control samples, measurements, or procedures in the field or analytical laboratory. A variety of quality control samples, measurements, and procedures are routinely used in analytical work. The Commissioner must establish minimum standards for use of these procedures to assure confidence in the test results.

Unit (c) addresses the use of gas chromatograph/mass spectrometer or other analytical procedures to achieve positive identification and quantification of sample substances. Some analytical methods cannot uniquely identify or quantify a test response. For example, a gas chromatograph yields a record of instrument deflections. Each deflection corresponds to a substance retained for a different time in the chromatographic column. These peaks are then matched against retention times that have been determined for known substances. A tentative identification is made when the retention time corresponds to a known value. However, it is possible that other substances have the same retention time, so the identification is not certain. Greater certainty can be achieved by repeating the analysis on a different type of chromatographic column. It is much less likely that an unknown substance will have the same retention time as the identified substance on both columns. However, identification is still not guaranteed.

In cases where positive identification is essential, it may be necessary to use a more precise method. The gas chromatograph/mass spectrometer (GC/MS) is one such method. The GC/MS produces a mass spectrum that can be uniquely matched to a single substance by using a computerized library of known spectra to achieve a positive identification. Some experts have concluded that GC/MS is preferable to gas chromatography for most environmental monitoring (Reference 117). See Exhibit XXVII. However, it is the opinion of the Agency and Minnesota Department of Health staff that gas chromatography methods using two columns are adequate for many monitoring purposes. Gas chromatography is more widely available, offers lower detection limits than GC/MS, and is often cheaper. In summary, required use of GC/MS and other methods is reasonable when there is a need to be certain about pollutant identity and quantity.

Item H specifies the minimum contents of the monitoring protocol for sampling and in-field test procedures. Subitem (1) requires identification of monitoring point locations, elevations, and the order in which monitoring points are to be sampled. The Commissioner must know the locations of monitoring points. Elevations are needed to determine water elevations in the monitoring points. Specifying the order of sampling establishes consistency between sampling events and minimizes potential sampling errors. Progression from the least polluted to the most polluted monitoring point minimizes the potential for false readings due to pollutant carryover from sample-to-sample.

Subitem (2) requires a listing of all tests, measurements, and procedures needed at each monitoring point, and the order in which these procedures will be conducted. Compliance with this requirement will ensure consistency and completeness in sampling. The required list will also provide sampling personnel with a checklist of everything that must be done at a monitoring point. The order is important so that successive procedures do not interfere with each other.

Subitem (3) requires a listing of the equipment and containers to be used and procedures and precautions for equipment and container use. Compliance will assure consistency and provide a checklist for personnel to use in preparing the equipment for sampling. Subitem (3) also requires identification of precautions needed to avoid introducing contaminants into monitoring wells, samples, and equipment. Examples of such precautions include placing sampling equipment into clean containers when not in use, leaving sample containers capped until ready for filling, and cleaning equipment between uses. These provisions assure that samples are not contaminated by the sampling and sample handling procedures.

Subitem (4) requires that the monitoring protocol list the procedures for evacuating each monitoring well before sampling. As discussed under subpart 10, item N, a protocol is needed to determine how much water must be removed from a well casing before sample collection. Two methods are commonly used. One method is to conduct a stabilization test before each sampling, i.e., remove water until measured values of such indicators as pH, temperature, and conductance remain stable (References 90 and 92). An alternative method is to conduct a one-time or occasional stabilization test, then remove the same amount of water before each subsequent sampling. Because of the variety of approaches, consistency is promoted by defining the procedure to be followed in the monitoring protocol.

Subitem (5) provides that if surface water or leachate monitoring is required, the sampling protocol must include procedures for that monitoring. The protocol must establish the exact sampling location and depth. Compliance with this provision assure comparability of sampling conditions between sampling events. If a series of surface water samples is taken from different locations and depths, the observed differences in water quality may be due to positioning of the sampler rather than a true change caused by the facility. Leachate sampling requires similar precautions. For example, the composition of a sample at the bottom of a leachate sampling point might be quite different than the composition at the top due to separation of the substances, which stratify based on density and chemical solubility.

Subitem (6) requires that quality control procedures be established for field activities and sample transport to identify outside sources of contamination and sampling error. The procedures must identify the type, number, and handling techniques used in obtaining quality control samples. Quality control samples and procedures are used to verify the success of all the precautions taken. Quality control samples are essential in sampling volatile organic chemicals because other substances can be introduced from foreign or airborne sources. A quality control technique commonly used is various kinds of trip blanks. The blanks are samples of distilled water that are either prepared in the laboratory or transferred to sample containers in the field, then subjected to the same handling and transportation procedures as the real samples. If volatile organic chemicals are found at similar concentrations in the ground water samples and trip blanks, the cause may be something in the sampling procedures or ambient air rather than in the ground water.

Subitem (7) requires procedures and criteria be established for field filtration of samples. Filtration removes suspended sediment so that pollutants adsorbed to the sediment particles do not bias analytical results. There are a variety of approaches to filtration and a number of situations that may cause changes in sample chemistry. Filtration will be discussed further under item K.

Subitem (8) requires procedures for sample preservation, including the use of preservatives and cooling requirements. This condition identifies measures essential to maintaining the sample composition. Common preservation procedures include the addition of acid to samples that will be tested for metals and packing sample containers in ice to retard biological and chemical breakdown of organic pollutants. Because there are different preservation needs for different samples, the protocol should identify the necessary procedures before sampling.

Subitem (9) requires procedures for labeling, handling, storage, and transport of samples. These requirements ensure the validity of the samples.

Subitem (10) requires that the monitoring protocol contain chain-of-custody procedures. A chain-of-custody is a record of signatures, times, and dates, showing the sequence of persons who had custody of the samples from collection to completion of analyses. The chain-of-custody ensures that samples are continuously secure from intentional and unintentional disturbance. Requiring chain-of-custody procedures is common when security is needed. Requiring chain-of-custody procedures is reasonable because samples are susceptible to tampering and disturbance, which could affect the analytical results. The experience with Minnesota land disposal facilities indicates enforcement action is possible at any facility. Since even future land disposal facilities will generate leachate and may leak, it is reasonable to require a basic level of custody control so that enforcement actions will proceed with confidence.

Subitem (11) requires the monitoring protocol to list the procedures, measurements, and observations that sampling personnel are to record. This provision ensures that sampling personnel are aware of the records needed for each sampling event. The preferred approach is to use a checklist so that consistency does not depend on what personnel can recall.

Item I requires that facility owners and operators use equipment, materials, and procedures in well evacuation, sampling, and subsequent sample handling to minimize conditions that alter sample composition. It is well-documented that the chemistry of samples may be altered in many ways. Some of the conditions that could alter sample composition are listed in this item. Four of these conditions, turbulence, water contact with air, gas exchange, and depressurization, must be minimized because they change sample pH and cause out-gassing or introduction of volatile organic chemicals. Sampling devices and sample handling precautions are available to minimize these conditions. Depressurization is a concern if samples are drawn from great depths. If depressurization is important, special sampling devices may be needed. Adsorption is the chemical bonding of substances to solid surfaces. Adsorption can be avoided by using devices and procedures that minimize contact time and surface area or are constructed of inert materials, and by using careful sampling procedures and in-line filtration that minimize sediment yield and sediment residence time in the sample. Desorption is the release of pollutants from sampling devices or sediment in the sampling device or sample. Desorption can be minimized by using clean, inert sampling and filtration equipment and procedures that minimize sediment yield and contact time. Finally, chemical reactions can be minimized through proper preservation procedures and by avoiding contact with air. Applying the requirements of this item will increase the reliability of water samples.

Item J establishes two procedures that must be completed before a sample can be collected. The first, measurement of the water level to the nearest 0.01 foot, is justified under item C, subitem (2), unit (e). A steel measuring tape graded in 0.01-foot increments can yield reproducible results. Other devices also can provide this level of accuracy. Accurate measurements to the 0.01-foot increment are required because of their use in establishing ground water flow gradients, which tend to be slight.

Item J also requires that a procedure be developed and followed for evacuating each well before sampling. This procedure must be a stabilization test, recovery rate test, or other procedure that can be justified based on the initial testing of the well. These procedures are established under subpart 10, item N and in item H, subitem (4) of this subpart. The requirement for developing the procedure is included in this subpart to ensure that the monitoring results are representative of actual ground water quality.

Item K allows the Commissioner to require filtration wherever necessary to obtain sediment-free samples representative of actual ground water conditions. The intent of sampling is to measure the dissolved pollutants traveling in the ground water, not the pollutants adsorbed onto soil or filter pack materials dislodged during sampling. If this dislodged sediment is present, filtration removes it and provides a sample that represents actual ground water conditions. If a well does not produce sediment, filtration is unnecessary. If the sampled well is a drinking water supply well, the usual procedure is to take unfiltered samples, so that the analysis takes into account everything consumed, both water and sediment. Filtration has been a standard practice by the U.S. Geological Survey for years. It has become common practice in other ground water investigations. The Agency shares the concerns expressed by some commentors that filtration should not be used to make up for the deficiencies in well construction. Filtration does not change the fact that poorly-constructed wells that yield excessive sediment may need to be replaced or redeveloped.

Item K requires filtration to take place, as needed, at the monitoring point location using procedures that minimize the loss of dissolved constituents from solution, such as in-line filtration. Compliance with this provision will minimize the contact time available for adsorption and other chemical reaction between sediment and the water sample. Nondisruptive filtration procedures are needed because cascading water through an aerated filter will alter the water chemistry. When aerated during filtration, some constituents oxidize and form complexes that precipitate out of the water. This results in adsorption and coprecipitation of other constituents (Reference 103). In-line and other filtration equipment are available to minimize aeration.

Item L requires that sampling personnel record their procedures, measurements, and the condition of the monitoring point at the time of sampling. The field records must document whether the procedures established under items G to K have been followed. Satisfying these conditions ensures that if questions arise about the sample, there is a way to determine how and under what conditions the sample was collected. Recording the results at the time of sampling avoids relying on memory to reconstruct events at each monitoring point.

Item L further specifies that the field records contain the names of the persons conducting the sampling, the time and date each monitoring point was sampled, water elevations and other required field measurements, and the evacuation procedures and stabilization test results completed before sampling. These provisions are used to reconstruct events that may have affected the samples. Recording evacuation procedures must include noting the volume of water removed or the stabilization test results.

Lastly, item L requires the facility owner or operator to retain the field records through the postclosure care period. This provision enables the Agency or facility owner or operator to reconstruct the sampling history for a facility at any time.

Items M to O contain requirements for analysis of water quality samples. As with sampling, laboratory procedures can affect sample chemistry and analytical accuracy. Formal quality assurance procedures are standard practice in analytical laboratories. Numerous tracts have been devoted to the subject of laboratory quality assurance (References 106, 118, 119, 121, 122 and 124).

The need for quality assurance/quality control applies to all types of analyses, but it is most critical for analyses of trace levels of substances that are volatile or unstable. Since volatile organic chemicals are proposed for use as routine monitoring parameters, the provisions of items M to O are especially critical to analytical work performed regarding them.

Items M to O specify the elements of quality assurance that must be addressed in the monitoring protocol rather than required performance levels for precision or accuracy. The technology in this area is evolving and a variety of procedures and performance levels may be acceptable depending on individual circumstances.

Commentors suggested that the State needed a laboratory certification program to address laboratory quality assurance/quality control programs. The Agency and the State Office of the Legislative Auditor agree with this position. In its 1987 report, "Evaluation of Water Monitoring Programs" (Reference 123, page 78), the Legislative Auditor recommended that the Agency "should initiate the establishment of a State certification program for laboratories." The Agency and the Minnesota Department of Health have been working jointly to develop a laboratory certification program. Until this program is in place, items M to O address the need for laboratory quality assurance. These provisions will be re-evaluated once a certification program is in effect, to include a more general requirement that facility owners or operators use only a certified laboratory.

Item M requires that water quality analyses be performed using methods acceptable to the Commissioner, based on their performance record, reliability, sensitivity, precision, and accuracy. This requirement ensures that analytical methods used are proven and will provide acceptable levels of performance. A number of proven methods are available for each constituent (References 107, 108, 109, 110, 111 and 124). As used in subpart 14, performance record and reliability are generic, qualitative terms with common meanings. Sensitivity more specifically refers to the method's ability to detect low concentrations as measured by the limit of detection and limit of quantitation. Precision is the degree to which data from replicate or repetitive measurements differ, i.e., reproducibility. Accuracy refers to the correctness of the data. It would be unreasonable to allow methods that were not accurate, precise, or capable of detecting pollutants, if better methods are available and feasible.

Item M further requires that analytical methods and quality control procedures must be chosen so that analyses yield accurate results within the range of concentration and composition of the samples analyzed. This condition is needed because some methods perform better than others under given circumstances. Next, item M reasonably requires that all appropriate actions be taken to minimize error and to assure the reliability, precision, and accuracy of the analytical results. This provision covers everything from maintaining clean laboratory conditions to making method adjustments, when necessary, to provide reliable results.

Finally, item M provides that, whenever the limit of detection or the limit of quantitation for a substance used by a laboratory is higher than the concentration of concern, including the standard or alternative standard established under subpart 4, the Commissioner may investigate the feasibility of attaining lower analytical limits and shall require lower limits if necessary and feasible. The limit of detection is the lowest concentration of a substance that can be determined to be statistically different from a blank. The limit of quantitation is the concentration of a substance above which a chemical analysis may obtain quantitative results. The requirement in item M provides a course of action for when the detection limit used by the laboratory is not low enough. The Commissioner may require a detection limit lower than the conventional methods provide, i.e., a different procedure, only if there is a compelling need to detect or quantify particular substances and a method is available that is both technically and economically feasible. An example of a compelling need might be a facility that has impacted ground water quality upgradient from a public water supply and is known to have received a particular waste that contains a mobile and highly toxic pollutant.

Item N requires that the monitoring protocol contain the analytical and quality assurance procedures that must be followed for all samples. This provision requires a formal procedure in handling samples. The requirement promotes consistency, completeness, and quality control in laboratory procedures. Specific elements of the analytical portion of the monitoring protocol are as follows.

Under subitem (1), the protocol must list responsibilities of laboratory personnel. This requirement is needed to clearly define, for the benefit of the laboratory personnel, the facility owner or operator, and the Agency, who is responsible and to demonstrate that there is someone in charge of each responsibility.

Subitem (2) requires that the monitoring protocol list procedures and establish criteria for the use of sample containers and preservatives, cleaning of sample containers and sampling equipment, shipment and storage of samples, and sample holding times. Most of these elements have been discussed in other items under this subpart. Limiting sample holding times is necessary because sample constituents undergo reactions and decomposition over time. If a sample is held past the laboratory's prescribed time, no assurances can be made as to the accuracy of the results.

Subitem (3) requires that the protocol establish the analytical methods and laboratory equipment to be used. The method and analytical instrument used in a test determine the sensitivity, precision, and accuracy of the analyses. The Agency must have a method to determine the validity of analytical results.

Subitem (4) requires quality assurance/quality control procedures be established for each analytical method used. These procedures must include the laboratory's measurements of precision and accuracy over a range of concentrations, limit of detection, limit of quantitation, and an explanation of how these quantities were measured. This provision indicates what level of performance that laboratory can be expected to achieve as opposed to what levels of performance are possible in theory. Laboratory performance varies. The Agency must know of the performance levels achieved by each laboratory, as this greatly influences the confidence level in analytical results. The significance of the listed performance measures was given regarding item M. The explanation of how the quantities are obtained at laboratories is needed because there are a variety of approaches to define and calculate the quantities, some of which are more reliable. The information is needed for each individual constituent and over a range of concentrations because performance varies between pollutants and between concentration ranges. For example, EPA's gas chromatographic methods, methods 502.1 and 503.1 have lower detection limits than methods 601 and 602, but the 500 series methods are less reliable than the 600 series for samples containing complex mixtures of pollutants.

Subitem (5) requires that the monitoring protocol include methods used to identify and prevent contamination of samples in the laboratory and during transport. This provision requires precautions to detect alterations of water chemistry. These precautions range from visual inspection of container covers for leaks to analysis of quality control samples.

Subitem (6) requires that the monitoring protocol list the analytical quality control procedures that have been developed pursuant to the requirements of item O. This provision is addressed in the discussion of that item below.

Subitem (7) requires that the monitoring protocol include methods for reviewing and assessing all data for completeness and accuracy. This provision assures that laboratories check their calculations, data entry, equipment calibrations, number of dilutions, and any other procedures where routine errors or omissions may occur.

Subitem (8) requires that the monitoring protocol establish sample retention time after analyses are completed. This requirement informs all interested parties of how long the remnants of a sample will be available if it becomes desirable to rerun the sample to verify the results. The Agency believes it is unreasonable to specify minimum post-analysis holding times because verification is often better achieved by collecting a new sample or by splitting samples at the time of collection. Analyses of the split samples are conducted by different laboratories.

Subitem (9) requires that the monitoring protocol include inspection, testing, and preventive maintenance programs for all laboratory equipment. This helps assure that laboratory equipment is in good working order and consistently attains acceptable levels of performance.

Under subitem (10), the monitoring protocol must contain chain-of-custody procedures. The need for chain-of-custody has been established under item H, subitem (10).

Subitem (11) requires that the monitoring protocol establish procedures for documenting and retaining quality control results. Many quality control tests are routine internal laboratory procedures. The results are seldom inspected by outside personnel other than an accrediting or certifying body. This provision requires laboratories to describe how they document and retain the quality control results in the event the information is needed.

Finally, subitem (12) requires the monitoring protocol to list continuing education requirements for analytical personnel. This provision assures the facility owner or operator and the Agency that laboratory personnel are keeping up with state-of-the-art analytical methods, procedures, and equipment.

Item O requires the use of quality control procedures in the laboratory to assess reliability, precision, and accuracy. These quantitative tests are needed to ensure that analytical tests continuously stay within desired limits of accuracy. The quality control procedures confirm the validity of the laboratory analyses with quantitative tests and assure that variations are detected so that they may be corrected.

Item O goes on to require that the monitoring protocol describe and state the quality control tests, their conditions, and frequencies with which each test is used. It is necessary to state conditions for use of the tests because some of the tests are not applicable to a given analytical method and they must be run in a logical sequence. A stated frequency is needed because the degree of quality control is indicated by the frequency of quality control samples, e.g., whether duplicates and spikes are run after every fifth or every tenth environmental sample.

Item O requires that the quality assurance program include trip blanks and laboratory blanks. Blanks are samples of laboratory pure water that is processed like the samples. All procedures, materials, preservatives, and labware used in the sample preparation are also used for the blanks to enable detection of sample contamination and definition of the level of background contamination that was beyond control. Blanks are quality control procedures that differentiate between pollutants representative of actual ground water conditions and sample contaminants originating from other sources.

Calibration standards are test samples prepared in the laboratory with known concentrations. They are used to calibrate equipment daily, so that the instrument response to a substance in the field sample can be accurately quantified by comparison with the daily calibration curves.

Laboratory quality control samples are like the calibration standards, but they are prepared from a different source and usually obtained from an outside supplier. They serve as a check on the calibration procedure and on the quality of the laboratory standards.

Laboratory spikes are prepared by adding a known amount of a pure substance to a sample, then analyzing the sample. The calculated percent recovery of the spike is used as a measure of the accuracy of the overall analytical test method for that sample. Use of spikes is the only means to identify analytical interferences due to the combination of substances present in the pollutant matrix. Spikes also help document and quantify the level of accuracy in the analysis.

Laboratory duplicates are separate aliquots made in the laboratory from the same sample. The percent difference between the separate analyses is a quantitative measure of the precision of the analytical method.

Laboratory replicates are multiple readings on the same sample made over the same time the laboratory instrument is in use. The percent difference among the analyses serves as a quantitative measure of the precision and stability of the equipment calibration over the time of the test.

Item P establishes the reporting requirements for water quality monitoring. The facility owner or operator must submit monitoring results to the Commissioner by the dates specified in a permit, order, stipulation agreement, or other enforcement document. This provision enables the Commissioner to establish the length of time that may pass from sampling to reporting based on facility-specific conditions. A facility showing no impacts on ground water or surface water is not as high a review priority as a facility being monitored for impacts on nearby residences. The Commissioner, under this item, may establish submittal times based on the need for the data to implement corrective actions.

Item P further requires that the results be accompanied by information sufficient to establish the reliability, precision, and accuracy of the reported values. This includes the information in subitems (1) to (5). This requirement can be fulfilled in at least two different ways. The first is to show the precision and accuracy values, corresponding to the values measured in duplicates, spikes, etc., with the concentrations reported on each laboratory data sheet. The complexity of analyzing leachate-polluted water matrices suggests that this would be difficult. The second way to fulfill this reporting requirement is easier. Each laboratory sheet can carry a statement that precision and accuracy met or exceeded a predetermined percentage or that the specific values were actually outside the predetermined cutoff.

Subitem (1) requires a certification signed by the sampling personnel, analytical laboratory, and facility owner or operator stating that all sampling and analytical procedures were performed as described in the monitoring protocol. The certification must contain a description and explanation for any departures from the protocol's procedures. Compliance with this requirement will provide evidence that correct sampling and analytical procedures have been used. The certification may be needed in the evaluations and possible future re-evaluations of the monitoring data. The required certification is preferable to the other only alternative that provides the same information; namely, requiring all in-field and laboratory quality control records to be submitted.

Subitem (2) requires submittal of water elevation data and other field measurements and observations. Subitem (2) further requires information on the dates and times when each sample was collected, received and analyzed by the analytical laboratory. This information verifies compliance with sampling schedules required by the permit; checks compliance with maximum recommended or agreed-to sample holding times; and allows checking of other time-dependent technical considerations.

Subitem (3) requires that the water monitoring results include analytical results from all blanks tested. Blanks identify possible extraneous sources of contamination, which might be erroneously attributed to pollution. If nothing is found in the blanks, they provide evidence that substances found in the samples were actually present in the water.

Subitem (4) requires reporting of retention times and peak sizes for unidentified substances. This is common practice when using chromatographic analytical methods. A peak on a chromatogram can indicate the presence of a substance, but if the retention time does not match with known retention times of other substances, the substance cannot be identified. Without knowing its identity, the substance cannot be quantified. This requirement provides information on the retention time needed to identify an unknown substance found in subsequent analyses. The requirement does not require positive identification of all peaks. Commentors from analytical laboratories suggested absolute identification could become very involved and may be unwarranted if the substance does not recur. The approach in subitem (4) assures that the information obtained is reported, but it defers the requirement for identification of the substance until a need is clearly indicated.

Subitem (5) allows the Commissioner to require that the monitoring reports include additional information needed to establish the validity of the analytical results, chain-of-custody records, and field records. This condition compels the delivery of needed evidence if the validity or security of water quality monitoring results is in question. This subitem is not unnecessarily extended to every facility.

Subitem (5) states that the additional information required to establish the validity of the results may include precision and accuracy data from the batch of samples in which each sample was analyzed. This provision is less flexible than the more general requirement for precision and accuracy information in the first paragraph of item P. This condition removes the option of simply reporting that precision and accuracy were within specified limits. The Commissioner may require that quality control samples be run during or immediately bracketing the field samples. This condition precludes simply queuing up the facility's samples with a series of samples from other locations, without regard to when quality control samples are run within that sequence. This provision will be used when there are doubts about the precision and accuracy of a test or when some pressing public health concern warrants greater than normal certainty about precision and accuracy.

Subitem (5) also allows the Commissioner to require reporting of limits of quantitation and limits of detection, and results from various other quality control procedures. These conditions will be applied selectively as needed rather than at all times. The Agency must have access to all relevant evidence, if there are questions about the quality of water monitoring results.

Item Q requires submittal of an annual summary and discussion of the monitoring results. This requirement is needed to ensure that the facility owner or operator interprets and understands the monitoring data. The facility owner or operator is not free to plead ignorance of the meaning of the data. This has happened before. If the facility owner or operator identifies a trend toward deteriorating water quality, this awareness can convince the owner or operator that a change in the facility operation or design is needed to curtail the trend.

Item Q specifies that the annual summary identify recent and long-term trends in the concentrations of monitored constituents and water elevations; tabulate the analytical results; and highlight results that exceeded either the ground water performance standards or surface water quality standards. The evaluation must include an analysis of the effect the facility is having on water quality. These provisions help organize the data into a useable form, make sense of data by interpreting the trends and evaluating the facility's impacts, and make the facility owner or operator and the Agency aware of instances of possible noncompliance with water quality standards. Finally, the annual summary must identify any additions, changes, or maintenance needed in the monitoring system. This provision reasonably provides for a regular reconsideration of the adequacy of the monitoring system. For example, if the data show that a pollution problem has developed at the outermost monitoring points, the need for additional monitoring points or corrective actions must be considered.

Subpart 15. Contingency action. This subpart establishes the minimum requirements under which the facility owner or operator must implement corrective actions. The facility owner or operator must implement the actions necessary to repair site features or to control, recover, or treat polluted ground or surface waters and explosive or toxic gases. The actions implemented must include the measures dictated by the situation and outlined in the contingency action plan. The contingency action plan must address the repair of clogged collection systems, repair of monitoring wells or probes, repair of cover systems, and the repair of liners or holding areas.

Corrective actions are used to minimize the environmental impacts a failure in the facility design components may have. It is reasonable to indicate by rule when corrective actions are considered necessary and the types of incidents that should be addressed in contingency plans. This requirement provides facility owners and operators an understanding of the Agency's view of corrective actions and provides for consistency in plan development and implementation. By understanding the types of events that may be considered corrective actions, the facility owner or operator will be better able to plan the financial responsibility attached to the operation of land disposal facilities and to develop a risk management program.

The nature of contingency action planning is that problems develop that were not anticipated in the plan. To the extent possible, a risk management program minimizes events never even thought to be possible at a land disposal facility.

The proposed rules address events that are truly unexpected. Should an unanticipated event occur, the contingency action plan must be modified to include this event and make appropriate adjustments to financial assurance instruments.

This subpart addresses conditions that may occur when corrective actions actually require a higher level of effort than was anticipated in the contingency action plan. If the level of effort needed to protect human health and the environment be greater than anticipated, the facility owner or operator must implement these actions even though they are not included in the contingency action plan. The contingency action plan is a tool for estimating both the level of effort needed if particular events occur and the cost associated with the effort. The plan is not expected to be 100 percent correct for every situation. This subpart states explicitly the responsibilities of facility owners and operators, so they know what compliance means and the Agency expects. This is a reasonable approach to developing detailed plans and reviews that ensures consistency in corrective actions.

Subpart 16. Closure and postclosure care. General closure and postclosure care performance standards for all solid waste management facilities are contained in parts 7035.2625 to 7035.2655. The Agency believes it is necessary to expand upon the general requirements for land disposal facilities. More specific requirements will compel the detail work needed to minimize infiltration into the fill area and protect site conditions after operations have ceased. Placing the additional requirements in rule provides for consistent review of the documents addressing these activities and enables facility owners and operators to more closely define costs associated with these actions and prepare for them.

Item A establishes the standards applicable to closure of mixed municipal solid waste land disposal facilities. This item requires closure of each fill phase to start within 30 days after reaching final permitted waste elevations. Final cover is used to control the amount of precipitation and surface water run-off that enters the fill area, ultimately minimizing the amount of leachate generated. If the waste remains uncovered for some length of time, unnecessary moisture enters the fill area increasing the amount of leachate generated needing treatment.

Leaving final cover for placement until operation at a site are complete is of little benefit to the facility owner or operator or surrounding neighbors. A fill area left uncovered becomes a harborage for rodents and small burrowing animals and disease-carrying vectors. Although intermediate cover would be required over these areas, the shifting and settling of the waste as it compacts under its weight and decomposition causes the intermediate cover to move into the waste. For the facility owner or operator to maintain intermediate cover over these areas is very expensive and time consuming. The final cover will provide more benefits and will maintain its integrity better than an intermediate cover because of the structural support given by the soils used during construction.

The proposed rules require the facility owner or operator to establish a financial instrument with funds collected over the operating life of the facility. This estimate will be developed considering the amount of area to be covered at closure, the amount of grading and surface water diversion structures needed at this time, and other construction activities that must be completed at closure. By covering the fill phases as they reach final permitted waste elevations, the facility owners and operators will be able to keep these cost estimates to a minimum. Item A establishes a reasonable standard for closure of fill phases because it compels a closure schedule consistent with overall facility design plans. Because the Agency alerts facility owners and operators to the need to promptly close fill phases, the closure can be scheduled into normal facility operations, reducing the need for hurrying any bid processes needed to complete the task or the installation of final cover materials over large portions of the site prior to cold weather.

Requiring that closure of fill phases occurs on a regular basis ensures a minimum level of effort to minimize the risk associated with excess moisture entering the fill area. The design of the facility will be based on the assumption that final cover is placed over fill areas as soon as possible. If final cover is delayed and excess moisture is allowed to enter the fill areas, the performance of the liner and leachate collection system can be impaired by overloading. This provision limits the probability of this event occurring and thus provides further protection of human health and the environment.

After considering past performances at land disposal facilities, the Agency believes it must provide a time frame under which closure activities should occur. In the past, closure activities including final cover were slowly, if ever, completed. In an effort to minimize the risks associated with land disposal facilities, the Agency proposes that closure activities be started within 30 days after final permitted waste elevations are reached. Initially, the Agency proposed a time frame for completion of these activities rather than initiation; however, commentors on the draft rules suggested that no specific number of days could address all the situations that might arise during construction. The Agency agreed that the time to complete closure construction could vary drastically due to factors such as weather or equipment malfunctions.

The Agency believes the approach chosen in the proposed rules contain a reasonable method for securing closure in a timely fashion. When work has been initiated, the facility owner or operator will be compelled to complete these activities in a timely fashion or incur the financial burden of increased costs for the construction. Thirty days ensures the work is started in a timely fashion but allows the facility owner or operator some flexibility in scheduling the work. To allow a longer period of time would leave the facility open to impacts from the weather and a shorter period of time would not allow the facility owner or operator sufficient time to mobilize the work force needed. The Agency received comments contrary to the proposal.

Item B establishes the activities the facility owner or operator must conduct after closure activities are completed. This item proposes standards that ensure facility integrity is maintained after daily disposal operations are complete.

Subitem (1) requires the facility owner or operator to restrict access to the facility by the use of gates, fencing, or other means to prevent further disposal at the site, unless the site's final use allows for access. Risk management at a land disposal facility depends on the quality of construction. As components are built, certification procedures on workmanship are followed to demonstrate the integrity of the components. Maintaining this integrity after closure minimizes the potential for impacts on the environment due to failure in the components.

In general, the only activity considered in the design for land disposal facilities is the proper disposal of solid waste. After filling operations have ceased the facility is left unsupervised, allowing for vandalism, unintentional intrusions, or animal disruptions of completed components if no protective measures are employed. The Agency recognizes that if a person intends to damage a facility, a method will be found to avoid access restrictions. However, for the average person or animal who may unintentionally intrude on the facility, a controlled method to prevent unauthorized dumping or disruption of the facility design components is needed. The proposed performance standard allows the facility owner or operator flexibility in attaining the standard.

Facility owners and operators who have used fencing to control unwanted disposal during facility operations have to do nothing additional; however, they may design and construct devices that fit into the overall facility design and are cost effective at the same time. The Agency believes this item strikes a reasonable balance between establishing a guiding performance standard and requiring site-specific designs capable of meeting the performance standards. The standard proposed allows facility owners and operators to take advantage of topographic features and cost-effective designs.

Subitem (2) requires the facility owner or operator to maintain the integrity and effectiveness of the final cover during the postclosure care period. Actions needed to accomplish these goals include making repairs to the final cover, as necessary, to correct the effects of settling, subsidence, gas and leachate migration, erosion, root penetration, burrowing animals, or other events that may impact the final cover performance. The final cover system is the design component responsible for controlling moisture infiltration into the fill area. Maintaining the final cover after the facility is closed will decrease the risk of more costly, corrective actions to be implemented at some point during the postclosure care period.

A performance standard is established rather than a specific set of design criteria because of the numerous situations that may impact final cover performance. The Agency believes it is important to retain sufficient flexibility in this provision to allow facility owners and operators to consider the specific facility design features and how they relate to the performance and integrity of the final cover. The list of items that need to be addressed by facility owners and operators are the types of events that have the potential to impact final cover integrity and performance. An effective risk management program would ensure maintenance of the final cover. Thus, this proposal only serves to explicitly state the facility owner's or operator's responsibility.

Subitem (3) requires facility owners and operators to maintain and monitor gas and ground water monitoring systems and to comply with the requirements of subparts 11 and 14. While subparts 11 and 14 govern the specifics of gas and ground water monitoring programs, respectively, the Agency believes it is necessary to state that postclosure care of these systems is required at all mixed municipal solid waste land disposal facilities. Maintaining gas and ground water monitoring systems during the postclosure care period ensures that the systems most critical in evaluating facility performance will be operable. The gas and ground water monitoring systems provide data used to evaluate waste stability and impacts the facility may be having on the surrounding area. The largest amount of decomposition and pollutant generation will occur after closure. It is important to understand the effect they have on environmental quality.

Subitem (4) requires the facility owner or operator to continue to operate the leachate collection and removal system during the postclosure care period. Leachate generation theoretically starts at low volume until the waste is no longer capable of absorbing incoming moisture and decomposition is underway. By the time of final closure, the facility leachate generation may not as yet have stabilized and if it has, the maximum rate of production may have been achieved (one drop of water in equals one drop of water out). If the leachate is not removed from the fill area, the increased depth of leachate on the liner could impact the volume of leachate released and the efficiency of the facility. The larger head of water on the liner could increase vertical pressures on the liner to the extent that downward vertical flow is dominant over the horizontal flow anticipated by the liner design. Continual removal of leachate is also needed to prevent pressures that could disrupt final cover and liner systems or build to the extent the fill area acts like a bathtub and overflows. Requiring continued removal of the leachate will avert potential pollution events and the high cost of some corrective actions. Gas and ground water monitoring provide back-up methods for evaluating facility performance. Unfortunately, if these areas indicate that pollution exists, the problem can become more widespread. This provides the Agency some assurance that any material leaking out of a land disposal facility will be small and easily correctable rather than requiring the implementation of the more costly and difficult corrective actions.

Subitem (5) requires the facility owner or operator to prevent run-on and run-off from eroding or otherwise damaging the final cover. As discussed earlier, the integrity of the final cover is directly related to the ability of the facility to meet performance standards. An efficient risk management program places considerable effort and importance on maintaining the final cover in good condition. Because the final cover is so accessible the effort needed to protect and repair it is much less than for the liner system. A main cause of final cover systems failure is erosion. Erosion is generally caused by the rapid or continual movement of liquids or wind over the surface of a cover system. By controlling run-on and run-off, the facility owner or operator will minimize the erosion potential of the facility's final cover.

The proposal of performance standards for erosion control allows facility owners and operators to use designs and maintenance programs responsive to site-specific conditions. The combination of facility designs and topographic features makes it improbable that any one set of design standards could address the site-specific conditions at all facilities adequately. Allowing facility owners and operators to evaluate site-specific conditions and facility designs in developing a program to prevent final cover erosion establishes the responsibility without necessarily increasing the level of effort needed by the facility owner or operator.

Subitem (6) requires the facility owner or operator to protect and maintain surveyed benchmarks during the postclosure care period. Benchmarks are used to establish elevations of specific design components. The elevations are further used to collect accurate data on the slope of final covers, the location of monitoring points, the depth to water, etc. This information is used to evaluate site conditions based on initial conditions and conditions at the time of a survey completion. Thus, it is important that the benchmark be maintained at facilities for continued use during the postclosure care period to ensure consistency between data collected while the facility is in operation and after closure. This continuity adds reliability to the performance evaluations for facilities. The maintenance of benchmarks requires little effort on the part of a facility owner or operator provided the benchmarks were initially property installed. This provision requires no additional effort on the part of facility owners and operators.

Subitem (7) requires annual surveying of the facility to determine the extent of settling, subsidence, erosion or other events. Erosion and settlement can occur so subtly that the human eye cannot detect the change. Consider the erosion of top soil each year. Although tons of soil are lost each year to wind and water erosion, it is difficult to perceive unless a complete layer of soil has been removed and a soil of different texture and coloration is revealed. Final cover must be maintained to minimize infiltration into the waste. Settlement at mixed municipal solid waste facilities may be as much as 25 percent of the fill depth each year or as little as 5 percent. The less dramatic the settlement the more difficult to determine without the use of surveys. If settlement is allowed to continue until slopes are flattened, water will pond on the cover and infiltration will increase. The information obtained from annual surveys is used to determine compliance with Agency performance standards.

Subitem (8) requires facility owners and operators to submit an annual report to the Commissioner describing present conditions and corrective actions taken during the year. Annual reviews allow for early detection of problem areas and implementation of corrective actions during times when problems are small and controllable at small costs. The annual report does not require that a sophisticated written document be submitted by all facility owners and operators. An annual report assures the Agency that facility owners and operators are aware of site conditions, yet does not create an unbearable expense for them.

Subitem (9) requires that all repair work be completed within 30 days of discovery. Left unchecked, small problems can result in large releases of pollutants over time or immediate failures in the near future. Because facility personnel are not generally on-site during the postclosure care period it is important that repair efforts be implemented promptly. Requiring complex repair work within 30 days during the postclosure care period minimizes the potential for pollutant releases to the environment. A shorter time period would not allow the facility owner or operator to assemble material and work force. If no time period were included in the rule, the facility owner or operator would have no direct responsibility to repair conditions unless monitoring data shows the facility performance to be inadequate. The Agency feels these options are unsatisfactory. No comments were received on the time period proposed under the rules.

2. Part 7035.2825 DEMOLITION DEBRIS LAND DISPOSAL FACILITIES.

As defined in part 7035.0300, subpart 30, demolition debris is solid waste resulting from the demolition of buildings, roads and other man-made structures. Demolition debris does not include asbestos wastes generated from these activities nor does it include the waste generated at construction sites. Demolition debris consists of inert materials such as glass, concrete, brick, rock, etc. This material is significantly different in chemical and physical composition from either mixed municipal solid waste or industrial solid waste. Therefore, the Agency believes separate design, construction and operation standards should be applied to the facilities used to manage demolition debris.

As with the standards applicable to mixed municipal solid waste land disposal facilities, the standards proposed in this part apply only to demolition debris land disposal facilities. The standards and requirements applied to demolition debris land disposal facilities and other solid waste management facilities are found in parts 7035.2525 to 7035.2655. The Agency believes this format eliminates the duplication of language and clearly indicates to facility owners and operators that the basic requirements apply to all solid waste management facilities in reaching the mutual goal of protecting human health and the environment.

A common complaint heard by Agency staff during public meetings held to discuss the proposed rules was the length of the proposed rules. Suggestions were made on organizing the rule in order to eliminate all repetitive language. There were counter suggestions to eliminate cross-references to ease the reading of the rules. The two suggestions are mutually exclusive particularly when the second option also contained a request to keep the rules short. The Agency considered both suggestions, chose the option using cross-references, and has combined standards applicable to all facilities in one area. Therefore, this part will contain cross-references, and has combined standards applicable to all facilities in one area. Therefore, this part will contain cross-references to other parts of the proposed rules that are applicable to these facilities. The Agency believes this will provide the detailed rules requested by the public during preliminary rule meetings, yet keep the rules as a whole within a manageable size.

Demolition debris is generated most often from the razing of office or residential buildings. The waste generated during road construction is often ground and reused in the road construction process. The amount of waste generated is often small and short-term. The Agency believes that a reasonable approach to managing the disposal of small quantities of demolition debris is through permit-by-rule status. The potential for environmental impacts from these facilities is small and the administrative process to obtain a permit would take longer than the facility would be in operation in many circumstances. Therefore, the Agency proposes to establish in rule standards for small, short-term facilities but eliminate the administrative permit process. In this way, the Agency will be able to focus its work efforts on larger, potential environmentally-sensitive projects yet ensure that minimum protective measures are employed at all disposal sites.

Subpart 1. Scope. This subpart details how the standards proposed in this part are divided between permit-by-rule facilities and regularly permitted facilities. Subparts 2 to 6 apply to owners and operators of demolition debris land disposal facilities granted permit-by-rule status under part 7001.3050, subpart 3. Subparts 7 to 14 apply to owners and operators required to obtain a permit under part 7001.3050. This subpart directs facility owners and operators to the appropriate subparts for the type of facility they will be operating.

By separating the permit-by-rule standards from the standards for larger, long-term facilities, the Agency believes any confusion over applicable requirements is virtually eliminated. The different facilities require rules written in different degrees of detail. Different amounts of information are needed to evaluate the facilities in an efficient and responsible manner. Additionally, this organization helps the facility owners or operators to locate the requirements applicable to their facilities and to understand the applicability of the requirements without Agency assistance. This allows more Agency staff time to be used for answering specific questions on the implementation of the rules rather than explanations on where the standards are located and which are applicable.

Subpart 2. Location standards for permit-by-rule facilities. Locating disposal facilities has become increasingly difficult in recent years regardless of the waste to be deposited at the facility. The Agency believes that by establishing particular standards for permit-by-rule facilities they will be more easily sited and will be located in environmentally acceptable areas. Because permit-by-rule facilities are small and short-term, the Agency believes the cost associated with a detailed hydrogeologic study would be inappropriate. However, some control on locating these disposal facilities must be exercised. Therefore, the Agency considered the types of environmental settings that could be environmentally sensitive to the disposal of any waste, and demolition debris in particular. After reviewing these areas, the Agency proposes a specific list of prohibited areas for the disposal of demolition debris. The specific prohibition of demolition debris in environmentally sensitive areas ensures the protection of these areas with minimal cost to the facility owner or operator.

Item A prohibits a facility owner or operator from locating a site on areas with karst features including sinkholes, disappearing streams and caves. Sinkholes, disappearing streams, etc., are indicators of subsurface conditions where water is acting on soluble bedrock. If a disposal facility is located in an area characterized by these conditions, the additional loads placed on the weakened bedrock may cause a collapse resulting in the demolition debris falling into the hole and impacting subsurface conditions. Facility personnel may be injured. Ground water flow is not well understood in karst areas because monitoring is difficult and flow patterns are irregular. The potential for disruption of environmentally sensitive ecology is great in karst areas.

Items B, C and D prohibit the siting of demolition debris land disposal facilities in wetland areas, floodplain areas, and shoreland areas respectively. If the facility is located in these areas, operations will become difficult to perform. Wetland areas, floodplains and shoreland areas are environmentally-sensitive areas because of the fragile balance that exists between flora and fauna. The use of these areas is governed by DNR and EPA. Disposal of wastes is not a permitted use.

Item E prohibits the siting of these facilities in areas with a water table within 5 feet of the lowest fill elevation. Although demolition debris has little potential for detrimental impacts on the environment, the introduction of any foreign substance into the ground water impacts its quality. By keeping the fill area above ground water table, the Agency ensures some natural treatment of moisture percolating through the fill before it enters the ground water. Additionally, facility operations are susceptible to malfunctions or other problems when conducted in moisture-laden soils because of lost stability. Five feet of separation between the lowest fill elevation and the water table allows for seasonal fluctuations in the water table and provides a safety factor in keeping the ground water and fill operations separated.

Subpart 3. Design requirements for permit-by-rule facilities. Facility owners and operators of permit-by-rule facilities are not required to submit design plans to the Agency for review and approval. Under permit-by-rule status, the facility owners and operators are required to construct and operate their facilities in accordance with standards established in rule. The Agency believes this eliminates an unnecessary administrative burden on owners and operators of small short-term facilities, yet ensures procedures to protect human health and the environment. Therefore, this subpart contains design standards the Agency believes are needed at all demolition debris land disposal facilities. Including these requirements in rule alerts facility owners and operators how they will be judged upon for compliance in order that the facility may remain under permit-by-rule status.

Item A establishes the requirements for site preparations at a location selected for a demolition debris land disposal facility. Site preparations must allow for orderly development of the site. Orderly development allows fill operations to achieve final waste elevations in short, discrete time periods, allows for final cover placement on a regular schedule, and minimizes infiltration into the waste. Unorganized fill operation causes backtracking in fill areas; requires long-term storage of final cover, as final waste elevations are slow to develop; and makes control of surface water difficult. Facility owners and operators must prepare the site in a manner that encourages orderly development and closure of fill areas because these disposal facilities are intended to be short-lived.

Initial site preparation activities must include clearing and grubbing; topsoil stripping and stockpiling; fill excavation, if appropriate; drainage control structures; and other design features necessary to construct and operate the facility. These items are common to any construction activity unless the area to be filled is an existing pit that requires no clearing to begin operations. By addressing site preparation work in a rule the Agency also indicates that surface dumping of demolition debris in wooded areas without taking proper actions is not appropriate. Fill areas must be discrete units that can be controlled, covered and maintained in a proper fashion. Facility owners and operators must properly prepare the site to minimize risk associated with operating the facility and to minimize environmental impacts that may result from improper disposal.

Item B requires the site to be developed in phases to achieve final fill elevations as rapidly as possible. The design of each phase must consider weather conditions, site drainage, and the waste flow pattern at the site. As discussed under item A, the Agency's preferred method in developing land disposal facilities is the construction of the facility in discrete units that permit orderly development, achieve proper closure, and control surface water drainage. Filling of the site vertically faster than horizontally allows facility owners and operators to control facility operations and moisture infiltration into the fill area. Demolition debris is bulky and heavy. The equipment used to haul and maneuver the waste must be large enough to handle the waste. This equipment may have difficulty operating on slopes steeper than a 5 to 6 percent grade particularly during winter operations. Thus, facility owners and operators are required to use design and operational procedures that will control the size of the fill area. This encourages the development of the facility in discrete units to attain final closure as disposal progresses and minimizes the potential for environmental impacts.

Item C requires surface water drainage to be diverted around and away from the fill area. By diverting surface water out of the fill area including active operating areas, the facility owners and operators will minimize the potential for environmental impacts from excessive soil loss from the fill area, leachate generation, and cover erosion.

Item D requires the facility owner or operator to design slopes and drainageways to prevent erosion. Slopes longer than 200 feet must be interrupted with drainageways. Erosion is a naturally-occurring event associated with surface water drainage and caused by rain, snow melt and wind. The amount of erosion in an area depends on the slope of the area and vegetative cover. The amount of soil disturbance can also affect the amount of erosion because loosening the natural soil provides easier soil movement due to drainage patterns or precipitation. It is necessary to control soil loss to preserve topsoil and prevent the overloading of aquatic habitats with sediment. Good management practices dictate the need to control erosion and eliminate the additional work required to repair the affected areas, the cost of obtaining additional soil, and the operational difficulties that might arise from the sloughing off of soil into the working area.

Two-hundred feet was chosen as the maximum run permitted on any slope, based on the Soil Conservation Service's recommended guidelines for controlling erosion. The amount of soil erosion is related to the slope, the speed at which water runs off an area, and the amount of water flowing over the area. On drainage runs greater than 200 feet the volume of water carried over the area can dislodge soil particles carrying them away with the water. Maintaining runs of 200 feet or less, the amount of water carried over any one area will be less, minimizing the potential for erosion.

Item E establishes minimum slope requirements for permit-by-rule facilities. Final slopes must be at least 2 percent and no greater than 20 percent. Demolition debris disposal sites are often used as building or parking lot locations. Demolition debris provides good structural support and makes suitable fill material for sites needing support. When a site is to be used for a building location, slopes need to be relatively flat to allow proper site use. The two percent slope allows drainage off the site without impairing the use of the site as a building location. For areas that are filled vertically above the surrounding ground surface, care must be taken to minimize the erosion potential. Requiring the facility owners and operators to keep slopes below a 20 percent grade, lessens the potential for erosion because water will be flowing down the sides of the disposal area at a slower speed than the current 25 percent grade allows.

Item F defines the design requirements for final cover at permit-by-rule facilities. The final cover must consist of at least two feet of soil and the top 12 inches must be capable of sustaining vegetation. Demolition debris is bulky with many sharp corners that could puncture synthetic membrane covers. The bulky nature of this waste makes compaction difficult to achieve, resulting in gaps and crevices. Large stresses cause tears in synthetic membranes. The inert nature of this material also makes the establishment of vegetation almost impossible without a suitable soil present. A synthetic membrane cover would require facility owners and operators to use less soil in order to make the synthetic cost effective. The use of insufficient soil amounts can result in poor vegetative growth increasing the potential for erosion of the soil, and exposure of the membrane to physical attack by weather and animal intrusion. Therefore, the final cover material must be soil. Most vegetative grasses used in seed mixtures have a root zone of 18 inches or greater. By requiring at least two feet of cover, the cover will sufficiently support vegetation and minimize erosion due to insufficient root structure development to hold the soil particles in place.

Demolition debris is often used to fill mined gravel pits to lessen the burden and expense of finding adequate amounts of soil. However, this often means on-site soils are either very sandy or a very tight clay material. Neither of these materials provides a good growth medium for vegetation. Therefore, a standard of 12 inches of soil capable of sustaining vegetative growth was included in this item. Although the root zone of many vegetative grasses is 18 inches or more, 12 inches of the final cover of a quality soil material will hold sufficient moisture to support vegetation. This standard allows facility owners and operators to use on-site soils to the extent possible yet ensures that vegetative growth will occur.

Item G requires the final contours to be consistent with the planned ultimate use for the site. If the facility owner or operator intends to use the disposal site as a building location, it makes little sense to establish final contours that result in 20 percent slopes. In this situation, the proper slope may be closer to the minimum 2 percent. A final contour with 20 percent slopes would only require the facility owner or operator to rework the area to make it suitable for construction purposes. Planning is the key to a successful operation for present and future activities. This item provides a reasonable opportunity for facility owners and operators to develop a site to fit their needs while still addressing minimum design standards.

Subpart 4. Operation and maintenance requirements for permit-by-rule facilities. Owners and operators of demolition debris land disposal facilities eligible for permit-by-rule status are not required to develop an operation and maintenance plan for review and approval by the Agency. It is still important, however, that they consider the operational procedures that are needed to manage incoming waste. The Agency will not have the opportunity to advise facility owners and operators of small facilities on the minimum operational techniques that should be followed. Therefore, these techniques must be in rule to ensure consistency in operations at permit-by-rule facilities.

The demolition debris land disposal facility must be operated by an operator certified in accordance with Minn. Rules pts. 7048.0100 to 7048.1300. The certified operator must be present during the time the facility is open to accept waste. The rules governing the certification of land disposal facility operators require operators of these facilities to complete four hours of training before certification. No exemption is provided for short-term facilities under the operator certification rules so facility owners and operators must be forewarned of the need to obtain certification. It would be inconsistent for the Agency to establish certification requirements for facility operators yet permit a facility to be operated without a knowledgeable person on the site.

Item A under this subpart requires the waste to be spread and compacted to the extent possible. Demolition debris is bulky and hard to compact. Merely dumping the waste in the fill area can cause bridging of wooden timbers between concrete sections. By spreading the waste and attempting compaction, the facility owner or operator can minimize the amount of bridging that occurs saving space in the fill area for more waste rather than soil used to fill cracks and crevices. This performance standard will ensure some effort to attain compaction at these facilities. A specific depth and compaction standard would not work because not all demolition debris will be delivered in the same shape or size and the equipment available will differ.

Item B requires the waste to be covered at least monthly. Demolition debris is relatively inert and offers very little enticement for vectors. However, the bridging that may occur in the fill area could create habitat for small animals. To eliminate these activities, it is good practice to fill any cracks or crevices with soil to eliminate natural caverns that may exist. Periodic covering of the waste ensures that open spaces in the waste will be filled, further solidifying the structural support provided in the fill area. Monthly covering also minimizes the perception that the facility is a dump available for common use for any waste. Eliminating this perception will preclude the facility owner or operator from having to remove unacceptable waste and dispose of it properly.

Item C requires the facility owner or operator to maintain suitable cover material on-site. Under subpart 3, the facility design is to encourage rapid vertical filling of the site to achieve final waste elevations. Rapid vertical progression is encouraged to control the width of the fill operation and to provide for orderly development of the facility. The placement of cover is part of the development process of the facility. Final cover placement is needed as waste elevations are reached in order to avoid violations of projected volumes for the facility. Permit-by-rule facilities are governed by volume limitations and operating life. If original contours are not properly followed, the facility owners or operator may violate the terms governing permit-by-rule status. Additionally, prompt placement of final cover minimizes work effort at the time of closing and allows for better scheduling of facility operations. Monthly covering is not eliminated for activities conducted during winter months or wet weather. Under final cover or monthly cover operations, activities are more easily coordinated with cover available on-site. During freezing or extremely wet conditions, the facility owner or operator may not be able to obtain cover from off-site sources. This provision ensures cover material is available when needed.

Item D requires the facility owner or operator to stake each fill phase for proper grading and filling. By staking the phase, the facility owner or operator can control the fill progression and ensure site activities do not interfere with adjoining properties. The placement of final cover is made easier by utilizing grade stakes to determine the proper depth of cover to be achieved in any area. Additionally, if the fill area is staked, trenching activities will progress more rapidly as repeated checking of boundaries will not be necessary. Requiring staking of fill areas for grading eliminates the potential for disorganized fill operations; eliminates the potential for filling outside proper boundaries; and allows for more efficient use of construction equipment.

Item E requires that a minimum distance of 50 feet be maintained between the fill boundaries and the site property line. Filling up to the property line has in the past resulted in fill operations moving off the facility owner's or operator's property on to adjacent properties. Maintaining the proper separation distance will eliminate this from happening in the future. The 50-foot separation distance also provides sufficient area outside the fill area to install surface water drainage control structures and sufficient stable ground to conduct site operations. Controlling surface water before it leaves the site property prevents the disruption of activities on adjacent properties due to excessive surface water flooding and uncontrolled erosion. It is reasonable to control the fill boundaries at a facility because compliance will minimize impacts the facility has on surrounding areas.

Item F permits only the disposal of demolition debris at permit-by-rule facilities. The Agency will not be reviewing design, construction or operation plans for these facilities and will be unable to ensure the necessary precautions will be instituted to protect the environment and human health from impacts of different waste accepted at the facility. The design and operation standards proposed under subparts 2 to 6 are based on the assumption that only demolition debris is accepted at the facility. It is reasonable to prohibit the acceptance of any waste other than demolition debris at permit-by-rule facilities because the facilities are not equipped to properly handle the waste, nor is monitoring present to determine the impacts these wastes might have on the environment.

Item G requires that any waste stored at the site be stored in accordance with the requirements of part 7035.2855. The facility owner or operator might need to store some waste at the site prior to proper disposal or removal from the site if unexpected wastes are delivered to the site. Facility owners and operators should be informed of the requirements that would govern these activities.

Subpart 5. Closure and postclosure care for permit-by-rule facilities. All disposal facilities must be closed at some time. Although the Agency does not require facility owners and operators of small, short-term facilities to obtain a permit through the normal administrative process, it is important that the basic protections of human health and the environment be required at all facilities. Therefore, the Agency clearly indicates here the specific closure and postclosure activities that must be completed at permit-by-rule facilities.

The facility owner or operator must close each phase as it reaches final waste elevations. The final cover must consist of at least 2 feet of soil capable of sustaining vegetative growth and minimizing erosion problems. Alternative solid waste management facilities do not necessarily require any special activity at the time of closure; however, proper closure of disposal facilities is particularly important in minimizing the impacts from these facilities. To eliminate the need for extensive work when the entire fill area has reached capacity, closure activities should proceed as filling progresses. This allows for facility owners and operators to more closely budget operational costs while ensuring facility activities are conducted in a manner that minimizes the potential for environmental impacts. The reason for requiring 2 feet of cover in the final design was discussed regarding subpart 3. The Agency has repeated this requirement to emphasize the importance of utilizing proper cover materials when closing a facility.

Conducting closure activities as filling progresses preserves orderly site development, minimizes environmental impacts, and maximizes operational efficiency.

After closure, the site must be inspected at least once each year between June and September. All problems at the site must be corrected within 30 days of the inspection. Final cover placement on a land disposal facility fill area does not guarantee protection from settlement or erosion. Although settlement at demolition debris land disposal facilities should be minimal due to the stability of the waste, it is important that an inspection be conducted yearly to evaluate the impacts weather conditions, such as freezing and thawing, have on the shifting of materials. Freshly compacted and seeded cover material is susceptible to erosion until vegetation is well established.

Thirty days is a reasonable time period to implement corrective actions because the area impacted should be small. The stability of the waste would indicate little potential for correction of settlement areas and erosion should be minimal provided good construction techniques were followed during placement. Proper care of facilities after closure is prudent risk management activities to eliminate future corrective actions.

A site closure record must be completed after closure and submitted to the Commissioner. A notation must be placed on the property deed indicating the site use and location of the waste. Requiring facility owners and operators to submit a site closure record is the most effective way to notify the Commissioner of the completion of facility activities and to update Agency files on the fill progression of these sites to ensure volume and operating life limits are not violated. The site closure record is not a hardship on the facility owner or operator because it is basic information that must be prepared to responsibly operate the facility. Future owners of a particular site have a right to know how prior owners used the land so they understand the risks they may be accepting in purchasing the land and the limitations that may be placed on site activities. Requiring facility owners and operators to place a notation on the property deed ensures future owners are made aware of past site activities.

Subpart 6. Notification of permit-by-rule facilities. The owner or operator of a facility qualifying for permit-by-rule status must notify the Commissioner of the facility's existence by letter within 30 days after the effective date of the proposed rules. Owners and operators of new facilities must notify the Commissioner by letter before operations begin. The notification letter must include the initial date of operation, the type of waste accepted, the capacity of the site, the location of the site, the users of the facility, and the expected closure date of the site.

A notification letter provides a method for facility owners and operators and the Commissioner to communicate about a particular disposal facility. The information in the notification letter will give the Commissioner sufficient facility location and design information. The Commissioner will be able to notify the facility owner or operator of circumstances that may cause a violation of the permit-by-rule standards and provide advice on design or construction techniques that would prevent these violations. The information to be submitted to the Commissioner is all readily known by the facility owner or operator as it is necessary to determine the eligibility of a particular site for permit-by-rule status.

Subparts 7 to 14 establish the minimum standards applicable to demolition debris land disposal facilities that will be operated for 12 months or longer or have a volume equal to or greater than 15,000 cubic yards. Separate standards should be developed for larger, long-term facilities because of the greater potential impacts from these facilities. The Agency believes having only one set of standards and trying to indicate clearly that provisions apply to permit-by-rule facilities and that apply to permitted facilities would result in confusion on the part of facility owners and operators. The Agency believes a more reasonable approach is to separate the standards, even though some repetition of information occurs. Facility owners and operators looking for information on applicable standards can restrict their search to the particular subparts applicable to their situation.

Subpart 7. Location standards for permitted facilities. The owner or operator of a permitted demolition debris land disposal facility is prohibited from locating the facility where the impacts from operations could have severe detrimental effects on the surrounding area. Unlike permit-by-rule location requirements, these standards do not specify all areas that may be excluded from consideration for use by larger, long-term facilities. The approach to location standards is somewhat different from those for permit-by-rule facilities because the Commissioner will have an opportunity to review how proper design, construction, and operation activities will be used to mitigate potential impacts.

Item A prohibits locating permitted demolition debris waste land disposal facilities on sites with active karst features including sinkholes, disappearing streams, and caves. As with permit-by-rule facilities, it is important to stay out of areas characterized by unstable bedrock due to the potential for bedrock collapse, which can injure facility personnel and impact the environment. Additionally, some of these facilities may accept other wastes depending on waste characteristics and volume and the design, construction and operation plans for the facilities. It becomes more important in these cases that maximum protection be used when locating the facility to ensure site conditions cannot impair facility operations.

Item B prohibits facility owners and operators from locating facilities on sites where topography, geology, or soil is inadequate for protection of ground and surface waters. Under part 7035.2555, these facilities are prohibited from environmentally sensitive areas such as wetlands and shorelands. The Agency believes that other areas exist that are inappropriate for the locating of these facilities. One goal of the proposed solid waste rules is to minimize the impacts solid waste management facilities have on the waters of the State. In striving to meet this goal, facility owners and operators and the Agency must consider all factors that contribute to proper management of these wastes. The physical features of a site are some of the factors that must be considered. Steep embankments, high ground water tables, or surface water drainage basins are physical characteristics that may prohibit the location of a disposal facility on a particular site.

Subpart 8. Design requirements for permitted facilities. This subpart sets out the minimum design standards the Agency believes are necessary for all permitted demolition debris land disposal facilities. Minimum design standards are necessary to ensure a base level of protection at every site through the design of the facility. As a risk management effort, the facility owner or operator may choose to design the facility so that it exceeds the standards. Including the minimum standards in a rule alerts facility owners and operators to what the Agency expects each design to attain to comply with the goals of the proposed rules.

Item A requires the facility owner or operator to develop specifications for site preparation during the permit process and submit them as part of the permit application. Site preparation must allow for the orderly development of the facility. The specifications must address clearing and grubbing, topsoil stripping and storage, cover material excavation, drainage control structures, and all other design features needed to prepare the site for operation. Site preparation is important in maximizing fill capacity while minimizing the impact site operations have on the surrounding area. Controlling surface water drainage is important to maintain fill operations, minimize erosion, and minimize impacts on surrounding areas. Preparation of the fill area must be controlled to maximize use of existing topographic features such as natural depressions and surface water drainage, thus eliminating costly construction activities. Stripping off topsoil and stockpiling it for use as cover is a prudent construction maneuver to obtain as much cover as possible from on-site soils rather than wasting this valuable material. Unless site preparation activities are planned, the facility owner or operator will not be able to schedule work functions systematically to minimize the amount of open area to control drainage problems and encourage controlled filling. This provision requires of the facility owner or operator only sound business and environmental control procedures.

Item B requires the site to be developed in phases. Each phase must contain individual cells that will provide vertical filling to final waste elevations. The facility owner or operator must consider seasonal differences in weather and amount of waste received in determining the length and size of each phase. The facility owner or operator must bring each phase to the final waste elevations shown on the ultimate development plans and in the approved facility closure plan. The Agency believes that the most efficient method to minimize impacts from land disposal facilities is organized filling that is vertically oriented to obtain proper slopes and closure of the fill areas. By filling the site in phases, the facility owner or operator will be better able to control surface water drainage, final cover activities, and routine operations. Minimizing the areas to be filled through phase development plans controls the amount of space the facility owner or operator must manage. The facility owner or operator can control the amount of site preparation work that must be completed at any one time, allowing these costs to be worked into the operating budget of the facility.

For long-term facilities, phase development is necessary to prevent demolition debris land disposal facilities from becoming garbage dumps to the unknowing. Demolition debris is generated in cycles in most areas of Minnesota. Construction activities are limited to approximately 9 months out of the year. Although winter construction does occur, the demolition activities associated with these projects are normally conducted prior to this time. It is important that the facility owner or operator size the fill areas with these cycles in mind. If the facility is left for long periods of time with large, inactive areas, members of the general public will see it as a location to dump unwanted materials.

Under item C, the facility owner or operator must divert surface water drainage away from and around the site operating area. The design of the drainage control system must take into account the expected final contours, site drainage patterns, need for temporary structures, and other site conditions that may impact site operations. Excessive surface water entering the fill area can disrupt facility operations and create severe erosion problems. Demolition debris is bulky and heavy and requires heavy equipment to operate the facility. This type of equipment does not function well in high moisture conditions. Sediment loss off the property can be minimized by controlling surface water drainage to prevent flowing water from carrying soil particles off the site. Excess soils in ecosystems surrounding fill areas is detrimental to the aquatic habitat and surrounding activities. Surface water drainage must be controlled at demolition debris land disposal facilities.

Item D requires the facility owner or operator to design slopes and drainageways to prevent erosion. Slopes greater than 200 feet must be interrupted with diversion drainageways. Demolition debris land disposal facilities offer great environmental risk of sediment loading impacts on the surrounding area. The large disturbance from equipment preparing a site, the nature of the waste, and the type of equipment used to operate these facilities produces perfect conditions for erosion to occur if proper precautions are not observed. Constructing a ditch to interrupt surface water before it reaches a fill area is in theory the proper action to follow. However, if the ditch is not protected to minimize soil loss, erosion will only be encouraged. Steeper slopes should have shorter runs before draining water is intercepted. Shorter runs control the area placed under the pressure of rapidly moving water that can scour the surface and loosen soil particles. The limit on uninterrupted slopes was developed from U.S. Soil Conservation Service information on erosion control. Facility owners and operators must consider prevention of erosion when determining slopes and drainageways to minimize risks associated with land disposal operations.

Item E establishes the minimum standards for designing final contours for the facility. The facility owner or operator must design the fill area so that the final contours are at least a 2 percent slope but no greater than 20 percent. The slope of an area has immediate impact on the potential for erosion of the final cover over a fill area. The steeper the slope, the higher the potential for erosion even when drainage breaks are used to slow the velocity of water flowing over an area. A minimum slope is needed to encourage some surface water drainage yet allow the site to be used. The structural stability of demolition debris and its resistance to decay make it a suitable fill material for building sites or parking lots. The flatter slopes provide the facility owner or operator the opportunity to investigate more end uses for sites that allow future development. The proposed slope standards provide minimum protection but allow the facility owner or operator to consider future site uses.

Item F requires the facility owner or operator to include in the facility design a cover system that meets the requirements of subpart 11. Referencing in subpart 11 alerts facility owners and operators to their total responsibilities regarding the facility design. Subpart 11 provides a clear definition of cover standards for permit applicants and owners and operators.

Item G requires the facility owner or operator to address the need and the specifications developed for a water monitoring system. The Agency believes that in certain situations ground water or surface water monitoring systems will be appropriate. For instance, under certain circumstances industrial solid waste will be acceptable for disposal at demolition debris land disposal facilities. One waste in this category is certain foundry sands that contain low levels of contaminants. The feasibility of these wastes going to a demolition debris land disposal facility will depend on site geology, depth to ground water, and facility operations. Therefore, the facility owner or operator must consider during the design phase how these conditions impact the need for monitoring at the facility. Another waste that may indicate the need for monitoring is debris from the demolition of large buildings. This material may be more chemically active than ordinary demolition debris. Facility owners or operators accepting debris from large demolition projects may see a need for monitoring potential impacts. Facility owners and operators have some flexibility in deciding acceptable risk levels by accepting certain waste. This rule enhances the ability of facility owners or operators to manage these risks.

Subpart 9. Operation and maintenance requirement for permitted facilities. This subpart establishes the minimum standards to be followed by facility owners and operators in operating these disposal facilities. By establishing minimum standards for operation of demolition debris land disposal facilities, the Agency intends that every facility be operated to provide for environmental protection. Consistency of facility operations will be enhanced by using a standardized approach to minimizing impacts on surrounding areas. By establishing operational standards, the Agency alerts facility owners and operators to their responsibilities in adopting a risk management program for these facilities. Proposing in the rule operation and maintenance requirements provides an understanding of the Agency's base criteria for reviewing facility operations.

An operator certified under parts 7048.0100 to 7048.1300 must be present at the facility during operating hours to minimize the potential for environmental impacts that exists at all solid waste management facilities. The training and certification requirement appears in parts 7048.0100 to 7048.1300. This provision serves as a reminder to facility owners and operators of their responsibilities in this regard. It alerts facility owners and operators to requirements governing their actions in a rule they are most apt to be reviewing for such responsibilities.

Item A requires that all wastes be covered on a monthly basis, at a minimum. The Commissioner may require a different frequency of cover based on the waste accepted, site operations, and site conditions. Due to its size and composition, demolition debris does not easily become airborne nor provide a food supply for rodents, vermin or other animals in the area. Because the waste is inert, the need to control the rate of decomposition or leachate generation is minimized. Thus, need for daily cover does not exist as it does for industrial solid waste or mixed municipal solid waste. By covering the area at least monthly, facility owners and operators will fill voids along with developing the site, allow for more reasonable cost estimates, provide more structural support as filling progresses, and eliminate settlement due to the final cover shifting into void spaces.

If a facility owner or operator elects to accept industrial solid waste for disposal, the frequency of cover must relate to the type of waste being handled and site operations. The Commissioner will establish the cover frequency based upon review of the facility owner's or operator's plan for waste management because the review allows for consideration of site-specific activities. No one set of standards can be established in rule because of the differences in site geology, waste volume, waste characteristics.

Item B requires the facility owner or operator to spread and compact all wastes. Demolition debris, if simply dumped from the incoming trucks, can form bridges (cross intertwining of timbers and boulders forming voids) and hamper the ability of the facility owner or operator to compact the waste. The bulky nature of the waste also makes it difficult to compact. However, spreading the waste will reduce and achieve some compaction. In situations where industrial solid waste has been approved for disposal at demolition debris land disposal facilities, the facility owner or operator will be able and expected to achieve better compaction of the industrial solid waste than demolition debris. Due to the variability in waste size and shape, no one standard can be established in rule that would allow consistent compliance by facility owners and operators. Therefore, a general performance standard is established for compaction and spreading waste at demolition debris land disposal facilities.

Item C requires that suitable cover material be maintained at the site. For development of the fill area to progress in a reasonable fashion, the necessary equipment and materials must be readily available. It is inefficient and expensive to obtain equipment on a daily basis and it is inefficient to haul in cover on a daily basis. Planning for needed materials and guaranteeing their availability allows facility owners and operators to fit the costs in a routine operating budget. To comply with cover requirements, the facility owner or operator must coordinate cover material availability with the fill schedule. Maintaining cover on-site makes this effort easier. Proper business practices require equipment and cover material to be readily available for use as needed.

If suitable cover is not available on site, cover material must be delivered to and stockpiled at the site. If cover material cannot be acquired at the disposal site, the facility owner or operator must ensure its delivery to the facility in a timely fashion. If a facility owner or operator waits until cover is required before seeking out sources of material and contracting for its delivery operations at the facility could be delayed unnecessarily.

Item D establishes the time at which final cover must be placed at demolition debris land disposal facilities. As each fill phase reaches final waste contours, the facility owner or operator must place final cover over the phase. By establishing in rule the time at which final cover must be placed at these disposal facilities, the Agency alerts facility owners and operators to their responsibilities and allows them to properly plan for this activity so that it is completed during normal construction periods.

Achieving proper compaction during winter months is impracticable. Compaction is achieved by passing equipment over the soil material under proper moisture conditions. The cold weather experienced in Minnesota during the winter months make this difficult to achieve with any consistency and reliability. Therefore, the facility owner or operator will need to consider in the phase development plans the timing for opening and closing the fill areas. Placing final cover as final waste contours are achieved provides for orderly development of the facility, allows for better budgeting of time and money for this activity, and minimizes the potential for erosion during placement of the cover as smaller more controlled locations will be completed.

Item E requires the facility owner or operator to stake each fill phase for proper grading and filling. The equipment operator must understand the boundaries of disposal operations. The most efficient method of controlling the limits of fill operations is through the use of grade stakes. Locating the grade stakes on the boundary of the fill operation delineates the horizontal and vertical limits for filling. These limits are more easily established before filling so the equipment operator can use them to limit site activities. Staking each fill phase eliminates the potential for filling past approved boundaries or above the vertical limits approved in the permit. This rule does not require more of the facility owner or operator than is necessary to ensure compliance with permit conditions.

Item F requires the facility owner or operator to construct, operate, and maintain the facility in a manner that promotes surface water run-off without erosion. The Agency believes that erosion occurs at demolition debris land disposal facilities due to the difficulty of obtaining consistent, even surfaces to place cover on during fill operations. If the waste is spread and compacted, the working face can be maintained at a consistent slope that minimizes wash-out of the cover. Surface water dislodges soil particles as it moves over an area. The amount of soil loss is dependent on soil type, slope of the area, vegetative cover, and the length of run. By controlling these elements, erosion can be controlled.

If erosion is not controlled at disposal facilities, a number of problems occur. The sediment carried off the site to surface water areas can negatively impact local habitat by filling low areas, suffocating aquatic organisms, or depleting oxygen from these environments. Large mud slides can interfere with facility operations and cost the facility owner or operator time and materials. The loss of soil from the site requires the facility owner or operator to purchase more material, increasing operating costs, and creates a loss of valuable resource. Facility owners and operators must be cognizant of the impacts of surface water run-off if not properly managed at disposal facilities.

Item G requires surface water to be diverted around and away from the active portion of the facility. The active portion of the facility is most vulnerable to negative impacts from surface water. The amount of sediment in the surface water is substantially higher because of the slope and rough surface conditions. Excess moisture in the fill area can hamper the ability of facility personnel to complete their duties. The structure and stability of soil is related to the amount of moisture present. At optimum moisture content, the soil structure will be strongest. When the moisture content is higher, the upper surface can become liquid in nature. The equipment used to haul and move the demolition debris in the fill area does not operate efficiently under these conditions as traction is difficult to obtain. Any activity serves only to increase the potential for the soil to be further dislodged and carried off the site as the water drains away. Surface water must be diverted around and away from the active portion of the facility to maintain operations and minimize erosion potential.

Item H requires the facility owner or operator to maintain a separation distance of 50 feet between the fill boundaries and the property line. Separation distances are established to protect adjacent property owners from immediate impacts from site activities and to ensure that all facility activities take place on the proper side of the boundary line. Drainage control structures including ditches and berms can be constructed to reduce the amount of run-off flowing over adjacent property and interfering with activities on that site. Fifty feet provides sufficient room for construction and operation without unreasonably minimizing the area a facility owner or operator has available for use.

Item I requires the facility owner or operator to implement corrective actions to repair any conditions not in compliance with parts 7035.2525 to 7035.2605, the general operational standards applicable to all solid waste management facilities. This provision alerts facility owners and operators to their responsibilities and places them on notice that the Agency believes corrective actions are to be employed at all facilities as the need arises. Supplying this information by rule because it clearly indicates that noncompliance with rules is unacceptable.

Item J requires the facility owner or operator complete sampling and analysis of ground or surface water in accordance with subpart 12. Subpart 12 sets out the conditions under which ground water or surface water monitoring may be required by the Commissioner. Although the specifics are contained in subpart 12, addressing monitoring requirements under this item is an operational concern to facility owners and operators. This provision alerts facility owners and operators that monitoring water quality could be required at demolition debris land disposal facilities. The provision by itself requires no additional work from facility owners and operators unless monitoring is required by the Commissioner in accordance with subpart 12.

Item K requires the facility owner or operator to survey the disposal area annually by November. The survey must be completed by a land surveyor registered in Minnesota. An updated plan must be submitted with the annual report required in part 7035.2585. The plan must show the elevations of completed fill areas, partially filled areas, and all pertinent structures. The annual survey will be used by the Agency to evaluate the progress of facility operations and compare the updated plan with approved plans for compliance determinations. The annual update allows the facility owner or operator to evaluate the rate of filling and determine the time remaining before the site capacity will be reached. Annual surveying is the most efficient method to determine elevations and area covered by the year's operation. If comprehensive plans are maintained as the fill progresses, the annual survey should only require a minimal amount of time to delineate the most recent year's activities. Annual surveys ensure fill operations are proceeding as permitted and establish compliance or noncompliance in increments easily corrected, if necessary.

Subpart 10. Hydrogeologic evaluation. This rule establishes that a hydrogeologic evaluation may be required by the Commissioner for a proposed demolition debris land disposal facility. The need for and level of detail for a hydrogeologic evaluation will be determined on a case-by-case basis. If the facility owner or operator elects to accept industrial solid waste in addition to demolition debris, a hydrogeologic evaluation may be necessary to determine potentially sensitive areas. A hydrogeologic evaluation will be required for these facilities because the evaluations could provide information needed to determine potential risks. This provision alerts facility owners and operators that a hydrogeologic evaluation may be required, thus providing them with an opportunity to review the situation and discuss with Agency staff this possibility early in the design phase for the facility.

If a hydrogeologic evaluation is required, it must determine the types of on-site soils, the depth to water, and the general geologic setting. Soil borings must be completed in accordance with part 7035.2815, subpart 3. The Commissioner shall base the decision to require a hydrogeologic evaluation on the waste to be disposed of in the facility, the amount of waste disposed of, the size of the facility, known soil conditions, and the known hydrogeologic conditions at the site. It may be necessary to determine the potential risk associated with operating a facility beyond what can be determined through a site inspection and review of hydrologic maps. If a facility will be in operation for a period of years or will receive waste from industrial sources or from demolition work that may result in the disposal of unwanted materials due to the nature of the job, it is important that the facility be designed to minimize risks and monitor the performance of the design components. Establishment of adequate monitoring requires an understanding of the ground water flow system below the fill area so that well placement is completed in the areas most likely to detect impacts.

Subpart 11. Cover design. This subpart contains the performance standards governing the final cover design for permitted demolition debris land disposal facilities. The Agency has chosen to use performance standards regarding the cover design at these facilities because the cover design must be compatible with the intended final use. Should only design standards be used for regulating the final cover, the Agency would regularly be in the position of considering variances from the design standards to facilitate further use of the property in a productive manner. For instance, to require 2 feet of topsoil over an area to be used as a parking lot would be unreasonable unless necessary to construct a parking lot. Additionally, topsoil may not be the appropriate cover material under these circumstances; a well-drained sand may be better. These adjustments are more reasonably attained through performance standards than design standards.

Under this subpart, the facility owner or operator must demonstrate how the proposed design will comply with the performance standards. The cover system must be designed and maintained to prevent erosion of surface and side slopes, minimize particulate matter, retain slope stability, and maintain vegetative growth. These conditions must be controlled to prevent environmental impacts from these facilities. Clearly indicating the conditions establishing proper performance of the cover system allows facility owners and operators to develop the design details necessary to justify their proposals.

This subpart contains three specific design standards in addition to the general performance standards. The Agency believes it is necessary to highlight these areas as controlling factors in facility designs. By incorporating these factors into the facility design, the facility owner or operator will be able to meet the performance criteria discussed in the previous paragraph and the future needs of the site. Performance criteria coupled with the three controlling design factors provides a reasonable approach to minimizing environmental impacts from these facilities.

Item A requires the final cover to be compatible with the intended end use of the site. Mismatching these site components can result in failure of the cover performance and the end use. For example, moisture-laden topsoils used as cover over an area intended for a building location may not match the construction specifications for the building. The soils would be a costly alternative to cover and could impact the building's structural stability from freeze-thaw or shrink-swell actions on the soil. This provision is responsive to the needs of facility owners and operators and the Agency in maximizing site uses while providing environmental protection criteria.

Item B requires the final cover be capable of sustaining vegetative growth as appropriate. If the site is to be open space or park land, vegetation is necessary . If the site will be a parking area, gravel may be a more appropriate cover material and vegetation unnecessary. If industrial waste is accepted at the facility, good cover and vegetative growth will be necessary to minimize infiltration into the fill area. As realized through these few examples, many different cover designs may meet end-use objectives and protection of the environment. This item guarantees facility owners and operators flexibility in developing site use plans while holding the line on acceptable practices for protecting the environment.

Item C requires the final cover to consist of materials consistent with the overall site design. While item A is directed at the site performance after facility operations have ceased and the other uses of the site are implemented, this item addresses site operation and wastes accepted during the active life of the facility. If the facility owner or operator elects to accept industrial solid waste final cover materials would consist of lower permeability soils to discourage infiltration minimizing leachate generation and the potential for pollutants to reach ground water or surface water and negatively impact their quality. However, buildings or parking lots located on demolition debris only may be satisfactorily covered with more permeable soils.

Subpart 12. Water quality monitoring. In this subpart, the Agency sets out the conditions under which water quality monitoring may be necessary at demolition debris land disposal facilities. The Agency has the authority and duty under chapter 115 to require monitoring at all facilities when necessary to investigate the extent of pollution and to protect the environment from detrimental impacts. The Agency is given the powers and duties:

> (b) To investigate the extent, character, and effect of the pollution of the waters of this state and to gather data and

> information necessary or desirable in the administration or enforcement of pollution laws, and to make such classification of the waters of the state as it may deem advisable;
>
> . . . .
>
> (e) To adopt, issue, reissue, modify, deny, or revoke, enter into or enforce reasonable orders, permits, variances, standards, rules. . .in order to prevent, control or abate water pollution . . . ;
>
> . . . .
>
> (7) Requiring the owner or operator of any disposal system or any point source to establish and maintain such records, make such reports, install, use, and maintain such monitoring equipment or methods, including where appropriate biological monitoring methods, sample such effluents in accordance with such methods, at such locations, at such intervals, and in such a manner as the agency shall prescribe, and providing such other information as the agency may reasonably require;
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> . . . .

Minn. Stat. §115.03, subd. 1 (1986).

The Agency believes that it is reasonable to address the possibility of monitoring requirements in rules, invoking these statutory powers as needed. By including a provision establishing water quality monitoring as a potential permit requirement, the Agency alerts facility owners and operators to the conditions that will dictate the need for monitoring. Providing facility owners and operators this information in rule establishes a consistent base from which all facility operations will be judged.

The Commissioner may, under this subpart, require water quality monitoring for a permitted demolition debris land disposal facility based on the types of waste accepted, site location, site characteristics, length of operating life, size of facility, and potential for human health or environmental harm. These factors are key components in determining the amount of risk associated with operating a demolition debris land disposal facility. By understanding the Agency's concerns in evaluating the need for water quality monitoring, facility owners and operators will be better equipped to use design, construction and operational controls to address these concerns or prepare for water quality monitoring at the facility.

Subpart 13. Financial assurance. This subpart provides for financial assurance at permitted demolition debris land disposal facilities. The Commissioner, under this subpart, may require facility owners and operators to obtain financial assurance for proper operation, closure, postclosure care, and corrective actions. The Commissioner's determination will be based on the size, site hydrogeology, operating life, past and existing operational practices, and types of waste accepted at the facility. The proposed rules allow owners and operators of demolition debris land disposal facilities to accept industrial solid waste. The acceptance of industrial solid waste depends on the waste characteristics, site conditions, and operational practices used at the facility. Demolition debris is an inert material with low potential for environmental impact. The same cannot be said of all industrial solid wastes. The industrial solid waste at these facilities represents an increased risk that a pollutant may be released into the environment. Some assurance must be provided by the facility owner or operator that money will be available to control any pollutant migration.

The amount of waste received at a facility is dependent on the amount of demolition activity occurring at any given time. Therefore, the permitted life of a site designed for five years worth of fill capacity may be extended because projected waste is not received. Extending the life of the facility can generate operational problems in providing suitable cover and controlling intrusion onto the site be unauthorized persons. It is reasonable to take into account the expected operating life of the facility assessing the problems that might arise and the financial ability of the facility owner or operator to address these problems.

The site hydrogeology controls the potential for pollutants entering the subsurface stratum below the fill area. If ground water is near the bottom of the fill area and/or the soils are highly permeable, the potential is great for pollutants to negatively impact the ground water. The Agency believes that this potential must be considered in determining the need for financial assurance at a facility.

Subpart 14. Closure and postclosure care of permitted facilities. This subpart clearly directs facility owners and operators to close each phase of the fill area as it reaches final waste contours and to close the entire facility when its capacity is reached. Closure activities must be conducted in accordance with the closure and postclosure care plans developed under parts 7035.2625 to 7035.2655. Including this requirement clearly indicates to facility owners and operators when closure activities must occur.

3. Part 7035.2835 COMPOST FACILITIES.

This part establishes the requirements applicable only to compost facilities. Compost is generated from the decomposition of organic material into simple, stable compounds, carbon dioxide and water. This process occurs as a result of a balance between the microorganisms that break down the organic material and their environment. If the compost pile becomes too hot or cold, too wet or dry, or if insufficient oxygen or carbon sources are available, the microorganisms will be unable to adequately complete the decomposition process.

The requirements address the design, operation and construction of yard waste compost facilities and solid waste compost facilities. The regulatory standards in the existing solid waste rules address locational needs and general product quality, but contain few specifics on the basic design requirements for compost facilities. The existing solid waste rules do not distinguish between yard waste composting and solid waste composting. Yard waste consists of grass clippings, leaves, and garden waste; minimal environmental or health risks exist with the final compost product. Other solid waste compost will contain metals and objects that may be of concern in its distribution. The standards applied to compost facilities differ in relation to the risk associated with each management technique. See Appendix XVI.

During the drafting stages for the proposed rules, the Agency received numerous comments suggesting that the compost rules contain facility design standards and quality control requirements for the final compost product. Commentors indicated the need for consistency in product quality across the State, and that all facilities should be designed based on a specific set of criteria. The Agency believes it should establish base level criteria in rules but allow for flexibility based upon the amount and type of waste to be handled and the end use planned for the compost. The subparts addressing this approach are further discussed below.

Subpart 1. Scope. This subpart states which subparts are applicable to yard waste compost facilities and which are applicable to all other solid waste compost facilities. It notes that yard waste compost facilities are given permit-by-rule status under part 7001.3050, subpart 3, provided they comply with subparts 2 and 3 of this part. This subpart reiterates the requirement to ensure facility owners and operators are aware of their responsibilities. Additionally, this subpart notes that backyard compost facilities are exempt from part 7035.2835.

Backyard compost facilities are completely exempt due to their size and the material handled. It would be unreasonable to expect each homeowner or business operating a grass and leaf compost operation to request a permit or even notify the Agency of their existence. It would likewise be unreasonable to expect the Agency to process these permits/notifications in a timely fashion and maintain an enforcement program to watch over their actions. Nuisance laws and local ordinances govern the activities of backyard compost facilities to ensure they are not creating conditions that may endanger human health or the environment.

Subpart 2. Notification. Facility owners and operators of yard waste compost facilities must notify the Commissioner by letter before opening the facility for operation. The notification must include the facility location, the name of the contact person, the contact person's telephone number and address, the facility design capacity, the type of waste received, and the intended distribution of the finished product. The Agency is responsible for monitoring solid waste management within the State. The Agency must know where and how the waste is being processed, treated, stored, or disposed of. Since yard waste compost facilities are permitted-by-rule, the Agency will receive no application detailing the amount of waste handled or the location of the facility. Permit-by-rule status does not exempt facilities from regulation but rather permits their operation without submittal of formal documents or receipt of express approval by the Agency. The Agency remains responsible for the enforcement of standards at yard waste compost facilities. Therefore, the Agency must know where facilities are located and who to contact regarding them. The information required in the notification must be known to the facility owner or operator for proper controls to be established. The requirements of this subpart do not add any burden to the facility owner or operator.

Subpart 3. Operation requirements for a yard waste compost facility. A condition of retaining permit-by-rule status is compliance with the operation requirements established in this subpart. The Agency will not review the design of each facility for components that will control the quality of compost generated and prevent unacceptable conditions that result in negative impacts to human health and the environment. Since yard waste compost facility owners and operators are expected to regulate themselves, it is necessary to establish equitable standards by which all facilities can be judged as to their adequacy. The items contained in this subpart establish the conditions under which all yard waste compost facilities must be operated in order to be eligible for permit-by-rule status.

Item A prohibits the emission of odors from yard waste compost facilities in excess of the standards contained in parts 7005.0900 to 7005.1400. The standards referred to are existing air quality rules. Odors generated under normal operating conditions are musty in nature and would not violate the air quality standards referred to above. A facility operated poorly, in which regular turnings are not completed to maintain aerobic conditions, generates a very pungent odor characteristic of emissions violating the odor standards. Accepting materials other than yard waste may also result in violations. Violations of this requirement indicate overall operational problems at the facility. Meeting this requirement helps ensure proper operation of the facility.

Item B requires that composted yard waste offered for use by the public be produced by a process that encompasses turning of the waste on a periodic basis to aerate the waste, maintain temperatures, and reduce pathogens. The composted yard waste must contain no sharp objects greater than one inch in diameter. The objectives of leaf composting as a waste management process are a reduction in the mass and volume of the material received and the destruction of putrescible substances. Leaves must be processed in a manner that accelerates decomposition. Because leaves and grass clippings are relatively homogeneous in nature, they can be processed using relatively uncomplicated procedures.

Optimum conditions for composting require control of oxygen, moisture, and temperature. The decomposition rate is slowed in the absence of oxygen. When deprived of oxygen, microorganisms are not as efficient at processing the waste and produce noxious odors. By maintaining conditions with sufficient oxygen levels, the facility owner or operator will ensure temperatures are sufficient to kill pathogens and weed seeds found in the pile. The most cost-effective method in controlling process temperature and oxygen is using windrows sized for easy turning and self-insulation. If sufficient oxygen is not provided, the decomposition process may take as long as three years to complete. This could create a demand for land space not readily available and result in the distribution of incompletely composted materials.

Another problem associated with the improper turning of yard waste is the lack of pathogen kill. Pathogens are killed at a temperature of 155 degrees Fahrenheit. In order to achieve this temperature the compost pile must be adequately turned or provided with oxygen by some other means for decomposition to occur at a rate sufficient to generate heat. Because turning of the composting yard waste is necessary under any management scheme to achieve final decomposition and a suitable product for distribution, it is reasonable to include in the proposed rule a general operation requirement that turning be included as a management technique. Reference 132.

Sharp objects are not permitted in the final compost product. Yard waste is most often picked up in large quantities by vacuum trucks or in bags placed in vehicles. Yard waste compost facilities are normally also open to individuals bringing in their yard waste. Under these circumstances, the facility owner or operator has little control over the quality of incoming waste. Branches are like spears and can impale tires or personnel at the facility as well as those handling the final product. Additionally, individuals put household refuse in with the yard waste, which not only affects the composting process but also leaves glass, metal and other potentially dangerous objects in the compost. Yard waste compost is usually distributed free to individual homeowners for use as a soil conditioner in flower beds and vegetable gardens. Injury to the individuals using the compost must be avoided. The one-inch diameter limitation was chosen as the maximum size for objects in the compost because anything smaller than this diameter would require fine screening to remove and unnecessarily increase the cost as smaller material is unlikely to injure the individual user.

Item C requires all by-products to be stored in a manner that prevents vector problems or aesthetic degradation. This includes residuals and recyclables. Materials that are not composted must be stored and removed at least weekly. A yard waste compost facility is designed to handle leaves, grass clippings, and other lawn waste. Wastes that cannot be composted may be improperly handled because the yard waste compost facility owner or operator is not equipped to handle it. If not removed, uncompostable material may harbor rodents and small animals that are capable of spreading diseases and disrupting the composting area. Because yard waste compost facilities are not always open daily and the amount of unacceptable waste should be small, the rule provides for weekly removal. Longer storage allowances would require facility owners and operators to construct larger holding areas increasing the cost of operating the facilities and require the Agency to be involved in governing these facilities. A shorter time period would not be cost effective due to the limited amount of uncompostable material expected at these facilities.

Any wastes stored on site must be stored in a manner that prevents vector problems and aesthetic degradation. One week is enough time for loosely stored materials to be scattered by small animals. Compost facilities are normally located in an area surrounded by open space to provide a buffer zone for the operation. This type of space also accommodates large populations of small wild animals. Cats and dogs can also be disruptive to facilities located in the more densely populated area. It is important that the facility owner or operator take steps to minimize the potential for animal intrusion.

Item D requires facility owners and operators to prevent leachate run-off into surface waters. Surface water draining over the facility must be diverted away from the compost and storage areas. Any decomposition process generates water as a by-product. The water contains dissolved organic compounds and sediment that can adversely impact surface waters areas. Of most importance are the decrease in sunlight due to the turbidity of the water, the increase in oxygen demand needed to break down these compounds decreasing the oxygen available for aquatic organisms, and the pH imbalance the compounds may impose on the water body. The amount of leachate generated at yard waste compost facilities should be small because the type of waste being composted does not contain much water and during decomposition moisture is evaporated or readsorbed into the compost. However, the facility owner or operator still must design the facility in a manner that permits easy control of any excess moisture generated.

The design could include working on a paved area or a hard dirt surface gently sloped to discourage ponding and to direct the flow pattern. Windrows should run with the slope rather than across the slope so they do not dam excessive moisture. By addressing these issues in the design of the facility, owners and operators will minimize the amount of corrective actions needed to control drainage and prevent operational difficulties. Planning ahead for potential problems is cost effective in construction projects as it eliminates the remobilization efforts needed for corrective actions.

The compost and storage areas must also be protected from surface water draining through them. Excess moisture in the composting area makes it difficult to operate equipment in this area and may cause the compost piles to go anaerobic, decreasing the rate of decomposition and increasing the odors associated with the facility. Disruption of facility operations because of washouts or the compost operation failing to operate as designed increases the potential that this waste must be landfilled or that considerable efforts must be employed to blend in new materials to absorb the excess water encouraging aerobic decomposition to begin again.

Item E requires an annual report to be submitted to the Commissioner. The annual report must include the type and quantity of yard waste received at the facility; the quantity of compost produced; the quantity of compost removed; and a description of the end-product distribution and disposal system. The quantities may be reported by weight, if scales are present, or volume. This information must be submitted in addition to the information required of all solid waste management facilities under part 7035.2585. It is necessary to state clearly the specific reporting requirements of yard waste compost facilities because no administrative document will be issued with site-specific conditions that are required. The information required by this item is necessary for the Agency to fulfill its responsibilities under law. The Agency is responsible for understanding how solid waste is managed. The facility owner or operator must have this information to understand the costs associated with operating the facility and to make any adjustments necessary to address the fluctuation in incoming waste.

Subparts 2 and 3 contain the design and operational requirements for yard waste compost facilities. Although these facilities are not expressly permitted by the Agency because of their size and the relative inertness of the material being composted, compliance with the requirements of subparts 2 and 3 is essential in minimizing any risks associated with the operation of these facilities. The Agency believes the requirements allow facility owners and operators flexibility to address their local needs yet provide a reasonable set of standards to protect human health and the environment. Subparts 4 through 9 contain the requirements for operating a facility to compost solid waste material other than yard waste. References 133 and 134.

Solid waste material other than yard waste have a high potential to negatively impact the environment if not carefully managed. Materials included in this category are mixed municipal solid waste or industrial solid waste, municipal wastewater sewage sludge, septage, or agricultural waste. A wide variety of options exist on designing and operating these compost facilities. Therefore, the Agency believes it is important to establish standards that ensure proper design and operation techniques are used at all facilities. This provides consistency in the quality of compost generated and in how this management option is approached. The reasonableness of subparts 4 through 9 is discussed below.

Subpart 4. Personnel training program. The owner or operator of a solid waste compost facility must submit a personnel training program plan for approval with the facility permit application. The plan must address the items in part 7035.2545 and the specific training needed to operate a compost facility in compliance with subparts 5 to 9. Facility personnel directly involved in the management of the decomposition process must understand the factors that control the rate and completeness of decomposition. Because not all facilities will be designed the same, accept the same wastes, or have the same end distribution requirement, the Agency cannot establish a training program with general application to the personnel at all solid waste compost facilities. However, the Agency does believe that all facility personnel can receive training on the proper operation of their compost operation.

A training program tailored to the specific facility will familiarize personnel with the equipment and the process planned for the compost operation. This serves to protect facility personnel from injury and ensures a quality product is generated and risks to the environment are minimized. Training of facility personnel benefits facility owners and operators because it ensures that the various components of the operation will be operated to maximize efficiency and minimize breakdowns. The training program should be incorporated into the overall risk management program for the facility. The program should include both classroom and on-the-job training. Although the basic compost process is the same from one facility to another, the intricacies of each facility are different. Therefore, the facility personnel must understand their specific process thoroughly enough to adjust the process as needed.

It is also necessary that facility personnel understand how compost is used and how the mismanagement of the end product can result in environmental impacts. Facility personnel must be capable of instructing users of the final product on its proper use. The Agency conducts yearly courses on the land application of sewage sludge and believes that with minor modifications it will be applicable to solid waste compost. The Agency also expects to provide additional training through its annual solid waste seminars, a guidance manual based on actual Minnesota composting experience, and special training programs, as needed. Proper operation of compost facilities is critical to their satisfactory use as a solid waste management technique. All facility owners and operators must consider how facility personnel will develop the skills necessary to properly operate the facility and control any risks associated with it.

Subpart 5. Design requirements. There are four basic steps involved in most compost operations. These steps include feedstock preparation, decomposition, curing and finishing. The processes and equipment used to accomplish these steps may vary from facility to facility. The Agency believes that no one set of design criteria can be developed for all compost operations to provide sufficient flexibility in facility construction and operation to handle waste-specific and climatic conditions. To accomplish such a task, the facility owners or operators would all be required to construct identical facilities. This option would take away the facility owners' and operators' ability to do a risk analysis on a specific technology and incorporate the technology into the facility's design and operation. The Agency believes this to be unreasonable and, in fact, wishes to encourage new technologies capable of producing compost in an environmentally-safe manner. The Agency believes that design standards are necessary to ensure some level of protection is provided at all solid waste compost facilities. In general, however, the design standards required under this subpart are performance oriented to allow for maximum flexibility in designing these facilities. Performance-oriented standards are reasonable for compost facilities because the operations are above ground and monitorable. Modifications to the system are more easily accomplished than below ground systems. The specific design standards are further discussed below.

Item A requires the facility owner or operator to include the specifications for site preparation in the engineering design report for the site. Site preparation must include clearing and grubbing for the compost and storage areas, berm construction, drainage control structures, leachate collection system, access roads, screening, fencing, and other special design features. This information must be included in the engineering design report because it provides the Agency with an understanding of how the total site functions in the compost operation. All the facility components mentioned are critical in analyzing the final facility design and its ability to meet the overall performance standards for the facility. By reviewing the site preparation specifications with other design specifications, the Agency will be able to provide facility owners and operators with needed design changes for the project to be acceptable. Complete review in one document avoids the chance of key components receiving less scrutiny than deserved. The information listed above must be known by the facility owner or operator to adequately schedule construction activities. This item establishes the form in which the Agency wants the facility design information to be submitted.

Item B requires that the facility design incorporate measures to divert surface water drainage around and away from the operating area. Equipment used to produce compost may contain electrical and mechanical components that are sensitive to moisture. If the operating area becomes inundated with surface water, the facility may fail to operate properly, causing the facility owner or operator to shut down operations until repairs can be made. Such occurrences are time consuming and expensive. While the facility is shut down, the potential for negative impacts on the environment increases. If the waste is not being composted in a manner that adequately stabilizes the waste, the final product may become unusable. Additionally, waste may need to be stored at the facility if other management options are not available. Storage of the waste on the facility without processing raises human health concerns and environmental concerns that are associated with the movement of excess moisture out of the waste into subsurface soils and surface waters.

The washout of compost areas is also of concern. Flooding the working area of a compost facility can spread uncompleted compost product over the facility or off the facility property. The uncompleted compost product could then get into surface waters or onto surface soils, providing routes for pollutant migration. Washout can be prevented if there are adequate surface water drainage control structures and if the overall design of the facility, e.g., windrow piles, directs drainage with the pattern not across the pattern.

Surface water flowage may saturate the compost piles causing the system to go anaerobic or stop functioning altogether. Anaerobic decomposition is slower than aerobic creating additional storage needs because the facility is designed to be aerobic. Anaerobic decomposition also occurs at lower temperatures, so another process must be used to reduce pathogens, e.g., lime stabilization or long curing. Methane gas is also a by-product of anaerobic decomposition, which causes a safety hazard. Under these circumstances, ventilation is key to a safe facility design.

If the compost area and the storage area are damaged by surface water, the facility owner or operator will be unable to fulfill the performance standards of this part. Because the facility owner or operator has much to lose in terms of repair costs and management problems, the control of surface water should be a normal part of the overall facility design. The Agency includes this standard to ensure that surface water drainage control is considered for all compost facilities; it provides a base level of protection while not requiring additional work effort by the facility owner or operator.

Item C requires composting, curing, and storage areas for uncured compost to be located on surfaces that minimize leachate release into the ground water or onto the surrounding land surface. If natural soils are used, the liner permeability must not be greater than 1×10^{-7} centimeters per second. During the active decomposition process, organic material is broken into smaller, more stable organic compounds, carbon dioxide, and water. The more complete this process is, the more stabilized the organic compounds are. The water generated during this time is usually either evaporated by the heat or readsorbed into the composting waste. Excessive watering, insufficient turning, or improper surface water drainage control can cause the compost pile to become saturated, leaving the facility owner or operator little choice but to stop the process. Decomposition is an ongoing process and cannot be turned on or off like a water faucet. If excess water exists in the system, it will move through the pile dissolving pollutants like solids and metals. If this polluted water is allowed to migrate into subsurface soils, ground water or surface waters, the result is risk to human health and the environment. Should these events occur, the facility owner or operator is faced with costly repair efforts. Discussions with vendors of compost technology have indicated that leachate control measures are standard policy and that this item requires nothing unreasonable.

Two feet of natural soils is considered the minimum acceptable depth for use as liners because of construction difficulties. Construction of a liner requires the soil to be placed in 6-inch, loose lifts followed by compaction. The first lift is placed directly on subsurface soils and, although the subsurface soil has been graded, the first lift is used to fill gaps and holes in the subsurface soil. This lift is directly influenced by the subsurface soils and is normally considered a protective layer rather than a critical component of the barrier system. The middle lifts form twelve inches of a firm, low permeability barrier system that functions to minimize the downward migration of liquids. The uppermost lift again functions as a protective layer since facility operations occur directly above this layer. Thus, the 24-inch thickness requirement is needed to ensure that the integrity of the liner is maintained.

The permeability standard established in this item is consistent with the standard established in part 7035.2815, subpart 7, for liners at mixed municipal solid waste land disposal facilities. The liner's basic function is to control the downward migration of pollutants. The single most important factor in controlling the migration is permeability of the liner. In this case, the standard of 1×10^{-7} centimeters per second was chosen not only to be consistent with other liner standards in the proposed rules but also because it provides a reasonable control on the amount of liquid percolating out of the storage area into the surrounding area.

Flow rates through a liner are estimated using Darcy's equation for saturated flow conditions. Reference 68. Darcy's equation is as shown below:

$$Q = (K)(A)\ (h/L)$$

where:

Q = flow rate (cubic feet/day)
K = permeability (feet/day)
A = cross-sectional area (square feet)
h = change in hydraulic head (feet)
L = liner thickness (feet)

Knowing the permeability of the liner material enables one to calculate the flow rate through a saturated, homogeneous liner. For example, assuming a liner is constructed of material having a permeability of 1×10^{-7} centimeters per second (2.85×10^{-4} feet per day) over a 20000 square foot area and 2-feet thick, the flow rate would be calculated as follows: if one foot of liquid is on the liner.

$$Q = \frac{2.85 \times 10^{-4}\ \text{feet}}{\text{day}} \times 20{,}000\ \text{sq. feet} \times \frac{3\ \text{feet}}{2\ \text{feet}}$$

$$= 8.64\ \text{cubic feet/day}$$
$$= 64.6\ \text{gallons/day}$$

A similar calculation can be made for liner materials having a permeability of 1×10^{-6} centimeters per second and 1×10^{-8} centimeters per second. The resulting flow would be 636 gallons per day and 6.36 gallons per day, respectively. From these results, assuming all things to be equal, the liner constructed of materials having a permeability of 1×10^{-8} centimeters per second would retard the downward flow of liquids the most. However, in choosing a standard, the Agency needed to consider not only the level of protection provided, but also the availability of the material.

Clays and silty clays found in Minnesota are quite capable of meeting either 1×10^{-7} centimeters per second or 1×10^{-6} centimeters per second. Soils meeting the 1 x 10^{-8} centimeters per second are not as common or widespread as soils meeting the other permeability figures. Meeting a permeability requirement of 1 x 10^{-8} centimeters per second would, thus, be more difficult to achieve and more costly as it would probably require transportation for some distance. For these reasons, the Agency believes it would be unreasonable to require owners and operators of solid waste compost facilities to construct storage liners of materials meeting a performance specification of 1 x 10^{-8} centimeters per second. However, the Agency also believes to set a permeability standard of 1 x 10^{-6} centimeters per second would be inappropriate because of the amount of leakage permitted under this scenario. The proposed permeability standard of 1 x 10^{-7} centimeters per second maximizes ground water protection within the constraints set by soil availability.

Item D requires that the leachate collection and treatment system be designed in accordance with part 7035.2815, subparts 7 to 9, as applicable. If leachate is generated or water comes into contact with the waste, the design requirements of item C become effective and the liner system must impede downward flow. Thus, if the water cannot move through the liner, it must be removed from the containment area in order for normal operations to proceed. Leachate contains pollutants from the waste. These pollutants are mainly metals. Organics are broken down during the decomposition process. Metals are phytotoxic to plants and toxic to humans and animals. If the leachate were allowed to be disposed of indiscriminately, these pollutants might find their way into ground water, surface waters, or agricultural lands. Leachate from the decomposition of solid waste at a compost facility has an associated risk similar to the decomposition of solid waste in a land disposal facility. It follows, then, that collection and treatment needs will be similar.

The Agency believes that repeating the collection and treatment requirements found in part 7035.2815 would only be confusing and add unnecessary language to the proposed rules, even when factors not appropriate for compost facilities are eliminated. The Agency prefers to refer facility owners and operators to part 7035.2815 and assist them in defining applicable requirements. The size and specific facility design will affect how the leachate should be collected and treated. No one set of requirements could be established to address facilities handling 70 tons per day and those handling 400 tons per day, given the multitude of design options available.

Item E requires owners and operators to design and operate solid waste compost facilities to control odors. Odors are an expected result of compost operations. Odors are generated from a number of sources, including the waste material, the stage of decomposition, the type of decomposition, and weather conditions. If not properly controlled, the odors generated at the facility may present environmental and human health risks in addition to the secondary problem of aesthetics. It is reasonable that the design for the facility reflect the potential for odors of solid waste compost facilities because odors can indicate problems with the compost operation.

Item F requires the facility design to include the collection of residuals and provide for their transportation and proper final disposal. Not all waste received at a compost facility will decompose at the same rate as the main organic components, if at all. Therefore, as the waste is being processed or during the finishing process these uncompostable and slowly compostable materials will be sorted out of the compost. Some handling scheme must be available to handle these components. Solid waste management requires more than just processing the incoming waste dedicated to the specific facility. It involves the review of incoming waste, understanding facility operations, and making decisions on the ability of the facility to handle waste for processing, disposal or collection prior to application of these management options. The facility design must be able to control the storage, handling and disposal of these wastes. Facility owners and operators dislike disruption of normal operations because of a particular waste's incompatibility with the facility. Designing a facility involves understanding just what wastes are expected, how the waste will be managed and the potential problems that might arise. Once accepted at a facility, the proper management of wastes become the responsibility of the facility owner or operator.

The Agency must understand how the entire State is managing its solid waste. This understanding is gained from annual operating reports and reviewing facility plans and specifications. Requiring facility owners and operators to address residual waste collection and disposal in the facility design provides the Agency the knowledge ahead of time to coordinate the entire State management options. The intended disposal site may not be suitable for the specific residual waste. Through the facility design reviews, the Agency will be able to inform the facility owner or operator of this matter.

Item G requires the facility owner or operator to include in the facility engineering report the specific design and performance specifications for the facility including the facility layout. As stated earlier, many design options are available to owners and operators of solid waste compost facilities. The Agency believes that it would be unreasonable to impose design requirements for all facilities in the rules. But the design information is still pertinent to the Agency review of permit applications. The permit review process provides the Agency with sufficient information for the Agency to determine what impacts might be expected from a particular facility. Therefore, the rules require facility owners and operators to submit the particular design specifications and the performance expected. Compliance will allow Agency review of this information and ensure that all necessary components are included for the proper operation of the facility.

Subpart 6. Operation requirements for a solid waste compost facility. The operation of a solid waste compost facility is a critical factor in the overall performance of the facility. Well-designed facilities can still perform poorly if operational practices are not good. Thus, the Agency believes operation requirements will ensure good basic techniques are used at all facilities to meet the performance standards included in the rules and those established by the facility owner or operator for the specific compost process chosen. The operation requirements contained in this subpart become the basis for the personnel training program established under subpart 4. The Agency believes the combination of a personnel training program and operation requirements addresses the importance of facility operations in minimizing the risk associated with the composting of solid waste. Each of the operation requirements, items A to K, is discussed below.

Item A requires the owner or operator of a solid waste compost facility to maintain a record of the characteristics of the waste, sewage sludge, and other materials, such as nutrients or bulking agents, being composted. This information must include the source and volume or weight of the material. The record must be submitted as part of the annual report required under part 7035.2585. The characteristics of the materials being composted have a direct impact on the quality of compost generated. Whether the materials are mixed municipal solid waste alone or with sewage sludge will result in a different final product. Sewage sludge or other nutrient sources generate a compost richer in nitrogen than mixed municipal solid waste alone. Additionally, wastes higher in metal content will generate a compost that must be more carefully controlled regarding distribution and uses. Wastes from canning operations are normally much wetter due to the processing techniques than household refuse. It is critical to the facility operations that the waste characteristics be understood by the Agency and the facility personnel to generate a quality compost. The facility owner or operator will need the information on waste characteristics to properly control temperature, oxygen and moisture conditions during the compost process. This item is merely a reporting requirement to provide the Agency with the information so the Agency is aware of what and how much material is going where.

Item B establishes parts 7005.0900 to 7005.1040 of the Agency's air quality rules as the standards governing odors at solid waste compost facilities. Under good operating conditions, composting facilities may have a musty odor. Under situations where the wrong waste has been accepted or the wrong process is in effect, anaerobic compost processes generate methane gas, non-odorous yet explosive, and other gases with significant odor components. The expectation of compliance with this item is high. Few sites are expected to violate the rule and little additional work is required.

Item C requires that all waste delivered to a facility be confined to a designated delivery area, and stored and removed frequently to prevent nuisances. Nuisances include small animals and wind blowing of the waste. It is expected that incoming waste will be processed at a rate that eliminates the need for long-term storage areas. However, the Agency believes it is necessary to confine deliveries to a designated area to control traffic patterns and maximize efficiency of the operations. Designating delivery and storage areas for incoming waste and noncompostable materials allows for better control of surface water drainage, liner construction, and coordination of on-site operations. A prudent facility owner or operator would establish such areas anyway as it reduces the amount of work needed to deliver and retrieve wastes. Designated areas also reduce the safety hazards caused by the crisscrossing of traffic flow patterns. The designation of specific areas for purposes such as receiving incoming wastes or delivery of noncombustible materials also allows facility owners and operators to better control nuisance conditions caused blowing waste, improve facility maintenance, and consolidate construction efforts. All facility owners and operators can easily meet this standard, which provides diversification in actual facility designs based on site-specific needs.

Item D requires that access to the facility be controlled by a perimeter fence and gate. The gate must be locked when the facility is not open for business. In designing, constructing, and operating a solid waste compost facility, owners and operators expend considerable time and cost to guarantee a specific performance. It would be unwise to allow easy access to the facility by unauthorized persons, who may jeopardize facility operations or themselves. A fence will also deter animals from wandering onto the facility premises and interfering with facility operations. By enclosing the facility with a fence, the facility owner or operator will also better define the space that must be controlled and considered in site preparation, construction and operation. The environmental and operational benefits from using a fence to secure the facility outweigh any additional costs incurred by the facility owner or operator.

Item E requires the facility owner or operator to store all by-products including residuals and recyclables in a manner that prevents vector intrusion and aesthetic degradation. Materials that are not composted must be removed at least weekly. A compost operation is a management technique for solid waste. The management process involves more than just putting solid waste on a pile, watering it, and periodically turning it. The operation involves the proper handling of all materials entering the facility until the time the material is removed, whether as a final compost product, a residual material, or a recyclable material. The Agency would be remiss in its responsibilities if the solid waste compost facility operation standards addressed only the front end processing of incoming waste and ignored the handling of the waste rejects or recyclable materials.

Because a particular material cannot be utilized in the compost operation does not make it of any less concern. The proper management of uncomposted wastes is as important as their separation from the wastes that can be composted. The uncontrolled storage of the nonusable materials presents an inviting nesting area, feeding area, or curiosity for animals. Early indications are that facility owners and operators see the front end waste processing area as a prime location for pulling out recyclable materials as well as the unusable materials in the composting process.

Storage of the recyclables is also important. Although aesthetic problems have little direct environmental damage attached to them, they are usually a symptom of deeper operational problems at a facility. Storage is easily accomplished and places little burden on facility personnel during the daily operations. Recognizing the need for proper storage allows the facility owner or operator to take storage into consideration during the facility design process and maximize operational efficiency in this area.

A weekly removal rate was chosen as a reasonable time period for storage of materials not included in the composting process. The owner or operator of a solid waste compost facility is in the business to process solid waste, not store it. To allow a longer time period than one week would increase the amount of material that would be stored at a site, increase the storage area requirements for the facility, and increase the risk that mismanagement of these materials may occur. To require a shorter time period may place an unnecessary financial burden on smaller facility owners and operators that would pay for collection of small quantities of unusable material or recyclables. No comments were received on the reasonableness of this provision.

Item F requires that all run-off water having come in contact with composted waste, materials stored for composting, or residual waste must be diverted to the leachate collection and treatment system. If the run-off water is held in a holding pond, it must be monitored on a quarterly basis for the parameters listed in item H and for fecal coliforms. Leachate is generated by precipitation moving through a waste material and removing pollutants and fine particles from the waste. Run-off water is surface water draining off the property as the result of precipitation. If the run-off water flows through a waste pile, it may assimilate pollutants and fine particles as precipitation falling on the waste does. This water must be managed in the same manner as leachate.

If the run-off water is contained in a holding pond, it must be monitored for the parameters in item H, the elements of concern. The holding pond serves as a reservoir for later treatment and disposal at a wastewater treatment facility. The analysis of the water contained in the holding pond is necessary to determine the proper balance required to prevent any disruption of the treatment facility. Fecal coliforms are included in the required analysis because they are an indicator of contact with intestinal wastes from humans or animals. Quarterly sampling is a reasonable monitoring schedule because anything more frequent may require monitoring when no treatment is necessary. Continuous run-off water in the holding pond is not expected. The holding pond should only be needed when large precipitation events occur. The holding pond must not permit direct seepage to the ground water unless specifically permitted and designed for seepage. Seepage can be an acceptable treatment process. Therefore, it is necessary to design the size of holding ponds to accurately reflect expected precipitation events and routinely monitor the quality of water held in the ponds.

Item G requires the temperature and retention time for the material being composted to be monitored and recorded each day. The rate of decomposition, the stability of the compost, and the amount of pathogen kill are directly related to the temperature of a compost pile. If the temperature is too high or low, the rate of decomposition will be slow because the microorganisms responsible for decomposition are sensitive to temperature and will not reproduce under conditions that limit the amount and speed of decomposition. Pathogens are killed at a temperature above 155 degrees Fahrenheit. If this temperature is not reached during the composting process, little assurance can be given that users of the final product are not at risk of developing a disease.

The temperature of a compost pile under normal operating conditions will rise as the microorganisms begin to break down the organic material into smaller, more stable organic compounds, carbon dioxide, and water. Heat is a by-product of the decomposition process. The temperature can reach as high as 175 degrees Fahrenheit if not carefully controlled (References 132 and 135). As decomposition continues the temperature will stabilize at about 130 degrees Fahrenheit until the organic matter is mainly reduced to smaller compounds. The temperature begins to decline as the microorganisms become less active due to the lack of the food source. Thus, temperature can be indicative of compost stabilization. However, temperature is not the only indicator for stabilization. For example, improper environmental conditions, lack of oxygen or moisture, can cause the microorganisms to die, and the resulting drop in temperature would not be indicative of stabilization.

Because temperature is a critical factor in achieving good decomposition and is an indicator of the amount of decomposition that has occurred, facility owners and operators must record the temperature. The facility owner or operator needs to be aware of the temperature to ensure the compost process is proceeding as designed. This item merely requires the facility owner or operator to record the temperature each working day so this information will be available to the Agency during its review of the facility operations. After discussing temperature recordings with reviewers of the draft, daily recording was agreed upon. An hourly monitoring requirement was thought to be unreasonable for small facility owners and operators without a computerized method of recording temperatures. However, if temperatures were not recorded at least daily, neither the facility owner or operator nor the Agency would be able to determine compliance with the performance standards for temperature.

Although most of the compost activity is completed at the end of 21 days, some of the more complex organic compounds require a longer period of time for complete decomposition to occur. Some time is also needed to stabilize and be completely sure the other compounds are decomposed, and that pathogens have been killed. Lignin and cellulose are the main organic compounds requiring a lengthy decomposition period. These compounds are found in paper, cardboard and other materials made from woody plants. Decomposition of these compounds can occur at lower temperatures than needed to kill pathogens. If facility owners and operators maintained a complete compost operation including aeration, moisture and temperature control, the size of the compost site would need to be two to three times greater than normal. This would be an unnecessary cost burden to facility owners and operators. Thus, once pathogen kill has been obtained by high temperatures and the bulk of the material has been composted, normal compost practices have the facility owners and operators removing this material from the active compost area to a storage area for curing. The curing process then takes another three to six months for completion. Little maintenance of the compost pile is required during this time. Additionally, because the pile usually goes anaerobic, is maintained dry, and has little food source content, any pathogens that may have survived the high temperatures during the initial stages of decomposition are killed during this time. Specific curing times are included in the performance standards for operating compost facilities. Curing also ensures total dissipation of phytotoxic gases (carbon dioxide, methane) and offensive odors (hydrogen sulfide) generated during the decomposition process. Therefore, facility owners and operators must maintain a log of when piles were established and how long curing has progressed.

Item H establishes the monitoring parameters for all compost. Under this item, periodic analyses of the finished compost must be completed for the following parameters: percent total solids; volatile solids as a percentage of total solids; pH; Kjeldahl, ammonia, and nitrate-nitrogen; total phosphorus; cadmium; chromium; copper; lead; nickel; zinc; mercury; and polychlorinated biphenyls. All analyses must be reported on a dry weight basis. The parameters to be analyzed for under this item are required because they determine the proper use for the material, the proper application rate of the material, and the stability of the material. These parameters are routinely considered in evaluating a product for land application. No comments on the suitability of the parameters were received. References 132, 135 and 136.

Conspicuous by its absence in the monitoring program is for pathogens. Numerous studies have shown that pathogens are killed at temperatures above 155 degrees Fahrenheit. Analyzing for pathogens requires careful controls on sample collection, preparation and analysis to prevent contamination from outside the compost pile. In 1980, the U.S. Environmental Protection Agency completed its research on the composting of sewage sludge. A manual was developed from this research and is considered a primary source of information for those involved in composting (Reference 132). The methods developed to reduce pathogens in human waste during this research project are used throughout the country as acceptable technology for composting, whether sewage sludge, paper sludge, mixed municipal solid waste, or any other waste type. The Agency believes facility owners and operators should be required to choose a process that kills pathogens rather than analyzing for pathogens in the final product. This is consistent with the Agency's present regulations regarding the management of sewage sludge and accommodates the cost concerns raised by commentors on the draft solid waste rules. Concern was raised about the type of analysis available for pathogen determinations and recommendations made that the Agency consider process control rather than testing. The Agency supports these recommendations and proposes to eliminate testing requirements for pathogens in compost.

Original drafts of rules on composting mixed municipal solid waste contained requirements for the analysis of certain organic compounds and the toxicity of the compost. The organic compounds were pesticide chemicals no longer permitted for use on agricultural land. As the Agency further evaluated the reasonableness of analyzing for these compounds, it determined that it would be of no benefit to require costly analytical work for compounds no longer found in the market place. The Agency believes that it may be appropriate to evaluate some compost material for organics but this is highly dependent on the characteristics of incoming wastes. Most compost facility operations employ waste separation techniques to obtain process control over the type of waste entering the composting area. It is expected that little synthetic organic material that is not decomposed will be placed in the compost piles. For this reason, the Agency believes it is reasonable to eliminate mandatory analysis for organics at all compost facilities and address this need on a case-by-case basis dependent on the waste handled by a particular operation.

Toxicity was eliminated from the required analysis because no definitive test is available to determine if toxicity is due to a specific chemical or nutritional imbalance. Discussions with University of Minnesota experts have resulted in the Agency's decision to exclude specific analyses for toxicity. The Agency believes that the metal analyses will provide sufficient information to evaluate the potential impacts the compost may have on plant growth or human health. The Agency believes it is unreasonable to require analyses for toxicity until proven methods are available or a need for the analyses is shown to outweigh the information received through the metals parameters.
See Appendix XVI.

Original drafts of this item required the analysis to be completed monthly. The Agency believed that it was necessary to monitor the compost process from its original stages until completion to ensure stabilization is complete. Many comments were received regarding the reasonableness of monthly analysis while quality at the time of distribution is of most importance. Other commentors suggested that owners and operators of compost facilities in Europe analyze the compost as it matures in order to evaluate the developmental process. Reasons for the concern during development stages stem from the use of immature composts (incomplete decomposition) and the use of the information as a performance check on the facility. In considering the comments received regarding the number of analyses required, the Agency reviewed the performance objectives for compost facilities and the benefits gained by mandating a specific test schedule in rule. A schedule established in rule makes it easier for the Agency to enforce testing requirements as all facility owners and operators will be required to meet the same requirements. Facility owners and operators will be able to read the rule and know what is expected of them. Requirements in rule also provide the surest method in obtaining consistency among facilities. The Agency believes these to be sound and justifiable reasons for including a specific monitoring schedule. However, the Agency has chosen an alternative approach to monitoring the compost quality.

The Agency has chosen to include a more general requirement in the proposed rule. The alternative requires periodic monitoring of the compost. The monitoring requirements will be established in the facility permit. This approach allows facility owners and operators to propose a schedule consistent with the intended end use of the compost and the particular design of the facility. This approach is consistent with the overall approach used in the technical requirements for the design and operation of compost facilities. No increase in risk to human health and the environment is experienced under this approach because all compost generated will be analyzed prior to distribution to ensure proper use.

As indicated in this item, the sampling and analysis program will be established in the facility permit. The program will be based on facility design, intended end use distribution for the compost, waste composted, and facility operation. As discussed previously, the sampling procedures can affect the quality of results received regarding a particular compost. It is necessary to integrate a sampling protocol into the facility design and operation in order that representative samples are obtained for analysis. The protocol cannot be established in rule for all facilities because of the diversity in facility designs available to conduct compost operations.

The Agency anticipates the sampling and analysis program will establish baseline performance standards for a particular facility and then be used as a check on the performance. This type of program would include frequent monitoring at initial start-up and then decline to a more routine monitoring frequency to ensure final product quality. Experts in the field of composting agree that this is a reasonable approach for the Agency to take. Reference 137. The experts explained that normally considerable temperature and product monitoring are completed during the initial facility operations by consultants in this area to determine if the various facility components are functioning as designed. This provides facility personnel with comparative data on which to base future operations and provides product quality information to the facility owner, the regulatory body, and potential users of the product. The Agency, therefore, believes this program should be established in permits rather than rules as it provides more flexibility, imposes no additional burden on facility owners and operators, and maintains an acceptable level of environmental protection.

Item I requires quarterly reports from the owners and operators of compost facilities. The reports must be submitted to the Commissioner within 30 days after the end of each calendar quarter. The report must contain: results of the analyses required in item H; quantity of solid waste delivered to the facility; sources and quantities of other materials used in the compost process; description of the process to reduce pathogens; temperature readings; retention time; quantity of compost produced; quantity and type of by-products removed; and description of the end-product distribution and disposal system. Quarterly reports are necessary for compost facilities so the Agency may closely follow the performance of these facilities. Composting is a biological process that will not meet performance criteria unless properly controlled. Factors influencing the final product are waste types entering the system, temperatures achieved, and the operational practices followed. Monitoring the facility on a quarterly basis will enable the Agency to obtain information needed to judge facility performance, recognize problem areas, and understand how compost is being utilized in the State.

The decomposition process used to produce compost can occur under aerobic and anaerobic conditions, under cool or warm temperatures, and under drier or wetter than optimum conditions. Optimum conditions promote rapid decomposition to a stable product, with few odors and sufficiently high temperature to kill pathogens. If optimum moisture, pH, oxygen, temperature and food sources are not present, decomposition may occur slowly creating a larger storage need than originally anticipated. Extra methods may be needed to ensure pathogen kill when optimum conditions do not exist. The information submitted in the quarterly report will supply the Agency and facility owner or operator with the data necessary to develop operational or design changes at the facility to maintain product quality. The information requested under this item must be collected by facility personnel for facility operations to ensure a product suitable for distribution is generated. The Agency believes it is necessary to evaluate conditions at compost facilities on a regular basis and that facility owners and operators should supply the Agency with operational data collected during the monitoring period.

Item J requires the facility owner or operator to notify the Commissioner within 48 hours if, for any reason, the facility becomes inoperable. The facility owner or operator must implement the contingency action plan developed under part 7035.2615. This provision advises facility owners and operators of their responsibility to notify the Agency through the Commissioner of all situations that occur requiring facility shutdown. The Agency must be aware of these situations to properly review any alternative management techniques needed during the period of facility shutdown. Forty-eight hours is a reasonable time for facility owners and operators to notify the Commissioner because it allows time for implementation of emergency procedures, if needed; allows for weekend facility closures during which small operations may have no personnel present; and ensures Agency involvement as soon as possible in helping determine correct follow-up measures.

Including a reference to implementing the contingency action plan developed under part 7035.2615 provides a direct connection between the development of the plan and its implementation. Contingency action plans are used to train facility personnel in the proper actions to employ under unplanned circumstances that require facility shutdown. Facility personnel must be properly trained in order to minimize any negative impacts to human health or the environment during periods of inoperation at the facility. By clearly stating that implementation of the contingency action plan is an operation requirement for all compost facilities, the Agency emphasizes that these plans should be carefully developed and used in the personnel training program. This requirement does not increase the owner's or operator's burden regarding facility operation but does clearly indicate responsibility.

Item K is a crucial requirement for the operation of a compost facility. This item addresses the reduction of pathogens in the waste during the compost process. Solid waste contains disease-bearing organisms that must be destroyed during the compost process. Compost is used by individual homeowners, horticulturists, and agricultural persons in soil amendment applications. In many cases, the compost will be directly handled by humans or ingested by animals in the area. Therefore, it is necessary to produce a hygenically safe product that is also an acceptable soil amendment.

Three general categories of compost systems are available: open or windrow/pile systems, enclosed or mechanical systems, and combination systems. When properly controlled, each of these systems is capable of producing a suitable compost product free of pathogens and sufficiently stable for use as a soil amendment. This item establishes the minimum operational conditions that must be attained in each system to achieve pathogen kill. The requirements are performance oriented and do not contain specific design criteria. The Agency recognizes that a variety of facility designs will meet the performance criteria proposed under this item. The performance criteria for each system will be discussed in further detail below.

Subitem (1) establishes the performance requirements for the windrow method of composting. The windrow method is defined as an unconfined composting process involving periodic aeration and mixing. Aerobic conditions must be maintained during the compost process. A temperature of 55 degrees Celsius must be maintained in the windrow for at least three weeks. The windrow must be turned at least twice every six to ten days. The key to the successful operation of a windrow system is maintaining sufficient oxygen in the interior of the pile for aerobic decomposition. Aerobic decomposition is faster than anaerobic decomposition and generates a higher temperature. Aerobic conditions are maintained by turning the piles or through forced aeration (References 132 and 135). The other reason for turning the piles is to assure that the microorganisms at work within the pile have a constant source of foodstuffs to maximize their activity level. During the decomposition process, microorganisms need sufficient nutrient sources to continue to function. As decomposition progresses, the microorganisms break down the material into stable organic compounds that can be processed no further. This process generates heat that evaporates the moisture in the immediate area resulting in the pathogen kill. As the pile is mixed, the temperature will drop in the pile's interior until decomposition of the new material is actively underway again. This is the standard windrow compost system process. References 83, 132 and 135.

The Agency obtained input into the specific performance criteria included under this subitem from consultants in the compost field and vendors of compost systems. It is the Agency's understanding that a temperature of 55 degrees Celsius for at least three weeks is necessary to ensure pathogen kill (Reference 132). The Agency believes it is reasonable to use a generally accepted industry standard because the technology currently available can meet these standards and provide adequate environmental and human health protection. The process contained also meets the requirements found in the part of the Agency's sewage sludge rules, Minnesota Rules part 7040.4700, subpart 2, which discuss the composting of sewage sludge. Since the decomposition process for solid waste and sewage sludge is the same and the Agency fully expects that sewage sludge will be composted with solid waste, the requirements should be consistent.

Subitem (2) addresses the performance requirements for static aerated piles. For purposes of this requirement, the static aerated pile consists of an unconfined composting process involving mechanical aeration of insulated compost piles. Aerobic conditions must be maintained during the compost process. A temperature of 55 degrees Celsius must be maintained for at least seven days. Static aerated piles use forced aeration methods to maintain aerobic conditions in the waste. Forced aeration ensures a constant level of oxygen is maintained throughout the pile. The pile is turned only to provide nutrient value and ensure the pathogen content of the outer material is reduced with the high internal temperatures maintained within the insulated pile. Because oxygen and temperature are maintained at a consistent level, decomposition occurs at a faster rate than the windrow compost system. The biological activity within the static aerated pile operates at a constantly high level because the microorganisms are provided with a constant supply of oxygen and nutrients. Thus, temperatures at or above the 55 degrees Celsius are maintained. This constant level of high temperature provides for pathogen kill in a shorter time period. The performance criteria have no specific requirements for turning the waste because turning is only necessary to ensure complete decomposition and to obtain pathogen kill on the outer edges of the pile. The technical community has agreed with these standards.

Subitem (3) addresses the requirements for composting in enclosed vessels. The enclosed vessel method for reducing pathogens consists of a confined compost process involving mechanical mixing of compost under controlled environmental conditions. The retention time in the vessel must be at least 24 hours with the temperature maintained at 55 degrees Celsius. A stabilization period of at least seven days must follow the decomposition period. Temperature in the compost pile must be maintained at 55 degrees Celsius for at least three days during the stabilization period. Although the windrow and static aerated pile have been consistently used as composting technology capable of providing a suitable product, enclosed vessels are a somewhat newer technology with less supporting documentation available. The Agency believes that enclosed vessel composting is a viable alternative for composting solid waste. Composting in an enclosed vessel is similar to digestion of sewage sludge from wastewater treatment facilities. The fundamentals of decomposition are the same under these conditions although use of enclosed vessels may result in anaerobic decomposition as happens with sewage sludge digested in totally enclosed vessels that have no outside source of oxygen. Anaerobic decomposition will result in a quality compost product including pathogen kill when properly operated. It is reasonable that the Agency provide for enclosed vessel technology because it can result in an adequate quality compost product and requires less space than windrow compost systems. The smaller space requirement can be critical in populated areas generating large amounts of compostable material.

In many cases, enclosed vessel operations are used only for the initial stages of decomposition with product stability completed under the windrow or static pile methods. The enclosed vessel permits the facility owners and operators to carefully control temperature, moisture content, and oxygen levels. The vessel contents are mechanically stirred to ensure that oxygen levels are maintained and microorganisms have a constant source of nutrients. Under these conditions, the temperature within the vessel will rise very quickly and achieve the 55-degree-Celsius level within two days. This item requires the temperature be maintained at this level for at least 24 hours before the material may be removed from the vessel for further stabilization. The Agency believes it is necessary to ensure that pathogen kill temperatures are achieved prior to the material leaving the vessel as the vessel acts mainly for mixing prior to combining the material with previously processed waste for stabilization.

If pathogen kill is not obtained prior to the combining stage, it is possible for material in place to be innoculated with pathogens from the material being introduced from the vessel phase. It would be unreasonable to mandate that each batch from the vessel be placed in a separate area because of the number of small piles the facility personnel would be forced to maintain. Not only would this be an inefficient means of operation, it lends itself to mishandling due to the complexity of maintaining proper records and controlling conditions within each pile. The Agency believes it is reasonable to address this concern by requiring that temperatures high enough to kill pathogens be achieved within the vessel for 24 hours. Studies have shown that pathogens are killed within 24 hours of the high temperature level being obtained (Reference 138). The Agency believes that meeting this requirement followed by seven days of further processing, of which three days are at temperatures capable of killing pathogens, will produce a product suitable for use by individuals. The facility owner or operator must take this into account when designing the vessel capacity and the stabilization areas.

Comments were received regarding this subitem and its applicability to anaerobic decomposition technology. The Agency informed commentors who expressed this concern that the performance criteria permit the use of anaerobic digestion technologies for composting solid waste. These performance criteria permit the use of any technology that is capable of achieving pathogen kill and a stabilized compost product. Additionally, the Agency is unaware of any current compost method for solid waste that would be completely anaerobic. Therefore, it is appropriate to present the criteria as if they were applying to aerobic processes only while not expressly prohibiting the use of anaerobic decomposition technology. Discussions with the commentors regarding these concerns appears to have settled the matter in a positive manner.

Subpart 7. Operation and maintenance manual. This subpart requires owners and operators of compost facilities to prepare an operation and maintenance manual. The reasonable approach to regulating solid waste at compost facilities must be technology specific. Because of the variability among facility designs, it is important that a process manual be developed for personnel at each facility. Additionally, the manual will inform the Agency how the facility is intended to be operated to achieve the proper compost quality.

The operation and maintenance manual must contain the design information required in subpart 5 and the operation requirements of subpart 6. The Agency expects this information to contain detailed discussions of how the items under subparts 5 and 6 apply to a specific facility, not a simple repetition of the requirements contained in these subparts. The facility owner or operator must provide facility personnel with this information to maintain compliance with the proposed rules and prevent disruption of facility operations by improper operation of equipment. The facility owners or operators benefit from proper operation of a compost facility by minimizing disposal costs attributed to residual wastes and unacceptable compost product.

The operation and maintenance manual must contain a list of allowable end uses for the compost and the procedures to be used in sampling and analyzing the compost before distribution. The requirements governing compost facilities emphasize performance. The facility owner or operator choosing a compost process design, must consider the use of the final product. A performance-based rule requires the facility owner or operator to give consideration to the product quality needed and the design process that will achieve this quality.

Monitoring product quality is a critical factor in achieving compliance with rules and a marketable product. Because the operation and maintenance manual functions as the training guideline and informs facility personnel of acceptable practices, it will contain the steps needed to collect data necessary to make informed decisions regarding the facility design and operation. Sampling and analysis procedures must be detailed in advance of sample collection so that representative samples are taken and useable data is obtained.

Subpart 8. Compost classification. To this point the discussion of compost facilities has centered on the facility itself. Subpart 8 addresses the compost product and the quality that must be achieved prior to distribution for use. Considerable discussions were held with reviewers of the proposed rules during the drafting of this subpart. The concerns raised during these discussions will be highlighted as appropriate. Product quality is the key to a successful compost operation. Classification of the compost will be of great interest to vendors of compost processes and the regulated community. The Agency received valuable input during the drafting process and believes the proposed classification system is appropriate.

The Agency proposes to classify the final product generated at compost facilities into two classes. The facility owner or operator must classify each batch of final product into one of the classifications based on the information contained in items A and B. It is the product that is classified and not the facility. The facility owner or operator in designing the facility will plan for the generation of a product that meets a particular classification. However, the variability of waste material makes it impossible to guarantee the final product quality of each batch of compost produced; thus, the product must be monitored.

Item A contains the parameters of a Class I compost. Class I compost is regarded by the Agency as the most inert form of compost generated based on contaminant levels, stabilization, and inert material content. These three parameters are considered most important in determining the proper utilization of the material. Class I compost may contain no sewage sludge because its presence overrides the analytical results regarding contaminant levels, stabilization, and inert material content. Under federal rules governing sewage sludge and the Minnesota Waste Management Act of 1980, the Agency is required to approve sites used for land application of sewage sludge.

Comments were provided on using sewage sludge as a criterion to eliminate a particular product from the Class I compost category. Commentors believed that if compost generated with sewage sludge could meet the other criteria it should be eligible for classification as Class I. Agency staff spent considerable effort explaining the requirements placed upon the Agency by federal regulations and State statutes requiring knowledge of the use of sewage sludge. Under the proposed rules, Class I compost is permitted for unrestricted distribution by the facility owner or operator. If compost generated with sewage sludge were in this category, the distribution of the compost would need to be controlled. The Agency believes it is reasonable to exclude compost made with sewage sludge from the Class I category and address it under the Class II category where approval is given on a case-by-case basis.

Subitem (1) establishes the maximum contaminant levels allowed in a Class I compost. The contaminant level will be based on an average result from a number of samples of the final product as determined on a milligram of contaminant per kilogram of compost (dry weight). The contaminants used to classify compost can be toxic to humans and animals and phytotoxic to plants if present in the environment at sufficiently high levels. Since it is intended that Class I compost be available for distribution to individual homeowners, the Agency believes the establishment of maximum contaminant levels is reasonable.

The establishment of acceptable contaminant levels in rules provides the facility owner or operator with sufficient information on which to base the facility design. Without understanding the criteria in advance, the facility owner or operator will have difficulty determining an acceptable facility design because the desired quality of performance will not be known. Specific performance criteria ensure consistency among facilities. The alternative to specific performance standards is detailed design requirements. The Agency believes detailed design requirements would unnecessarily restrict facility owner's and operator's choice of compost method and vendor. Therefore, specifying the exact performance criteria presents a reasonable approach to controlling the quality of compost generated at these facilities.

Reviewers of early drafts of the compost standards recommended that the proposed rules clearly indicate that classification and enforcement of the classification system be based on the average contaminant level found in the product. These commentors suggested that, unless the term average was included in the rule language, the rule could be interpreted to mean that any analysis taken from a final compost product must meet the contaminant levels contained in the rules. Strict compliance would, in the words of the commentors, place on them a risk of lawsuits or enforcement actions based on one sample and analysis. Recognizing that exceedance of contaminant levels indicates a potential problem, commentors suggested that classification and enforcement are more reasonably based on an average taken from a number of sampling events to avoid conflict over the analysis of one handful of material taken from a pile. The Agency believes that the commentors presented a reasonable argument on behalf of the inclusion of language basing classification on the average of analytical results.

The development of the actual contaminant levels was based on the reported levels permitted in sewage sludge and compost, and discussions with persons involved in compost operations. The contaminant levels were established so that individuals using Class I compost will not adversely impact their local environment using normal amounts of the material. Because the sites receiving compost will not always be closely evaluated for pH, cation exchange capacity, and existing metal levels, the Agency believes it is necessary to be conservative in establishing the contaminant levels for Class I compost. Thus, the levels are somewhat lower for classification purposes than used nationally for sewage sludge.

Some comments were received that the proposed contaminant levels are too restrictive and will deter communities from choosing compost as a solid waste management technique. These commentors expressed their concern that the Class I contaminant levels were more restrictive than sewage sludge requirements especially when, as they understood, sewage sludge contaminant levels are projected to be relaxed. The Agency disagrees with the concept expressed by these commentors. Sewage sludge and compost cannot be directly compared since sewage sludge is rarely taken home by the individual user to be placed on a home garden or landscape areas. Therefore, the question or concern being addressed under the different rules are not the same and a direct comparison cannot be made.

It should be noted that the proposed contaminant levels are considered acceptable by the majority of experts in the field consulted by Agency staff. In fact, the standards are equal to the levels suggested by one commentor (Reference 137). It should also be noted that the University of Minnesota compost study showed that compost composed of only solid waste could meet the Class I contaminant levels. See Appendix XVI. Thus, the Agency believes that it is reasonable to use the proposed contaminant levels in separating compost produced from solid waste into one class approved for unrestricted use and another for restricted use.

Subitem (2) establishes the stabilization period for curing Class I compost. The primary requirement is that Class I compost be stored for a period of at least six months, or until the compost is stabilized and will not reheat upon standing. In deference to comments, the Agency proposes that a shorter period may be permitted by the Commissioner. The Commissioner's approval will be based on the waste composted, the method used to reduce pathogens, and the intended end use of the compost. Class I compost must be cured for a sufficient length of time to ensure total decomposition and pathogen kill have been achieved. The initial compost process of aeration, turning and temperature control practices are not continued during the curing process to ensure rapid decomposition. Therefore, an extended period of time is needed to achieve decomposition. Operational practices must be employed to complete these processes as necessary. A compost product that is not completely stabilized may reheat after application. The compost product will reheat if decomposition is not complete as microorganisms continue to break down the organic matter remaining. Processes such as mechanical stirring of the waste material depend on long-term curing periods to ensure pathogen kill.

A six-month curing period is commonly used as the appropriate stabilization period. However, commentors suggested that this should not be the only method considered acceptable to the Agency. Stabilization can be achieved by adding lime to the compost or utilizing the initial compost process for a longer period of time. Also some wastes will decompose more rapidly than others. The facility owner or operator should have the option to present evidence of this to the Agency. The goal of this subitem is to achieve stabilization of the compost product and ensure pathogen kill, not to store compost for six months. Thus, the subitem provides an option other than six months storage, provided stabilization is indicated. This is analytically determined based on the amount of organic matter remaining. The analytical procedure is commonly used by facility owners and operators in monitoring the progress of the decomposition process. Facility owners or operators opting to show stabilization has occurred prior to a six-month curing period will incur little additional costs. The Agency believes this provision provides sufficient flexibility for facility owners and operators to adapt the criteria established under this subitem to the facility design yet ensures protection of human health and the environment.

The last option provided under this subitem is approval by the Commissioner for stabilization periods less than six months. A facility owner or operator may request to distribute a compost product that has not yet reached complete stabilization. There are end use options that do not require a stabilized compost and in fact, may prefer an unstabilized product. One such end use includes the use of compost on vineyards (Reference 137). As Minnesota vineyards continue to expand, this use for compost increases. Adequate protection of human health and the environment are provided for under this scenario.

Subitem (3) establishes the amount of inert material that may be present in the finished Class I compost. The quality of a finished compost product is partially dependent on the amount of inert material contained in the product. Inert material is defined in the proposed rules to mean the uncompostable material remaining in a compost system after decomposition, and does not include soil particles such as sand or small stones. Facility owners and operators must produce a compost containing inerts at a level and type/shape/nature presenting no hazard to humans, plants and soil. The inert material may consist of glass, metal, plastic, leather, etc. Because Class I compost will be used by individuals for use at their residences or farmlands, the compost should not contain large pieces of glass or metal capable of injuring the compost user, or any other material that might adversely impact the areas where the compost is used.

The particle size of the inert materials will vary dependent upon incoming waste and the processing of the waste prior to entering the compost system. If incoming waste is shredded to a three-quarter inch size, the inert materials found in this system would be much smaller at the start of the decomposition and may be further pulverized during turning. Waste that receives no processing prior to the decomposition stage will have a higher percentage of inert materials when decomposition is complete. The compost generated from the latter material will require more processing prior to distribution. The amount of inert material permitted in a final compost product is based on the dry weight of the inerts compared to the dry weight of the entire sample. The results are reported as a percentage.

The Agency received two types of comments regarding the proposed criteria for inert material - those concerned with restriction of facility owners and operators' negotiations with the product user and those concerned with the standards themselves. The second concern is more important. The questions raised on the proposed standards addressed the seeming unfairness to facility owners and operators who generate a fine compost being more restricted on inert material than those producing a coarser product. Under the proposed criteria, inert materials less than 10 millimeters in size may consist of only 1 percent of an entire sample by weight while inerts up to 25 millimeters may contribute up to 4 percent of the total sample by weight. On the surface, these standards appear to unfairly control the amount of small-size inert material. The standards are best understood if the size and percentage of weight are considered together. One percent by weight of small inert particles may, by volume, be as much as or more than 4 percent by weight of the larger particles. The smaller particles will weigh less on a piece basis than the larger particles; therefore, to obtain one percent of the total weight will in fact permit more than four percent of the larger particle-size material.

A 10 millimeter particle is approximately one-half inch in size; smaller than many shredders and preprocessing screens currently being used. The Agency believes that materials shredded to this size under normal circumstances will be decomposed, except for glass, plastic, slag stones or other slowly nondecomposing materials. The materials shredded to this size are of little concern except in marketing a compost of certain quality standards based on appearance. The Agency believes that consideration of the level of inert material should be based on percentage by weight rather than volume because of the potential for one large piece of inert material, a tin can in a quart sample, to overtake a total analysis based on volume. This would cause the compost to be disqualified as a Class I compost. The purpose of these standards is to protect the user from injury and the environment. By evaluating the inert materials on weight and allowing a larger percent by weight for larger particles, the Agency acknowledges that not all inert particles can be cost-effectively removed from the compost product yet maintains some control on particle size. Users of a compost with larger inert materials are more apt to apply the material on areas not commonly used by individuals who may be injured or who will care about the physical appearance.

The second concern raised by commentors was the unnecessary constraint placed on facility owners and operators by establishing criteria for the amount of inert material. These commentors felt the criterion that no sharp particles be contained in compost generated from yard waste would be suitable for solid waste compost products as well. This would allow the facility owner or operator to negotiate with potential users on the quality of compost generated. The Agency believes the simple requirement of no sharp particles can be even more restrictive than establishing the criteria of this subitem. Upon finding a sharp particle, the facility owner or operator could be found in violation of the rules. The proposed criteria require a more systematic approach to determining compliance. The criteria in the proposed rules provide facility owners and operators with sufficient detail to determine how the operations at the site can ensure compliance rather than having compliance be determined by subjective inspections. Specific criteria promote consistency of regulation among facilities and provides a method to obtain uniform compliance with standards established to protect human health and the environment.

Item B establishes the criteria defining a compost product as a Class II compost. The criteria are simply stated. Compost generated including sewage sludge or failing to meet Class I standards is defined as Class II. Initial drafts of the compost standards included from one to three classes of compost. The Agency established classes of compost to define the proper end uses of the material. From the original distribution of the rule drafts, the classification system has been altered many times based on how many classes should be developed and how the division should be made. However a dividing point is defined, commentors objected based on their relation to that point. Reviewers of the draft regulations did not want restrictions on the compost uses. The same reviewers were also interested in protecting the environment and health from any compost use. It thus became the responsibility of the Agency to balance the needs of the compost producers in light of the environmental goals of the State. The Agency believes it has reasonably reconciled these concerns with the development of a two-class system for compost generated from solid waste. Class I compost characteristics are very closely defined under item A while Class II compost is any product not meeting Class I characteristics or having sewage sludge in it. Class I compost is allowed to be distributed with no specific restrictions upon its use. Class II compost use is controlled based on its characteristics as discussed under subpart 9. This control does not mean every use will be scrutinized in detail. The Agency believes the two-class system presents a reasonable method to distinguish between low risk compost products and those with a somewhat higher risk. It also allows flexibility for facility owners and operators in marketing of their product as no use is specifically defined as unacceptable.

Subpart 9. Compost distribution and end use. This subpart addresses how the finished compost product may be used. It establishes what information is necessary when the final compost product is ready for distribution. The Agency believes it is necessary to provide facility owners and operators with what must be considered in evaluating the quality of compost and determining its proper end use and distribution. The Agency believes that flexibility is important in governing the end use so that all potential and existing markets are explored. This subpart establishes criteria by which the facility owner or operator and the Agency will evaluate the compost and determine its suitability for a particular use and the appropriate application rate.

Item A informs facility owners and operators of their obligation to register with the Minnesota Department of Agriculture any compost distributed or marketed as a commercial fertilizer, specialty fertilizer, soil amendment, or plant amendment. These terms are defined in Minn. Stat. § 17.713. Owners and operators of compost facilities may be unaware of the requirement to register the final product. Additionally, vendors of compost systems coming into the State may be unaware of these requirements. No additional registration or proof of registration must be submitted to the Agency. This provision alerts facility owners and operators of their obligations without increasing their responsibilities to the Agency.

Item B reaffirms that Class I compost may be distributed for unrestricted use. Although implied elsewhere under the proposed standards for the design and operation of compost facilities, this item clearly informs generators of Class I compost that it may be freely distributed. Any local controls or registrations required for the distribution of the compost must be complied with. The Agency believes it is reasonable to allow distribution of this material without specific approval on the intended end use because the criteria were developed so that anyone could use the material with a minimal amount of technical expertise. The high quality of compost generated for designation as Class I provides a reasonable justification for no restrictions on the distribution of this material.

Item C lists the factors to be used in evaluating the proposed end use of a Class II compost. The distribution of Class II compost is somewhat restricted under the proposed rules. A compost is designated Class II based on its inability to fully comply with the Class I criteria or because it was generated in conjunction with sewage sludge. Depending on why the compost was designated Class II, the review process may be simple and straightforward or detailed. For instance, a compost designated Class II because it could not meet the limits for inert materials would be treated considerably different from a compost generated from solid waste and sewer sludge that contains high metal concentrations. To address the extremes as well as the mid-range options, the Agency presents the basis for the approval of a proposed distribution system rather than trying to define distribution schemes to match the infinite possibilities for why a compost product was designated Class II.

Reviewers of the rule agree with this approach. Concern has been raised over the automatic inclusion of any compost generated from combined solid waste and sewage sludge. It has been said that the automatic inclusion unfairly penalizes communities that have sludges with low metal levels and that separate the solid waste at the source and are able to meet Class I criteria. The Agency has explained that the automatic inclusion is based on the federal and State requirements for knowing how and where sewage sludge is used. This designation of the waste as Class II does not automatically limit its use. Rather, it adds a requirement for Agency approval of the proposed distribution plan.

The Commissioner's approval will be based on the following characteristics:

(1) the waste composted;
(2) the heavy metal contaminant levels found in the finished compost;
(3) the degree of maturity;
(4) the extent of decomposition;
(5) the particle size;
(6) the moisture content;
(7) the amount of inert material;

(8) the proposed end use; and
(9) the characteristics of soil at the point of final end use.

The information described above is needed by the facility owner or operator to market the compost. This item merely requires the submittal of this information to the Commissioner to approve the intended distribution system. This information is used to determine proper storage requirements as well as application rates for the compost.

4. Part 7035.2845 RECYCLING FACILITIES.

This part establishes the technical design, construction, and operation requirements applicable to recycling facilities. These requirements are established in rule to provide facility owners and operators with an understanding of their responsibilities. The specific standards included in this part are further discussed below.

Subpart 1. Scope. This subpart requires the owner or operator of a mixed municipal solid waste recycling facility to comply with the requirements of this part. Facility owners and operators must know their responsibilities in order to comply with the Agency's standards to protect human health and the environment. Part 7035.2525, subpart 2, item B exempts recycling facilities handling only one type of waste from most requirements of the proposed rule.

This subpart also informs owners and operators of recycling facilities accepting or processing source-separated wastes in quantities less than 10 cubic yards per day that they are required to comply only with subparts 2 and 3 of this part. This notification differentiates between small, low-pollution potential facilities and the more complex operations. Only minimal information is required from facilities that have almost no potential to impact human health and the environment. It is unreasonable to require lengthy, detailed plans and specifications for these facilities given their size and the cost for such plans.

Subpart 2. Notification. This subpart sets out the information a facility owner or operator must submit to the Commissioner about the facility operations. Owners and operators of existing facilities are required to notify the Commissioner within 30 days after the effective date of the rules and owners of new facilities must notify the Commissioner before operations begin. The notification must describe the materials handled at the facility and the location of the facility. This information is needed to satisfy the Agency responsibility for solid waste management in the State and its need to be aware of the techniques used to handle solid waste. This notification provides the

Agency with useful information to share with the public on locations of facilities that may be used to deposit source-separated waste. Providing this information is not unduly burdensome for the facility owner or operator yet provides significant information on the types of solid waste being recycled and the location of the recycling facilities.

Subpart 3. Design requirements. This subpart establishes the minimum design requirements for a mixed municipal solid waste recycling facility. The design requirements for these facilities are performance-based. The facility owner must design and construct a facility to prevent surface water drainage through recyclable or unusable material, contain spills or releases, and provide proper storage for the recyclable materials and residuals. Storage of waste on-site must comply with part 7035.2855. The performance standards are necessary to present general guidance to facility owners and operators on the Agency's concerns with recycling facilities. Because there are many methods to operate a recycling facility for mixed municipal solid waste, it is not feasible to establish specific requirements in the rule.

Subpart 4. Operation. This subpart requires the owner or operator of a recycling facility to operate the facility in a manner that controls dust, wind-blown material, vermin, and other nuisance conditions (item A), remove residuals at least once a week (item B), and submit an annual report (item C). It is necessary to control nuisance conditions because these conditions can lead to health risks due to diseases carried by vermins, health implications of dust collecting in lungs; and viruses being distributed by wind-blown materials. Residual waste must be removed from the facility because residuals normally contain large amounts of putrescible wastes that could create odors as they break down. Improper management of residual wastes can result in nuisance conditions, at the very least, and leachate management problems in a worst case. Operating standards are prudent business practices that do not impose additional burdens on the owner or operator while providing a basic level of protection against human health and environmental impacts.

The requirement for an annual report ensures that the Agency receives at least annual updates on the facility operation. Item C requires that the annual report be submitted by February 1 of each year. The report must contain information on the type and volume of materials handled at the facility, the final markets for the materials, and the price received for them. The Agency is responsible for solid waste management in the State of Minnesota. This information provides the Agency with sufficient information to understand the management systems established in the State and the price received for the end products. This information allows the Agency to project future solid waste management activities and provide assistance to parties wishing to discuss potential recycling options. The information required in the report is readily available to the facility owner or operator without extra data collection.

Subpart 5. Contingency action plan. This subpart establishes the contents in contingency action plans developed for mixed municipal solid waste recycling facilities. Items included in the contingency action plan are actions taken if fire, spills, or releases occur and a back-up waste management plan if the facility must be closed for a time. These items must be addressed in addition to the requirements of part 7035.2615 because they require the facility owner or operator to tailor the facility contingency action plan to the design and operation of the specific recycling facility. To minimize any impacts associated with any unexpected failure, it is necessary to plan ahead and make appropriate design or operational changes to minimize the probability of occurrence or the extent of impact after the event. For instance, if the facility utilizes mechanical separators, the facility owner or operator may wish to have a back-up method for separation, if the first machine breaks down or to locate a facility that will manage incoming waste until the machine is repaired. Requiring the facility owner or operator to review these options in the contingency action plan prevents a break in waste handling during down times and minimizes impacts to human health and the environment during emergency situations.

Subpart 6. Closure. This subpart requires the facility owner or operator to remove and treat or dispose of all waste and contaminated soils or structures at the time of closure. This subpart further explains the standard the Agency will apply in reviewing the closure plan developed under part 7035.2625 and in approving the closure certification. A mixed municipal solid waste recycling facility will accept a variety of wastes for processing. The storage and processing of these wastes may contaminate soil liners, may create a need for leachate or surface water treatment, and may result in the acceptance of some wastes that cannot be forwarded for further processing as readily as others. The facility owner or operator will have to remove the contaminated soils or leachate and any waste remaining on site at the time of closure to ensure that no waste will remain after closure to pollute the environment and harm human health. By removing all contaminated soils, leachate or waste the facility owner or operator ensures no succeeding facility owner or operator will cause problems that are the responsibility of the former owner or operator. The removal of contaminated soils, leachate and waste will eliminate risks remaining at the site after closure. This provision serves as a reminder of what is already expected of the facility owner or operator.

5. Part 7035.2855 SOLID WASTE STORAGE STANDARDS.

This part establishes the specific design, construction, inspection, closure, and operation requirements of storage areas at solid waste management facilities. The processing of solid waste often requires the storage of waste before processing or the storage of components of the waste stream. Storage of solid waste can result in environmental impacts due to the release of pollutants through leachate movement or spills. Minimum standards are necessary to ensure that basic protection methods are utilized by all facility owners and operators when designing, constructing, or operating storage areas. These standards ensure consistency among facilities in the storage of solid waste. The specific standards included in this part are further discussed below.

Subpart 1. Scope. This subpart explains when the storage standards apply. Establishing the scope of this part alerts facility owners and operators to their responsibilities for the proper storage of solid waste.

Storage of waste tires is exempted from the requirements of this part because other rules apply to these facilities. Covering the storage of waste tires would only serve to duplicate efforts to govern them.

This subpart establishes further conditions under which facility owners and operators are exempt from establishing storage areas consistent with this part. The goal of establishing storage standards for solid waste management facilities is to provide protection for human health and the environment. If the facility owner or operator meets these goals with a method other than specified in this part, the facility owner's or operator's method may be used in lieu of this part. In the past, owners and operators of solid waste management facilities have allowed surface water to come in contact with the waste being stored and run off into surface water or seep into the ground water. This part requires controls on the movement of polluted waters off the facility before treatment. Construction certifications and closure requirements remain in effect for these facilities.

The general exemption provision of this subpart requires the solid waste to be stored in a building to prevent run-off or leachate generation as no liquid wastes or wastes with free liquids are added to the storage area. Items A to C must all be met in order for the facility to qualify for the design and operational exemption.

Item A requires that the waste in the storage area must be protected from surface water run-on by the storage building or in some other manner. Protecting the waste from surface water run-on minimizes the potential for the waste to be washed away during periods of heavy rainfall and minimizes the production of leachate from surface water flowing through the waste. The storage standards are intended to minimize impacts on the environment from wastes stored before or after processing. Areas exempt from the storage standards should be exempted only if there exists no potential for environmental impacts.

Item B requires that the storage area be designed and operated to control dispersion of waste by wind by means other than wetting. Protecting waste from the wind minimizes nuisance problems and additional work caused by blowing paper, plastics and other garbage. If the storage areas meet the standards of items A and C and this item, no leachate control system will be required. Therefore, wetting of the material should be prohibited as a control mechanism because excess wetting could increase the potential for leachate generation during storage.

Item C requires that the solid waste stored in areas exempted from design, operation and liner inspection requirements be incapable of producing leachate and gas through decomposition or other reactions. In other words, the waste must be relatively inert, slow to decompose, and not reactive with additional wastes placed in the area. Again, because these storage areas will be exempt from leachate and gas controls, the waste stored in the areas should not be capable of producing leachate or gases that could impact the environment because no controls are present.

Subpart 2. Location requirements. This part sets out specific standards for locating solid waste storage areas. Complying with these standards will minimize the risks to environmentally sensitive areas and minimize the impacts the site conditions might have on the storage area operations.

Item A specifies that storage areas may not be located in areas characterized by karst features such as sinkholes, caves and disappearing streams. It is necessary to prohibit the location of storage areas in active karst areas because these areas are prone to collapses that allow for the movement of waste or waste by-products directly into ground water causing pollution. By specifically prohibiting the location of storage areas in active karst areas, the Agency provides protection against this direct discharge. This standard provides a minimum level of protection in areas where solid waste cannot be recovered if a collapse occurs.

Item B specifies that storage areas and their underlying liner must be located entirely above the high water table. The storage area and all design features associated with it must be located above the high water table to protect the integrity of the design and prevent the leaching of pollutants out of the waste directly into ground water. The likelihood of environmental damage and operational problems prohibit the placement of design features in the water table.

Subpart 3. Design and operation requirements. This subpart establishes the minimum design and operation standards for solid waste storage areas. These standards will provide protection for human health and the environment while storing solid waste prior to or during processing. These standards in a rule alert facility owners and operators to the Agency's interpretation of the requirements needed to minimize adverse impacts from the storage of solid waste and assures the public that consistent requirements will be applied to all solid waste management facilities.

Item A requires solid waste storage areas to have a liner designed, constructed and operated to prevent the migration of waste or leachate into adjacent subsurface soil, ground water, or surface water during the active life of the facility or after closure. The specific standards that must be met in designing a liner are discussed below. These standards ensure that all storage areas will provide a minimum level of protection. By including the standards in rule, facility owners and operators are advised of the requirements the Agency will enforce. The requirement also promotes consistency in the Agency's enforcement of these standards.

Subitem (1) requires the liner to be constructed of materials that have appropriate chemical properties and the strength and thickness needed to prevent failures due to pressure gradients, climatic conditions, chemical dissolution or weakening, or operational stresses. The major factors in determining a soil's suitability for use as a liner material are its ability to support itself and overlying facility components, low permeability, and compatibility with the waste and waste by-products. Choosing a soil type requires balancing these factors to achieve an optimum design. An optimum design is one that produces a liner that when constructed is capable of impeding the flow of pollutants into the subsoil and eventually into the ground water, and of absorbing or attenuating the suspended or dissolved pollutants to meet ground water standards. If the liner is not compatible with the waste or waste by-products, e.g., concrete liner with acidic wastes, the liner will not maintain its integrity and will eventually allow the release of pollutants into the surrounding soils. As discussed in part 7035.2815, subpart 7, the integrity of the liner system is critical to managing the human health and environmental risks associated with the storage of solid waste. Liner materials may include synthetic membranes, admix liners, or soils. The rule includes general performance standards rather than specific design or performance standards concerning liner materials. General performance standards allow the facility owner or operator to assess the characteristics of material or materials and maximize their attributes to minimize the potential for a release of waste or waste by-products into the environment.

Subitem (2) establishes a maximum permeability standard for all liner materials and a thickness requirement for liners constructed of natural soils. The liner permeability and thickness control the direction of fluid movement from the solid waste storage area. A maximum permeability of 1×10^{-7} centimeters per second is needed to retard the downward movement of liquids from the storage area. This permeability sufficiently decreases the downward movement that any liquids impinging upon the barrier will move horizontally in the direction of the slope and can be collected for treatment prior to disposal. The storage of solid waste provides an avenue by which pollutants may move out of the waste into the subsurface soils unless they are deterred. The permeability standard provides a mechanism to prevent the downward migration of pollutants from a storage area.

This subitem also requires that the liner under the storage area be at least two feet thick if a natural soil is used. The thickness of a liner material and the low level of permeability provide an effective barrier to downward migration of pollutants. Two feet is the minimum thickness accepted by EPA for the construction of liners. This thickness is needed to ensure that a constant permeability is achieved throughout the lined area and provide structural support for the collection system. Construction techniques mandate small loose lifts to achieve optimum compaction. The number of passes is determined on a trial area before actual construction begins. To achieve the intended permeability, soil conditions such as moisture content must be controlled. It is impractical to assume that soil conditions are exactly alike throughout the selected material. Thus, a safeguard must be used to ensure structural support and permeability are achieved. By establishing a thickness requirement, the Agency provides the facility owner and operator a minimum standard that is acceptable for the construction of liners used to collect liquids for treatment and disposal. The two-foot thickness specified in this subitem is necessary to provide sufficient interlocking of the compacted lifts to guarantee achieving the required permeability.

Subitem (3) requires that the liner be constructed on a foundation capable of providing structural support to the liner, resistant to pressure gradients, and prevention of failure due to uplift or compression. The integrity of a liner must be maintained for the liner to meet performance standards. Good construction of the liner accomplishes little in protecting human health and the environment if subsurface soils are inadequate to support the construction and operation of the liner. To achieve proper subsurface conditions, the facility owner or operator may need to compact these soils, remove boulders and vegetation, or replace the top depths with a more stable soil. This standard alerts the facility owner or operator to the Agency's standards regarding the subsurface engineering before the construction of liners. The integrity of the liner is critical to its ability to meet performance standards.

Subitem (4) establishes the area that must be covered by a liner. The entire area that will be in contact with solid waste or leachate must be lined. The objective of installing liners under solid waste storage areas is prevention of solid waste, waste by-products, and leachate from moving into the subsurface soil and eventually into ground water or moving overland into surface water. To line only a portion of the area used to store solid waste would defeat the purpose of a liner. Including this requirement in the proposed rule establishes a performance standard easily achievable by facility owners and operators and allows them to meet other standards such as the control of run-off from the facility and surface water standards. Because the storage area needed at each facility varies depending on the facility design, it is impractical and unreasonable to establish a specific design standard. The facility owner or operator should be allowed to design, construct, and operate a storage area based on the specific needs of the facility.

Item B sets out the design, construction, and operation standards for the leachate collection and removal system to be used in conjunction with the liner discussed under item A. Standards for the installation of a leachate collection and removal system are needed to provide protection against the disruption of the liner due to improper management of liquids on the liner and to minimize impacts on human health and the environment. The basic standard under which the leachate collection and removal system must operate relates to the leachate depth on the liner. The leachate depth must be no greater than one foot. Depths greater than one foot will produce pressure on the liner such that vertical movement of leachate down through the liner will exceed the horizontal movements across the liner. Additionally, the storage of large volumes of liquid on the liner can result in scouring of side berms by wind action, increased decomposition of stored waste, and other detrimental effects on the liner system. Establishing standards for the collection and removal of leachate provides a base level of protection for human health, the environment, and facility operation. The continual removal of liquids from the storage area allows the facility owner or operator to design, construct, and operate a smaller leachate storage system because the quantity of leachate handled will be less. The liner may also be designed with lower berms to contain the liquids saving the construction costs and providing a total system much easier to operate.

Subitem (1) requires the leachate collection and removal system to be constructed of materials that are chemically resistant to the waste and leachate stored on the liner. Materials must also be strong and thick enough to prevent collapse under the pressures exerted by the waste, cover materials and equipment used on the area. In some instances, it may be necessary to operate equipment on the liner to place and retrieve solid waste. This operation may result in the equipment moving over the collection and removal system. If the collection and removal system is not properly designed and operated, equipment operations may result in breakage of the liner and a failure to operate efficiently. If the collection and removal system fails, the facility owner or operator will be unable to meet performance standards. The design, construction and operation of a collection and removal system in a manner that ensures its integrity is responsible risk management. Because the leachate collection and removal system is critical to the overall operation of the storage area's containment system, the collection and removal system must provide adequate protection against failure.

Subitem (2) requires that the collection and removal system be designed and operated to function without clogging for the life of the facility. As discussed under subitem (1), the integrity of the collection and removal system is critical to the overall performance of the storage area's barrier system to control the movement of pollutants into the subsurface soils or overland into surface waters. If a collection and removal system is designed and operated to prevent movement of the leachate out of the storage area, a failure of the system is imminent and the general performance standards of this part will be violated. By establishing a design, construction and operation standard, the Agency requires the facility owner or operator to use a system compatible with the entire facility design. The owner or operator of a small storage area may wish to utilize a collection system that is pumped out when liquids flow into the area. A large storage area may require conveyance pipes to a storage tank with routine cleaning the pipes.

Item C establishes the performance standards for a run-on control system around a solid waste management storage area. The purpose of the run-on standard is to minimize the amount of surface water entering the facility. Run-on controls prevent erosion, the surface discharge of waste, and the downward percolation of run-on water through the waste generating leachate. Diversion of run-on may be accomplished by locating the storage area on a portion of the facility that provides natural protection due to topography, by contouring the surrounding land, or by constructing ditches, culverts, or dikes. The capacity of these structures must be determined based on the site topography, size of drainage area, and the size of the storage area. This item requires that the facility owner or operator use as a minimum design parameter the 24-hour, ten-year storm.

The storage area at a solid waste management facility, if designed and constructed using natural soil materials, will need to be reconstructed on a periodic basis due to the movement of equipment over the area to place and remove waste, the freeze-thaw cycles experienced in Minnesota, and the technological advances being made in solid waste management in recent years. The Agency believes the useful life of an average storage area is five years. The Agency feels this is a reasonable estimate because of the physical demands on the liner system. Assuming a useful life of five years, the Agency compared the probability of various rainfall events occurring during this time and the cost associated with constructing run-on design features that would impact the storage area. A ten-year storm event would have a 40 percent chance of occurrence while a 25-year storm would have less than 20 percent chance of occurrence. Appendix XIII explains the development of the probability estimates for these storm events.

The Agency believes that achieving a 20 percent reduction in probability of occurrence would increase the cost to the facility owner or operator by 25 percent. The Agency believes it is unreasonable to require facility owners and operators to use the 24-hour, 25-year storm event as the minimum design requirement for controlling run-on to the storage area. The facility owners and operators may utilize the 25-year storm to design run-on control structures in order to minimize the risk associated with clean-up actions when design parameters are exceeded. The Agency believes the facility owner or operator must have some flexibility in determining acceptability of risk in operating a specific facility or portions thereof. The standard proposed in this item establishes a minimum standard to protect the environment. The clean-up of impacted areas, should the design features be exceeded, must be addressed in the contingency action plan developed for the facility. Thus, if the design features are exceeded, the facility owner or operator has procedures in place to minimize the impact of such an event.

Item D requires that a run-off management system be designed, constructed, operated and maintained, to collect and control at least the water volume resulting from a 24-hour, ten-year storm. The rationale for this requirement is the same as for item C.

Item E requires that collection and holding facilities that are part of the run-on and run-off management systems be emptied or managed to maintain the design capacity of the system. This standard maintains the integrity of the design capabilities of the system which are intended to minimize impacts on the environment due to storm events. If the standard in this item is not complied with, the facility owner or operator will be unable to meet the performance standards proposed elsewhere in this part. A failure to meet performance standards will jeopardize the environment.

Item F requires that a storage area designed to contain wastes subject to wind dispersal be operated to control the wind dispersal of particulate matter. One of the Agency's air quality rules, part 7005.0550, establishes a general performance standard prohibiting avoidable amounts of particulate matter from becoming airborne. It is unreasonable for the Agency to permit the design, construction, and operation of facilities or a portion of facilities managing solid waste to violate this standard. Facility owners and operators must utilize design and operation methods to prevent the storage area from violating air quality standards.

Subpart 4. Inspection of liners. This subpart establishes the inspection requirements for liners under solid waste storage areas. Included in this subpart are the Agency's minimum requirements for repairing conditions that are causing or could cause failures in the system as well what must be done during an inspection. It is necessary to establish a specific set of standards for the inspections of liners under storage areas because of the increased potential for failure of these systems due to their exposure to severe climatic conditions and physical disturbance. Including these requirements in the rule provides consistency between inspection programs and alerts facility owners and operators to the Agency's minimum standards regarding the maintenance of these liners.

Item A requires the storage area to be inspected at least weekly and after each storm event. To prevent the development of nuisance conditions and the deterioration of the solid waste processing capabilities due to enhanced decomposition during storage, normal operating practices minimize storage and encourage direct processing of the waste as it arrives. Little solid waste is stored more than 48 hours. The weekly inspection will allow for early detection of potential problem areas. The detection and correction of problems when they are small minimizes the time and costs associated with the corrections. Because the storage area is designed to handle a 24-hour, ten-year storm with a potential of being exceeded 40 percent of the time, it is reasonable to inspect the storage area after a storm event to ensure the leachate collection system is operating and that no damage has occurred to the liner.

Subitem (1) requires that the facility owner or operator review the liner for evidence of deterioration, malfunctions, or improper operations of run-on and run-off control systems. Early detection of problems at these structures can prevent a catastrophic failure and eventual washout of the solid waste management facility. The inspection of these systems is critical to maintaining the integrity of the facility design and operation facilities. Inspection of these areas is sound business practice and not a new requirement of the facility owner or operator.

Subitem (2) requires the inspection to determine the presence of leachate in and proper functioning of leachate collection and removal systems. The collection and removal system of a storage area is used to remove excess liquids from the storage area liner for proper treatment and disposal. If leachate is present on the liner, the design or operation of the leachate collection and removal system may have failed or it may be evidence of a more serious malfunction of the system. By inspecting the storage area after a storm, the facility owner or operator will be able to assess what is causing the leachate to remain in the storage area. On the other hand, the absence of leachate does not necessarily indicate that the liner and collection system are operating properly. The reason for inspecting the liner as well as checking for the presence of leachate is to ensure that the total system is operating to minimize the potential for solid waste or leachate entering surface waters or ground water. Because of the importance of the leachate collection and removal system to the performance of the liner and minimizing impacts from the storage of solid waste, the facility owner or operator must inspect the storage area on a routine basis to ensure that the system is still functional.

Subitem (3) requires the facility owner or operator to inspect the storage area for improper functioning of any wind dispersal control systems being used. A wind dispersal system may consist of a cover system or fencing to control the solid waste from becoming airborne and moving off the storage area. If rainfall washes off the cover system or another type of system ceases to operate properly, it is necessary to take actions to correct the problems and keep the waste from becoming airborne. The facility owner or operator should inspect the wind dispersal control system on a periodic basis to ensure it is functioning in compliance with performance standards.

Item B requires that waste in the storage area be removed at least annually to permit a thorough inspection of the entire liner surface. In addition, whenever waste is removed from the storage area, the liner must be inspected. The frequency of the inspection must be addressed in the inspection plan required in part 7035.2535, subpart 3, and must be based on the liner material, loading rates, rainfall, and other factors that may impact the integrity of the liner. A standard for the removal of waste must be established. Even though most facilities are designed to process incoming waste within 24 hours, waste may always be present on the liner if incoming wastes are even slightly more than the facility can process. If the entire liner is not exposed at least once each year, major cracks, punctures, or other damage could occur without being noticed, allowing for the release of leachate into subsurface soils and eventually the ground water. Requiring inspection of the entire liner at the same time at least once each year allows repair work to be integrated into the entire system and allows the facility owner or operator to maintain a system capable of meeting the performance standards included in parts 7035.2525 to 7035.2875. Establishing these standards in rule alerts facility owners and operators to the Agency's standards regarding the performance of liners under storage areas. Knowing this up front, facility owners and operators will be able to adequately address storage in the facility inspection plan and establish adequate funds for financing the inspection and any needed repairs.

Item C establishes the steps a facility owner or operator must take if conditions are found that are causing or are capable of causing leaks. The facility owner or operator must notify the Commissioner of the condition in writing within seven days after the condition is detected. After notification, the facility owner or operator must take actions to repair the condition, subitem (1), or comply with the approved contingency action plan incorporated into the permit and comply with the requirements of part 7035.2615, subitem (2). The Commissioner must be informed about conditions at the facility that are potential problems in order for the Commissioner to provide guidance on proper procedures to dispose of any contaminated or unusable materials correctly.

Subpart 5. Construction inspection. Although subpart 4 discusses inspections at the facility, it is important to highlight specific inspection concerns associated with the installation of a liner system under a storage area. Requiring a construction inspection on the liners installed under the solid waste storage area allows the performance standards to be met.

Item A requires that liner and cover systems be inspected during construction for uniformity, damage, and imperfections. The facility owner or operator is responsible for showing the Agency that the storage area is constructed in accordance with Agency rules and the facility permit. The facility owner or operator may use construction inspections as a means to check the quality of work done by the contractor. Specific details on the type of inspections, frequency of inspections, and documentation of inspections must be addressed in the quality assurance program established for the facility. The program will be site-specific. Design and construction materials will depend on the facility owner's or operator's desire to make the storage area compatible with other sections of the facility. Because designs are site-specific, the construction inspection program is also site-specific. It is reasonable to establish general performance goals to be met while leaving the details of the construction inspection program to be developed based on the approved design.

Subitem (1) requires the facility owner or operator to inspect synthetic liners and covers to ensure tight seams and joints and the absence of tears, punctures, or blisters. The construction inspection must ensure that no tears, punctures, or blisters exist because they become avenues for the release of leachate or waste or waste by-products into subsurface soils and eventually ground water. Weak areas in the seams must also be located and repaired. The specific process used to evaluate the seaming procedures and quality of the work will vary depending on the synthetic material and the seaming process used. Continuous visual inspection of the construction process is a major means of ensuring that work is being completed correctly. However, visual inspections must be backed by testing because not all defects can be determined simply by looking at the materials, e.g., ineffective seamed joints. If the top layer of a clay liner is disrupted, there is additional material of the same construction below the top layer as a back-up system. The general requirements of this subitem alert the facility owner or operator of the specific points the Agency wants covered during the construction inspections.

Subitem (2) requires that soil-based and admixed liners and covers be inspected for imperfections like cracks, channels, root holes, and other structural nonuniformities. As with synthetic materials, soil-based and admixed materials have structural weak points. The construction inspection must be designed to detect improper installation at these weak points. For instance, seams are a critical area of concern when using synthetic materials, whereas root holes and improper moisture control leading to releases of leachate to the subsurface soils are of concern with soil-based liners. Establishing inspection requirements for soil-based and admixed liners and covers is the most effective method of ensuring the Agency's standards for design and construction are met.

Item B requires that an engineer registered in Minnesota certify that the liner was constructed in compliance with approved plans and specifications. An engineer should be required to certify the construction was properly completed because the facility owner or operator does not have the technical expertise to determine if the results of a specific set of tests indicate that standards were complied with. The facility owner or operator must be aware of what is needed to properly evaluate the construction quality but does not have the background to do the actual evaluation. An engineer has the most familiarity with the approved design and is most involved in the actual construction.

Subpart 6. Closure. This subpart requires that all solid waste and contaminated portions of the storage area be removed and properly disposed of or recycled at the time of closure. It is important that any waste being stored at the solid waste management facility be properly removed before closure. To allow the waste or any contaminated portions of the storage area to remain after closure would serve only to create future environmental problems. Not all solid waste management facilities are required to monitor site activities after closure. If waste were to remain at the site, it would pose a risk to human health and the environment. Inadvertent users of the site could be injured by working around the storage area or being exposed to disease-carrying organisms that have grown in the waste pile. Long-term storage would only serve to allow the decomposition of the waste, which combined with rainfall, might generate leachate that may seep into subsurface soils or overland into surface water. Additionally, the Agency would look at waste remaining in a storage area after facility closure as disposal and not storage. A disposal facility is subject to far more restrictive standards than processing facilities because of the long-term exposure the environment will experience. Postclosure care and financial assurance would, at this point, be required of the facility owner or operator for the storage area. The removal of waste or contaminated portions of the storage area reduces the potential risk associated with long-term disposal of waste at the site.

6. Part 7035.2865 SOLID WASTE TRANSFER FACILITIES.

This part establishes the design, notification and operation requirements specific to solid waste transfer facilities. Improperly designed and operated solid waste transfer facilities create hazards to human health and the environment. They also disrupt the flow of waste from generation to processing and disposal. Accidents, fires, nuisances, leachate generation, and contamination of surface water and ground water can occur. Operating a solid waste transfer facility in an environmentally-sound manner is different than operating other solid waste management facilities. The solid waste rules should include a section dealing specifically with transfer facilities.

Subpart 1. Scope. This subpart sets out what facilities and persons are regulated by this part.

Subpart 2. Delivery of solid waste. This subpart requires that solid waste transported from a solid waste transfer facility be delivered to a facility permitted by the Agency. One overall objective of these rules is to establish a complete solid waste management system that is capable of protecting human health and the environment. Transfer facilities are most often used as collection points for solid waste for delivery to either a processing facility or a disposal facility. This provision does not add any additional functions to the facility operation, but it does emphasize that solid waste may only be handled by permitted facilities. Because normal transfer facility operations result in the delivery of solid waste to Agency-permitted facilities, this subpart serves only to clarify facility owners' and operators' responsibilities.

Recycled or composted materials are in a state ready for use; requiring that only permitted facilities could use these materials would reduce the markets available. The objective for creating recycled and composted materials is to provide resources available to a wide variety of users and decrease the amount of virgin materials used in the same manner. Disposal of those materials would directly contradict the Waste Management Act. These materials should be exempt from the delivery standard because their processing and product quality control are regulated under parts 7035.2835 and 7035.2845.

Subpart 3. Notification. This subpart requires the facility owner or operator of a transfer facility to notify the Commissioner. This notification must be done by letter and must include information on the facility location, responsible party and phone number, facility size, and the type of waste received. Because these facilities are small and present a low potential for environmental impacts, no formal permit application is necessary for their construction and operation. The Agency is responsible for solid waste management in the State and must, therefore, be aware of what types of facilities are managing the waste and how much is handled at each facility. This information can be used to evaluate statewide management needs. Because transfer facilities are small, the Agency believes it is not reasonable to require a lengthy development of plans and engineering report. Therefore, to obtain information about the permit-by-rule transfer facilities, some form of notification is needed. The Agency will also be able to review this information and advise the facility owner or operator of any locational or other problems associated with the operation of the particular facility. The notification process is easily complied with by facility owners and operators and provides useful information regarding solid waste management in Minnesota.

Subpart 4. Operating requirements. This subpart sets out the specific requirements for operating a solid waste transfer facility. Requirements for operating this type of facility should be established because the concerns with operating a transfer facility are unique to its management. Facility owners or operators should be alerted to the Agency's specific operational concerns regarding transfer facilities for them to design and construct the facility to meet these requirements.

Item A requires that an operator be on duty at all times the facility is open. If an operator is not present as waste is delivered to the facility, improper placement may happen resulting in disruption to the facility and possible environment impacts. Sound business practices dictate that a representative of the facility owner be present on the site to be sure operations do not endanger the physical structure or performance of the facility. This requirement does not add an additional burden on the facility owner and compliance will promote facility operations that protect human health and the environment.

Item B requires that access to the facility be closed when an operator is not on duty. This requirement is consistent with item A and addresses safety and environmental concerns. The inadvertent arrival of persons lacking knowledge of the proper operation of the facility could cause disruptions in facility operation or damage to the facility resulting in environmental impacts or injury. A transfer facility is designed to meet specific performance standards. Standards must be established for situations that could impair the ability of the facility to perform as designed.

Item C requires that all putrescible waste remaining at the facility at the close of each operating day be stored in an enclosed structure or in leak-, fly-, and rodent-proof containers. Putrescible waste must be removed at least once per week. Putrescible wastes are wastes subject to decomposition and usually thought of as food wastes or other organic wastes. These wastes, if allowed to sit out on open stockpiles, will attract flies, rodents, and animals. Flies and rodents quickly multiply and are disease-carrying vectors. It is important from a human health perspective that they not be allowed to prosper in the waste and carry diseases into the surrounding area. Often animals will find human food wastes as a good supply of eatables. These animals may disrupt the stockpile creating a cleanup need. Household waste is generally not separated into strictly food wastes. As waste decomposes, water is generated. The water generated during decomposition combined with rainfall could result in run-off problems at the site and operational problems in handling excessively moist waste.

Item D requires all salvageable and recycled materials to be containerized unless properly managed under item H. Item H requires all solid waste to be confined to the unloading area or other designated processing or storage areas. If appropriate, the storage requirements of part 7035.2855 would apply. It is reasonable to require containerization because if allowed to be distributed anywhere on the facility site, further operations of the facility could be disrupted, injuries could occur, and environmental impacts could result. Containerization provides organization of the materials for selection and pickup by outside users without endangering traffic flow patterns, interfering with other waste processing at the facility, or allowing the leakage of liquids into subsurface soils.

Item H requires all solid waste to be confined to the designated unloading area or processing or storage areas. The Agency requires the facility owner or operator to consider these options in the design of the facility. The use of a general performance standard allows the facility owner or operator some flexibility in deciding to utilize separate processing areas at the transfer facility. Confining the waste to the unloading area, unless other provisions have been made, minimizes the potential impacted areas at a facility, limits potential vermin attraction areas, and minimizes nuisance conditions and complaints related to the outward appearance of a facility. Compliance will minimize environmental risks.

Item E requires that all residuals be removed at least monthly from a transfer facility. The purpose of a solid waste transfer facility is the collection of waste from many points into a central area for transport to another solid waste management facility. In some cases, the waste is separated into categories such as compostables, tires and recyclables before transport. The segregation process may result in residual wastes being left in quantities too small for cost-effective transportation. This provision prevents the short-term storage of these wastes from becoming long-term storage or disposal without the additional design, construction, and operation changes needed to adequately protect human health and the environment. Because a transfer facility is not designed for long-term storage or disposal, standards must be established to prevent this from occurring.

Item F prohibits the storage of more than 500 tires at the facility without a separate permit for this storage. Minn. Stat. §§ 115A.90 to 115A.906 require facility permits for the stockpiling of more than 500 tires at a collection site. This provision is consistent with Minnesota Statutes.

Item G requires that demolition debris land disposal facilities established adjacent to a transfer facility must comply with part 7035.2825. This provision alerts facility owners and operators of transfer facilities that, if they decide to include the management of demolition debris at a facility, they must also comply with the standards for demolition debris land disposal facilities. This requirement adds no new standard on the facility owner or operator, it merely clarifies existing criteria.

Item H is addressed above.

Item I requires that special provisions for the storage of bulky items prior to transport must be made by the facility owner or operator. Bulky items, such as refrigerators, furniture, and clothes washers need special handling. They are not easily compacted for management with other wastes received at the facility. Therefore, special provisions must be made to avoid disruption of normal facility activities. Facility owners and operators should be notified of the Agency's requirement for special consideration to allow storage of bulky wastes prior to construction of the facility and during operation.

Item J requires that storage of wastes at the transfer facility must be conducted in accordance with the storage requirements of part 7035.2855. This requirement serves as a notice to facility owners and operators of other rules that apply to the design, construction and operation of this facility. This information should be included in this part as notice to facility owners and operators of other rules that apply to the design, construction and operation of this facility. This information serves to notify facility owners and operators of their responsibilities, but does not add requirements.

Subpart 5. Design requirements. This subpart establishes the specific design requirements applicable only to transfer facilities.

Item A requires that an all-weather road negotiable by loaded collection vehicles be included in facility development plans. A transfer facility is used as a central collection point for solid waste. If collection vehicles are unable to enter the facility for unloading purposes, the entire solid waste management scheme for the area will be disrupted and the result could be improper disposal of the waste resulting in environmental impacts or direct haul to the processing facility, which could increase costs and disrupt the operation of that facility. Because of the importance in getting waste to and from a transfer facility, the facility design must address this concern.

Item B requires the transfer facility to be designed with truck wheel curbs and tie downs if the facility has elevated unloading areas. Wheel curbs and tie downs on elevated areas must be required to avoid trucks with rear-end loaders backing over the edge and seriously injuring someone.

Item C requires that the tipping areas, loading and unloading areas, storage areas, and processing areas must be constructed of impervious material that is readily cleanable and suitable to collect free moisture. Solid waste brought into a transfer facility will contain free moisture. At times this moisture is absorbed by the paper present, but at other times excess moisture will be experienced because of rainfall during collection. The loading and unloading of solid waste is not a neat and tidy function. These areas must be swept and washed down to prevent unhealthy working conditions. If the water from this process were allowed to discharge onto the surrounding areas, the result could be polluted surface waters or ground water and impairment of driving surfaces, unloading areas, and loading areas. Low permeability surfaces must be required at transfer facilities because of the amount of solid waste handled, the potential for liquids to migrate out of the solid waste, and the potential environmental problems associated with allowing the liquids to flow overland to surface waters or infiltrate into the ground water without treatment.

7. Part 7035.2875 REFUSE-DERIVED FUEL PROCESSING FACILITIES.

This part establishes the design, operation, contingency action plan, and reporting requirements specific to refuse-derived fuel processing facilities. Providing the Agency's specific standards for refuse-derived fuel processing facilities in one rule will assist the facility owner or operator in understanding the responsibilities attached to operating such a facility.

Subpart 1. Scope. This subpart identifies who is required to comply with this part. Clearly specifying to whom the regulations apply enables the facility owners and operators to know what is required of them.

Subpart 2. Design requirements. This subpart specifies the design requirements applicable to refuse-derived fuel processing facilities. Including specific design standards advises facility owners and operators of the Agency's requirements for operating the facility.

Item A requires that the facility design plans must include the specifications for the facility site preparation. The preparations include at least drainage control structures, entrance and access roads, screening, fencing, and any other special design features. Site preparation is important in the ability of a facility to minimize impacts on the environment. Without access control, vandalism disrupting the facility operation may result not only in facility damage but also environmental impacts due to the release of pollutants. If surface water drainage is not adequately controlled, the result again could be the release of pollutants and soil erosion. Site preparation is needed before any facility operation begins, to minimize delays to operation start-up and ensure good facility operation after start-up.

Item B requires that surface water drainage must be diverted around and away from outdoor storage areas. Part 7035.2855 requires that storage areas be protected from surface water drainage to protect the integrity of the liner system. If the processed fuel is stored outdoors, surface water draining through the storage area could render the product unusable. If the waste stored prior to processing is inundated with surface water, the excess moisture could make it unacceptable for processing. In both instances the surface water may also proceed to wash the processed or unprocessed waste out of the storage area into the surrounding area resulting in at least cleanup costs and possibly environmental impacts. Including diversion of surface water drainage as a specific requirement for these facilities highlights the facility owner's and operator's responsibility to protect waste from surface water.

Item C requires that unprocessed or processed waste stored uncovered be stored on a liner capable of minimizing or eliminating leachate flow out of the area. The liner permeability may be no greater than 1×10^{-7} centimeters per second and natural soil liners must be at least two feet thick. These requirements are identical to the requirements found in part 7035.2855 for storage areas. The standards are repeated in this part to emphasize that both processed and unprocessed waste storage areas must comply with the requirements. The Agency does not believe screening, shredding or even compacting the waste eliminates the risk associated with storage of residual wastes or the fuel itself. If the waste or fuel were not stored on low permeability surfaces, precipitation or moisture within the waste or fuel could leach pollutants from the materials being stored and seep into the underlying soils.

Item D requires that the refuse-derived fuel processing facility be designed to contain an odor control system. Many types of wastes will be received at these facilities and the waste will be at different stages of decomposition. Organic wastes will often emit unique odors associated with those particular wastes. Waste stored in closed containers may have begun anaerobic decomposition, which forms many odorous gases, some of which are toxic. By constructing an odor control system capable of removing odors from the facility and replacing them with fresh air toxic gases will be removed from the facility as well as odors associated with the waste.

Item E requires a dust control system to be designed into the facility. Dust particles smaller than 0.075 millimeters, if properly mixed with air, are explosive. Cornstarch is commonly discarded in household waste and will explode if conditions are right. Over 300 substances common to household wastes, including paper, rubber, egg white, sugar and tobacco, have been identified with explosive characteristics. The shredding process exacerbates the potential explosiveness of some materials by decreasing their size while mixing them with air. The methods for reducing explosions at a refuse-derived fuel processing facility include visual inspection of incoming wastes, public awareness, vents, and water misting systems.

Item F requires the facility to be designed to handle all incoming solid waste within 24 hours based on materials flow and mass balance calculations. Requiring the waste to be processed within 24 hours prevents creating a need for large storage areas, decreases the ability of the facility owner or operator to generate suitable fuel, and minimizes the potential for precipitation to generate leachate and encourage decomposition.

Item G requires the facility to be designed to minimize the risk of explosions, spills, leakages, or releases that might harm human health or the environment. Because of the amount of waste processed at these facilities and the varied composition of the waste, standards must be established for a design that minimizes impacts from the facilities. Specific design standards cannot be included in the rules because of the variety of designs that may be used for these facilities. Therefore, this general performance standard was included in the rules.

Item H requires inclusion of the design and performance specifications of equipment to be used at the facility in the engineering design report. No one set of equipment design parameters can be used to control the quality of a facility design. The Agency, through the permitting process, is responsible to review the designs and decide if they are adequate to protect human health and the environment.

Item I requires the design of the facility to provide for waste management while the facility is down for maintenance or mechanical repairs. Only by addressing these situations during the design phase will the proper management of incoming wastes occur.

Subpart 3. Operation and maintenance manual. This subpart requires the facility owner or operator to prepare an operation and maintenance manual. The manual must be kept at the facility. Specific items to be included in the manual are listed in this subpart. The manual can be used in the personnel training program to be established under part 7035.2545. Having a manual is a sound business practice to control risks associated with the operation of the facility.

Item A requires the manual to address how the facility will be operated to comply with the odor standards of parts 7005.0900 to 7005.1040. The presence of odor at a facility may imply poor facility design, too much waste received, poor facility operation, not utilizing the odor control system, or operating below capacity.

Item B requires the manual to address access control. Without access control, facility operations may be disrupted due to vandalism, injury or destruction of fuel waiting for transport. This requirement does not require additional work by the facility owner or operator because controlling who is on the facility property is necessary to manage risks at the facility.

Item C requires all by-products including metallic and non-metallic residuals, to be stored to prevent vector problems and aesthetic degradation. The by-products must be removed or used at least once a week. The short-term storage of waste can attract vectors and become eyesores if allowed to be stored in open areas with no control measures. The general performance standard allows the facility owner or operator to design the storage area in a manner that is compatible with the rest of the facility. Requiring at least weekly removal of the by-products prevents short-term storage from becoming disposal.

Subpart 4. Contingency action plan. This subpart requires the facility owner or operator to develop and maintain a contingency action plan. The plan must address actions that will be taken to deal with spills, releases, explosions, or accidents that disrupt operations and what back-up systems, including contracts, exist for accidents that result in facility closure. To minimize the length of time a facility must be closed and to ensure a processing facility is available to act as a back-up facility, it is important to plan before the accident how to address the situation. The development and maintenance of a contingency action plan sensitizes the facility owner or operator to the responsibility associated with a facility.

Subpart 5. Annual report. This subpart sets out the information specific to refuse-derived fuel processing facilities to be included in the annual report. Specifying the items that must be addressed in the annual report allows the Agency to receive sufficient information to evaluate the performance of the facility and the success of the statewide solid waste management. The information is easily gathered and is not a burden on the facility owner or operator.

VI. SMALL BUSINESS IMPACTS

The Agency is required to consider the impacts of proposed rules on small businesses:

> Subd. 1. Definition. For purposes of this section, "small business" means a business entity, including its affiliates, that (a) is independently owned and operated; (b) is not dominant in its field; and (c) employs fewer than 50 full-time employees or has gross sales of less than $4,000,000. For purposes of a specific rule, an agency may define small business to include more employees if necessary to adapt the rule to the needs and problems of small businesses.
>
> Subd. 2. Impact on small business. When an agency proposes a new rule, or an amendment to an existing rule, which may affect small businesses as defined by this section, the agency shall consider each of the following methods for reducing the impact of the rule on small businesses:
>
> (a) the establishment of less stringent compliance or reporting requirements for small businesses;
>
> (b) the establishment of less stringent schedules or deadlines for compliance or reporting requirements for small businesses;
>
> (c) the consolidation or simplification of compliance or reporting requirements for small businesses;
>
> (d) the establishment of performance standards for small businesses to replace design or operational standards required in the rule; and
>
> (e) the exemption of small businesses from any or all requirements of the rule.
>
> In its statement of need and reasonableness, the agency shall document how it has considered these methods and the results.

> Subd. 3. Feasibility. The agency shall incorporate into the proposed rule or amendment any of the methods specified under subdivision 2 that it finds to be feasible, unless doing so would be contrary to the statutory objectives that are the basis of the proposed rulemaking.
>
> . . . .

Minn. Stat. § 14.115 (1986).

Nearly all private solid waste management facilities in Minnesota qualify as small businesses under the definition in subdivision 1. Only three solid waste management firms in the State take in enough waste to have gross sales in excess of $4,000,000. Two sites are subsidiaries of Browning-Ferris Industries, Inc. - the Flying Cloud landfill in Hennepin County and the Pine Bend landfill in Dakota County. The third site is a subsidiary of Waste Management, Inc. - the Anoka County Municipal landfill. These three firms comprise less than 7 percent of the total number of private landfill firms in the State. Because only a small percentage of private solid waste disposal facilities are not small businesses, the Agency considers that nearly all businesses affected by the rules are small businesses. This means the option described in section 14.115, subdivision 2, item (e), i.e., to exempt small businesses from some or all rule requirements, cannot be used.

The statutory objectives on which this rulemaking is based have been cited before, but they bear repeating in this section.

> It is the goal of sections 115A.01 to 115A.72 to improve waste management in the state to serve the following purposes:
>
> (a) Reduction in waste generated;
>
> (b) Separation and recovery of materials and energy from waste;
>
> (c) Reduction in indiscriminate dependence on disposal of waste;
>
> (d) Coordination of solid waste management among political subdivisions;
>
> (e) Orderly and deliberate development and financial security of waste facilities including disposal facilities.

Minn. Stat. § 115A.02 (1986).

> The legislature finds that:
>
> (1) the waters of the state, because of their abundant quantity and high natural quality, constitute a unique natural resource

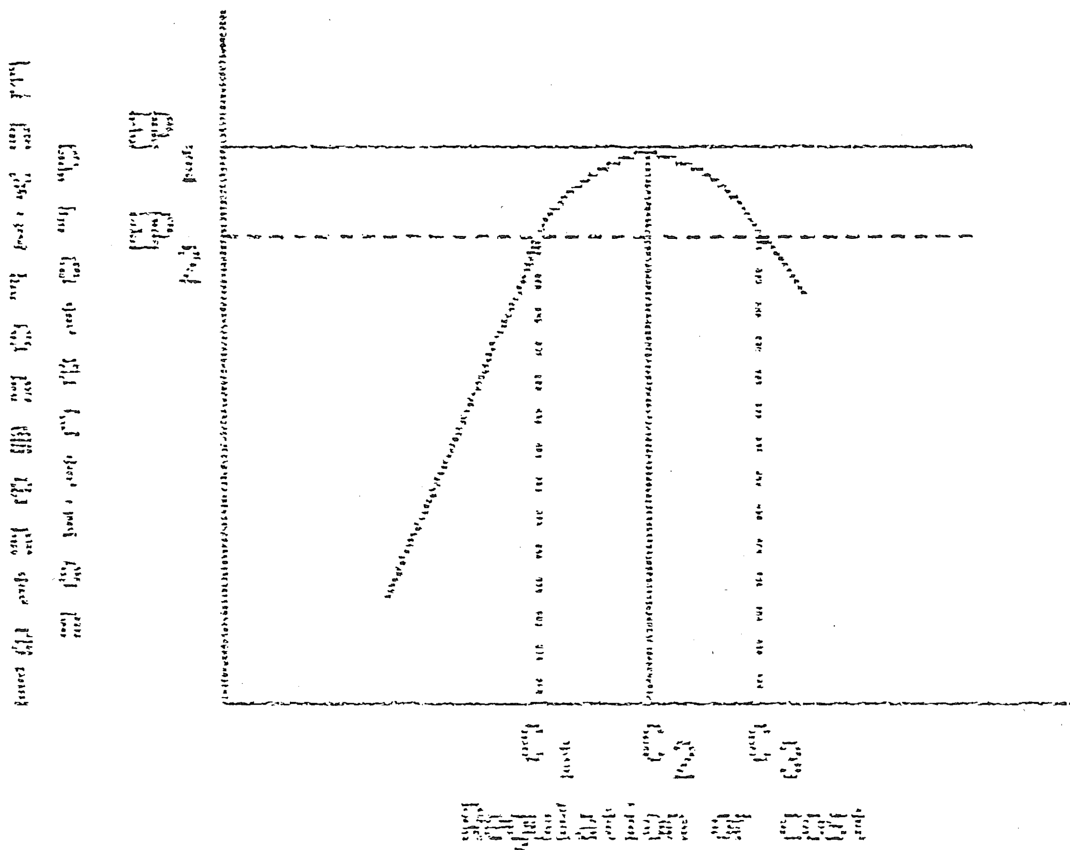
> of immeasurable value which must be protected and conserved for the benefit of the health, safety, welfare, and economic well-being of present and future generations of the people of the state;
>
> (2) the actual or potential use of the waters of the state for potable water supply is the highest priority use of that water and deserves maximum protection by the state; and
>
> (3) the disposal of hazardous waste and radioactive waste in Minnesota may pose a serious risk of pollution of the waters of the state, particularly potable water.
>
> It is therefore the policy of the state of Minnesota, consistent with the state's primary responsibility and rights to prevent, reduce, and eliminate water pollution and to plan for the preservation of water resources, that depositories for hazardous waste or radioactive waste should not be located in any place or be constructed or operated in any manner that can reasonably be expected to cause pollution of potable water.

Minn. Stat. § 115.063 (1986).

Minn. Stat. § 14.115, subd. 3 requires the Agency to consider the relationship of compliance costs to statutory goals. A clear implication of this statute is that, although administrative rules may serve statutory goals, at some point rules can become so costly that they are counterproductive. For example, rules could become counter productive if they are so stringent that they force a critical number of regulated firms out of business. A large number of closings in a vital service area such as solid waste management would quickly lead to a statewide series of local crises.

The relationship implied by this statutory requirement suggests a series of tradeoffs between regulatory, in this case environmental, goals and the types of regulations (or costs) actually imposed. This is graphically shown in Figure 11.

FIGURE 11



The graph presents environmental protection (EP) as a function of either regulatory effort or cost (C). There is some level of C that is optimal. This is shown in the graph as C_2. At point C_2, any change in regulatory effort causes a decline in environmental protection. It leads to either too little or too much regulation. If current regulations impose costs less than C_2, then it is possible to increase EP by adding regulations. However, if the current regulatory system imposes costs greater than C_2, new regulations will actually cause EP to decline. The directive in Minn. Stat. § 14.115 clearly focuses on the second case ($C_2 < C_3$) and requires the Agency to ease regulation if it imposes costs greater than C_2.

A further complication arises because many of the proposed rules involve gathering information that is needed to determine whether the current state of regulation places us at, above or below the optimal level of C. A decision to lower information requirements or reporting schedules would likely delay the determination of the regulatory system's position with respect to the optimum. The data problem leads to analysis paralysis. Change is needed, but there is no way to determine, quantitatively, just how much change is needed.

This leaves the question to be determined by qualitative means. There is a counter-productive tendency in qualitative debate to admit arguments based on unsupported guesses, hopes and fears. The Agency believes such debate can advance no useful purpose. Discussion of the appropriate level of regulation must accept modest and reasonable constraints or fair decisions will become very unlikely.

A reasonable characterization of equilibrium conditions at the optimum can serve as a substitute for quantitative precision until new data allow more precise judgments. In other words, the Agency proposes to consider what would likely happen if every part of the solid waste management system worked right, and then determine whether the proposed rules will help the system develop toward the optimum. If a rule advances a given goal, and weakening or eliminating the rule retards progress, then the rule should remain, according to the terms of Minn. Stat. § 14.115.

The Agency believes a solid waste management system at optimum would present the following characteristics:

1. Information: Facility owners and operators would have quite detailed descriptions of design, operations and locations. They would also have a good understanding of the ways facility design, operation and location interact. Facility owners and operators would use these basic data to make comprehensive plans for facility development and maintenance.

2. Information sharing: Facility owners and operators, facility users, facility neighbors, and regulators would all have access to site information and facility plans. Such information sharing would increase the likelihood that the regulation of solid waste management would reach optimum levels as successful solutions at one facility become known to other facility managers.

3. Distribution of costs: Billing for system costs would be equitable. That is, facility users would pay for all facility operations and maintenance. There would be no shifting of costs from facility users and operators to the users of contaminated resources.

4. Resource allocation: Least-cost management, subject to specific environmental constraints, would characterize the solid waste management system. Resources would be used to their maximum feasible extent and not over-used to the extent that resource quality falls to unacceptable levels.

The Agency believes that the proposed rules will help advance the State's solid waste management system toward the optimal conditions described above. The Agency finds no cases in which solid waste management facilities are now over-regulated. This means that the system probably now operates at some level below the optimum implied in Minn. Stat. § 14.115. A consequent implication is that any easing or elimination of proposed requirements would likely go against the statutory bases (Minn. Stat. §§ 115A.02 and 115.063) of the present rulemaking.

Section 14.115 directs the Agency to consider its rules divided into substantive provisions and procedural provisions. Substantive provisions govern compliance with requirements that affect physical structures and operations (e.g., facility designs, monitoring protocols). Procedural requirements set reporting standards and schedules. The regulatory requirements imposed, both substantive and procedural, have been designed to take particular account of the needs and conditions of small firms. The technical standards in the proposed rules include both design and performance elements. Many of the proposed rules provide regulated firms with opportunities to adjust standards so that special local conditions are taken into account. Procedural requirements, such as reporting and schedules, have been kept to the minimum level the Agency believes will do no damage to the equity of regulatory enforcement. The Agency must have a certain amount of information from all facility owners and operators if it is to regulate efficiently and fairly the State's solid waste management system.

Section 14.115 can only have meaning if firm size is the only variable that influences the events at issue. However, the conditions which give rise to this rulemaking (resource contamination) vary with respect to factors other than size. Location, historic waste management practices, economic growth and technological change can very likely each have a greater individual impact on environmental damage than firm size. The Agency believes that relaxing standards for small businesses will allow environmental risks to exceed the minimum acceptable levels embodied in the proposed rules. That would be clearly contrary to the goals of the rules and the statutory authority.

Procedural matters are also not very responsive to firm size in the area of environmental regulation. Land disposal facilities of all sizes generally receive waste at a steady, if not stable, rate. There is usually some disposal occurring at all sites on every business day. This means that operating activities will cause steady change at the facility site: available capacity will decrease; disposal activities may disturb ground water protection installations; moisture may enter the fill area; etc. The Agency must have a regular flow of information about the site in order to determine whether changes in conditions have led to environmental damages.

The rules require facility owners and operators to submit various reports at specified times. The largest information requirements occur every five years, when permits are renewed. Annual reports will contain less extensive information, mainly on the results of site operations. Facility owners and operators will also have to submit annual evaluations of the status of financial assurance programs. Reporting periods for ground water sample analyses are set according to individual site conditions. The Agency believes these reporting requirements will yield the minimum amount of information needed to monitor compliance with the rules.

In sum, the Agency believes that the proposed rules meet the requirements of Minn. Stat. § 14.115. The rules accommodate small business concerns without compromising the environmental values that are the rules' policy foundation.

A person may conclude from reading section 14.115 that administrative rules have only negative impacts on regulated firms. However, added costs are only one of the impacts. The Agency expects that regulated firms will also benefit from the adoption of the proposed rules. Section VII, ECONOMIC CONSIDERATIONS, discusses in some detail the question of the balance of regulatory impacts. A summary of that discussion is useful here.

The rules' technical elements require that facility designs and operations meet specified standards. If existing facilities are compared with future facilities that comply with the proposed rules, the future facilities will give their customers and neighbors much greater confidence in the soundness of facility operations. Likewise, the proposed rules' reporting requirements will give much more information to facility managers, customers and neighbors. Facility managers can use the new information to improve their risk management practices.

Current practice often rests on the unsubstantiated, often slim, hope that facilities will not require corrective actions. Facility management under the proposed rules will be much better informed. Facility managers will have sound bases for plans that take account of identified needs (e.g., closure and postclosure care) and risks (e.g., contingencies). The new information will be verifiable through independent means and, thus, will provide good reasons for needed price increases. In sum, the Agency expects the proposed rules will induce improvements in facility design, operational and financial planning. Such changes will yield long-term benefits for private operators.

Finally, consider the manner and timing of land disposal facility closures. There is a cycle of facility development, operation and closure. Land disposal sites have limited capacities. The facilities can only hold so much waste. Facility operators must plan and be prepared for the day when their facilities are full. Other factors also induce facility closures. Some sites will close because local government solid waste management plans call for site closure following construction of alternative waste processing facilities.

Section VII, ECONOMIC CONSIDERATIONS, provides more details on the expected pattern of facility closures induced by capacity shortages and solid waste management planning. This pattern indicates a continuing need, beyond 1990, for about 60 facilities located outside the Twin Cities Metropolitan region.

These facilities will gradually develop into sites quite different than most current land disposal facilities. Only relatively small areas will remain open for disposal operations. Disposal areas will be closed much more quickly than they now are. Operators will devote regular time to checking and maintaining environmental monitoring systems. New protective design features (e.g., leachate collection systems) will also require the facility manager's regular attention.

Land disposal facilities operating after 1990 will also have a different appearance in their financial statements. These facilities will also report financial reserves developed in anticipation of future costs. In brief, the private land disposal facilities operating after 1990 will appear to be more substantial firms. The physical sites will likely be larger, so that scale economies can offset greater fixed costs. The small businesses offering solid waste disposal services will not be quite as small in 1990 as they are now.

The question remains whether the post-1990 land disposal firms will be the same as the pre-1990 firms which now have adequate capacity and are not identified in local solid waste management plans as sites scheduled for closure. The question is indeterminate. Its answer depends on the managerial capabilities and inclinations of individual facility operators. Solid waste facility management will be more complicated in the future. The Agency strongly believes that the new regulations are not so complex or restrictive that they will make facility management impossible. But, facility operators will have to work harder. Some managers may choose not to operate simply because they do not want to recognize new constraints. This choice remains open to all facility managers, but it will be exercised due more to unwillingness than to inability to comply with the new rules. Other managers will be ready to take up any slack created when some managers choose not to operate simply because they do not choose to comply with the new rules.

VII. ECONOMIC CONSIDERATIONS

PROLOGUE

Earlier chapters have presented discussion on the need for and reasonableness of the proposed rules. The Agency proposes these rules because existing rules provide neither the Agency nor facility permit holders with the guidance needed to design, operate and maintain solid waste disposal facilities that manage waste and, at the same time, protect human health and the environment. In short, there is a compelling need to change the solid waste management system.

Nearly all of the changes required in the proposed rules impose costs. This is not a surprising finding, since the rules generally add management responsibilities rather than reduce them. State law requires the Agency to consider economic impacts when adopting rules. Minn. Stat. § 116.07, subd. 6 (1986).

Existing rules set forth a permit holder's general responsibilities. These rules lack specificity, particularly with respect to the goals of site management. Facility managers, given only general guidance, have tended to minimize operating costs. This is understandable. Competition among private sector facility operators discourages them from making costly operational or design changes. Private sector operators must increase their prices (tipping fees) if their operating costs increase. Increased prices could cause business to drop off if competitors' prices do not also increase. Likewise, public sector facility operators are reluctant to raise prices because they do not want to charge their customers more money for what customers believe is a basic public service. Public sector operators do not want to be responsible for actions their constituents may view as tax increases.

Both cost-minimizing attitudes derive from legitimate goals. The private sector operator wants to provide customers with cost-effective service. Public officials responsible for waste disposal facilities want to control the cost of public services.

The current body of general rules has accommodated these goals. For example, current rules require facility operators to construct and operate a:

> water monitoring program . . . to determine whether . . . solid waste or leachate therefrom is causing pollution of underground or surface water. . . . The conditions of monitoring, including the frequency and the analysis of water monitoring samples, shall be determined by the [commissioner] and may be changed at his discretion.

Minn. Rules pt. 7035.1700, item S (1987).

This rule offers the facility operator no specific guidance on the proper design and operation of a water monitoring system. Likewise, the rule provides the Agency with only a very general basis for enforcement actions. The Agency has found only limited compliance with this general rule among facility operators.

Many of the current rules have this problem. They impose responsibilities on facility operators but do not give the operators any detailed guidance that will help them fully comply. The proposed rules address the problem in some detail. Permit application procedures will require extensive and specific site information. Gathering this information will give permit holders more complete knowledge of their sites' characteristics than they now have. Sites' major physical features will be subject to explicit design and performance standards. This will give permit holders a much better understanding of how to site, develop, operate, maintain, close and care for facilities.

Permit holders will have very specific financial reporting responsibilities. This will strongly encourage prudent financial management. The proposed rules include specific ground water protection standards that help both the Agency and permit holders define problems and develop solutions. Contingency planning requirements will further prepare the Agency and permit holders for unexpected problems. In sum, the proposed rules give the Agency and permit holders the detailed guidance needed to design, operate and maintain environmentally-sound facilities.

The proposed rules also give permit holders little room to avoid site responsibilities. This means private and public sector permit holders will have to upgrade their facilities. All permit holders will incur new costs in roughly equal degree.

Facility permit holders will be the first to incur these costs. However, the impact will not stop there. Facility users will have to pay more for waste disposal services, as permit holders increase service charges to offset the new regulatory costs.

Charge systems vary throughout the State. Most facilities charge tipping fees that are based on the volume of waste, cubic yards (c.y.), received. A few facilities use scales to establish a charge rate based on weight, tons, which yields more accurate measures of waste receipts. Some of the newer and proposed waste processing systems do not charge tipping fees. Instead, they levy waste disposal service charges on property owners within the facility's service area. The service charges are customarily administered by local property taxation authorities. A few facilities in the State rely solely on local government appropriations. Property taxes are the only income source for these facilities. Many facilities owned or operated by local governments rely on mixed financial arrangements. Often, tipping fees pay for some costs and the municipality "lends" out equipment or services as needed. The municipality thus uses some tax resources to subsidize a facility which does not charge a tipping fee that is large enough to pay for all operations.

The mixed local financial management structure means that localized financial impacts will vary throughout the State. Facility users in many local areas will bear all of the new costs. However, it is unlikely that those who send the most waste to the facility will incur proportionate cost increases. This inequitable condition arises because very few waste collection services base their residential charges on unit costs. Most collection service charges derive from average costs. That is, the collection service manager estimates total operating costs plus profit margin and divides this value by the number of customers on residential routes.

Local government regulations further complicate matters. Very few municipalities regulate collection service rates, although a number do control disposal facility rates. Local authorities tend to rely on competition to control waste hauling rates. Theory holds that reliance on laissez faire should yield low rates, however narrative and informal evidence indicates the opposite. Apparently, landfill rate increases offer windfall opportunities that some waste haulers cannot resist.

Some localities will not directly impose cost increases on facility users. Assessment systems, whether property taxation or service fees, will spread costs in a different pattern. Cost incidence will depend, in these cases, on the idiosyncracies of local assessment, valuation and administrative systems.

The vagaries of financial management in the solid waste sector make precise estimates of local impacts impossible. The only precise answer to the question: "How much will these rules cost me?", is: "That depends on, among other things,:

* where you live;
* what you pay for waste disposal now;
* where your disposal facility is located;
* how long the disposal facility has operated;
* how long the disposal facility will continue to operate;
* the extent of local regulation of the disposal facility and waste collection services;
* the methods used to charge facility users for the increased costs; and
* whether or when the facility manager or local authorities began financial planning for the site's future."

The Agency does not have the data needed to determine local cost changes for all sites. However, the Agency can make some general statements, with the understanding that specific local conditions may invalidate the generalizations.

The Agency has developed a series of ideal-typical cost estimates that are based on assumed conditions at five landfill sites. The cost estimates can be found in Appendix XVII. The assumed conditions <u>cannot</u> be found at any one site that is now operating. The assumptions are broadly representative of conditions that can be found at most Minnesota landfills. The estimates assumed that design criteria, site operations, financial management, etc. meet the standards set in the new rules. The table below presents the results of the estimating exercise. Costs are presented as unit tipping fees, i.e., dollars per cubic yard (c.y.). The table also presents the variables which induce different results and the conditions of those variables that cause high or low estimates.

ESTIMATE

$11.80/c.y.	Tipping fee	$43.20/c.y.

VARIABLES

Large	Acreage	Small
Long	Remaining site life	Short
Uniform	Geologic variability	Varied
Simple	Hydrologic conditions	Complex
On-site	Materials availability	Off-site
Remote	Location	Residential

A "typical" Minnesota landfill site will have a mix of these characteristics. The tipping fee needed to operate the "typical" site will likely fall somewhere near the middle of the estimated range. It is very likely that new landfill facilities developed after the rules become effective will charge tipping fees in the lower half of the estimated range. Developers will have control over all important variables before site operations begin. This means developers will be able to hold down costs by exercising care in site selection, facility design, operations, financial management, and so on.

Conversely, smaller-scale existing sites will very likely have to charge tipping fees in the upper half of the estimated range. Operators of these sites will have less control over cost-increasing variables. They will have to accept the status of some variables and work on controlling costs through the variables that can be changed.

It is useful to compare the estimated tipping fee range with existing landfill rates. Tipping fees in the State now range from $1.50/c.y. to $10.00/c.y.; excluding sites that do not charge tipping fees. Analysis relating tipping fees to waste receipts finds that metropolitan region tipping fees average $4.12/c.y. and nonmetropolitan fees average $3.59/c.y. (These results derive from 1985 data. Informal reports indicate that tipping fees are increasing throughout the State.) Since the existing charges are included in the ideal-typical cost estimates, they should be deducted from the cost estimates to arrive at one possible measure of the rules' impacts. This yields a new range of $7.68/c.y. to $39.61/c.y.

We can make some fairly safe assumptions about aggregate values to arrive at further impact statements. Assume: 1) 10.5 million cubic yards of mixed municipal solid waste are sent to landfills for disposal, 2) the State's population is 4.3 million and 3) the State's population of households is 1.7 million. The estimated ranges can be combined with these assumptions to yield statements of aggregate impacts:

	LOW	HIGH
Annual cost per capita	$ 18.74	$ 96.65
Annual cost per household	$ 47.46	$244.79

These values compare well with findings reported in the second part of this section, which presents a more technical analysis of the rules' economic impacts. That analysis considers impacts from a statewide perspective. That analysis found that the rules' initial annual financial impacts amount to about $29.00 per capita. It is worth noting that this value derives from conservative (i.e., expensive) cost-estimating assumptions. It is also worth noting that the financial impact declines each year after the initial impact. Finally, bear in mind that these values aggregate over the total population. The estimates do not take into account the composition of the State's waste stream. Wastes can be separated into three very broad categories: industrial, commercial and residential. All waste generators pay for disposal, so the new costs imposed will be distributed among industrial and commercial business firms and households. This means that the annual costs estimated do not relate to expected impacts on households. These impacts will depend on how costs are distributed among the three types of waste generators.

The high values for per capita and per household costs appear very high. Recall that the ranges derive from ideal-typical cost estimates. Local conditions will have an important effect on final impacts.

Moreover, if it appears that new costs will be unacceptably high, local permit holders still have some cost-minimizing steps they can take. Operational and planning changes can "scale back" a facility's level of business, thus extending the site's useful life, which also extends the payment period for some of the more costly capital expenses. Low-cost abatement measures (e.g., recycling, yard waste composting) can also be used to extend a site's useful life. As a final measure, if it appears there is no way to bring cost down to acceptable levels, permit holders can close costly facilities and send waste to facilities that can more efficiently manage wastes.

The proposed rules offer some measure of administrative relief from initially high costs. The effective dates of some of the more costly elements of the rules lag behind rule adoption. The financial assurance rules do not impose the largest part of their costs until a year after the rules are adopted. Final cover requirements will not, and liner requirements may not, apply at a site until 18 months after the rules are adopted. These lags allow permit holders time to plan and prepare for increased costs. The financial assurance rules include ability-to-pay tests that may allow some permit holders to extend the pay-in period for trust funds. The rules that relate to facility design and ground water protection contain provisions that allow permit holders to establish site-specific standards. All of these considerations operate to mitigate the local financial impacts of the proposed rules.

Analysis of economic impacts cannot be limited to a narrow investigation of costs. Thorough analysis must also consider: 1) the costs of alternative methods which can accomplish the same goals as the proposed rules, and 2) the benefits gained by the required expenditures.

The main effect the rules will have on the solid waste management sector will be to raise the cost of land disposal. The rules will impact waste processing facilities, but not to the extent that they impact landfills. The trend of rising landfill costs is not limited to Minnesota. The National Solid Waste Management Association (NSWMA) has conducted national surveys of waste disposal facilities since 1982. The NSWMA surveys indicate a clear upward trend in landfill tipping fees across the nation.

AVERAGE TIPPING FEES, 1982-1986
($1 ton)

Year	Landfill	Resource Recovery
1982	$10.80	$12.91
1983	$10.80	$14.96
1984	$10.59	$17.26
1985	$11.93	$23.17
1986	$13.43	$30.42

TIPPING FEE SURVEY - 1986 - LANDFILLS AND TRANSFER STATIONS

Location	Landfill Fee ($/ton)	Transfer Station ($/ton)
ALABAMA		
Huntsville	3.80	
ARKANSAS		
Fayetteville	9.00*	
Little Rock	12.50	
N. Little Rock	6.15*	
CALIFORNIA		
Long Beach	7.00	14.22
Los Angeles	5.00	
Richmond	18.00	
Sacramento	4.60	
San Diego	8.00	
San Francisco	36.32	
COLORADO		
Bounder	6.00*	
Denver	6.00*	
Denver	9.00*	
CONNECTICUT		
Hartford	15.18	
DELAWARE		
Kent County	18.65	
New Castle County	32.84	
Sussex County	22.80	
DISTRICT OF COLUMBIA		
Lorton (Va.)	10.00	14.00
FLORIDA		
Broward County	25.00	
Dade County	27.00	36.00
Tampa	14.10	35.90
GEORGIA		
Atlanta	9.75*	
HAWAII		
Honolulu	11.00	24.00
IOWA		
Des Moines	10.00	
IDAHO		
Boise	2.70*	
ILLINOIS		
Bloomington	8.25*	
Chicago	10.95*	
Macomb	4.50*	
Ottawa	9.60*	

TIPPING FEE SURVEY - 1986 - LANDFILLS AND TRANSFER STATIONS (CONTINUED)

Location	Landfill Fee ($/ton)	Transfer Station ($/ton)
INDIANA		
Fort Wayne	6.90*	
Indianapolis	10.65*	
KANSAS		
Wichita	3.22 - 3.51*	
LOUISIANA		
Abbeville	6.00*	
New Orleans	4.00	
MAINE		
Biddeford	no fee; tax supported	
MARYLAND		
Baltimore County	30.00	
Mongomery County		38.00
Ocean City	no fee; tax supported	
Prince Georges County	25.00	
MASSACHUSETTS		
Haverhill	13.88	
Millbury	no fee; tax supported	
MICHIGAN		
Detroit	5.25	
Lansing	11.40	
MINNESOTA		
Minneapolis		35.00
St. Paul	19.00	
MISSOURI		
Kansas City	10.50	
St. Joseph	2.07 - 6.66*	
St. Louis	13.50*	
St. Louis	20.00	
NEBRASKA		
Lincoln	no fee; tax supported	
NEVADA		
Las Vegas	60.00*	7.50
Las Vegas		9.00
NEW JERSEY		
Burlington County	21.66	
Burlington County	29.13*	
Cape May County	29.80*	
Gloucester County	28.53*	
NEW MEXICO		
Albuquerque	12.60	

TIPPING FEE SURVEY - 1986 - LANDFILLS AND TRANSFER STATIONS (CONTINUED)

Location	Landfill Fee ($/ton)	Transfer Station ($/ton)
NEW YORK		
Allegheny County	16.30	
Islip	18.00	
New York City	35.25*	52.50*
Niagara Falls	9.50	
Niagara Falls	18.50	
Onondaga County	13.50	
Rochester	18.00	25.00
Westchester County		43.75
NORTH DAKOTA		
Bismark	7.50*	
Bismark	5.40*	
OHIO		
Akron	9.00 - 9.75*	
Cincinnati	7.80*	
Cleveland	37.27*	
OKLAHOMA		
Tulsa	12.75*	
PENNSYLVANIA		
Chester County	20.00	
Erie	13.50*	
Northampton County	33.00	
Philadelphia		65.00
Pittsburgh	8.25*	
RHODE ISLAND		
Providence	13.00	
Warwick		26.00
SOUTH CAROLINA		
Spartanburg County	4.75	
TENNESSEE		
Memphis	4.50	
Nashville	6.00	
TEXAS		
Clute	10.50	
Dallas	5.40*	
San Antonio	8.20 (7.35 for city's trash)	
VIRGINIA		
Fairfax County	16.75	16.75
Prince William County	10.00	
Richmond	19.00	
Suffolk	16.50	

TIPPING FEE SURVEY - 1986 - LANDFILLS AND TRANSFER STATIONS (CONTINUED)

Location	Landfill Fee ($/ton)	Transfer Station ($/ton)
WASHINGTON		
Bremerton	12.30	
WISCONSIN		
Green Bay	8.50	
Madison	11.00	
Germantown	12.75 - 19.50*	
NATIONAL AVERAGE	$13.43	$28.26

* Converted from cubic yards to tons at three cubic yards per ton.

1986 TIPPING FEE SURVEY - RESOURCE RECOVERY PLANTS

	Tipping Fee ($/ton)
CONNECTICUT	
Windham	25.50 ($30.00 for nonparticipating municipalities)
FLORIDA	
Dade County	27.00
Lakeland	56.00 ($6.00 for city trucks)
Pinellas City	37.50
IOWA	
Ames	18.00 ($5.00 per truck to city/county)
ILLINOIS	
Chicago	No fee; tax supported (city trucks only)
MAINE	
Auburn	42.00 ($29.00 to communities under contract)
MASSACHUSETTS	
Andover	55.00
Pittsfield	20.00 ($13.50 to city)
Saugus	55.00 (less to communities under contract)
MINNESOTA	
Duluth	17.75
MONTANA	
Livingston	25.00 (city and county trucks only)
NEW YORK	
Albany	15.00 (no charge to city)
Glen Cove	50.00
Niagara Falls	15.00
Westchester	42.50 ($18.45 for county's residential waste)
PENNSYLVANIA	
Harrisburg	27.00 ($20.00 to communities under contract)
RHODE ISLAND	
Portsmouth	No fee for city's residential waste; tax supported
TENNESSEE	
Sumner County	10.00 ($25.00 for municipalities with long-term contracts)
Nashville	25.00 (no charge to city)
WISCONSIN	
Madison	14.75 (no charge to city)
NATIONAL AVERAGE	$30.42

* Converted from cubic yards to tons at three cubic yards per ton.

1986 TIPPING FEE SURVEY - REGIONAL AVERAGES (LANDFILLS)

Landfills	Regional Averages
Northeast	$20.59
South	$10.95
Midwest	$10.86
West	$10.01
National Range	$ 2.07 to $37.27

Reference 139.

Minnesota's current average tipping fees fit into the lower range of national costs. (To convert dollars per cubic yard into dollars per ton, multiply the cost per cubic yard by three.) The estimated changes that assume the proposed rules are adopted fit into the higher range of the survey. The difference between higher and lower landfill costs roughly follows a pattern of stringent environmental regulation and/or landfill capacity shortages. The higher costs tend to occur in the states with more comprehensive, detailed regulations and/or a shortage of landfill capacity.

The NSWMA survey also shows that the estimated costs for Minnesota landfills are not far different from the resource recovery prices reported nationally. This condition of rough equivalence occurs in Minnesota also. Solid waste management plans and project feasibility studies indicate that waste processing facilities in the State will charge tipping fees in the range of $30.00/T to $50.00/T.

These data do not support firm conclusions. The NSWMA survey is informal. It cannot be used as a statistically valid sample. The Minnesota data derive from plans and feasibility studies, not operating experience. Still, the data support a qualified conclusion that landfill rates will be able to compete with waste processing facility rates after the rules are adopted.

The Agency does not propose these rules with the intent of making life hard for permit holders. The Agency believes the rules will yield benefits that offset the costs incurred. Considered broadly, the rules' benefits consist of minimizing potential hazards that threaten human health and the environment. This goal underlies all Agency rules.

More specific descriptions of the rules' benefits focus on environmental media and solid waste system management.

1. The rules concentrate on measures designed to prevent, mitigate or correct ground water contamination. Landfill design, operation, closure, postclosure care and corrective action standards address this

concern. Successful application of the rules will yield both environmental and economic benefits.

2. The rules will produce further benefits to the extent that they prevent surface water contamination.

3. Land pollution occurs through erosion and excessive settlement at landfill sites. The rules' design and operating standards address these problems.

4. Mixed municipal solid waste decomposition can generate gases that have hazardous components. These gases become an environmental threat when they escape through the landfill cover. Design standards address this problem.

5. Site operating standards also address safety problems. Properly operated sites will pose minimal risks from accident.

6. The rules are expected to improve facility risk management. Facility permit holders will be compelled to gather new information about their sites and about the wastes they receive. This new information will improve their knowledge of risk and should encourage them to manage facilities so that risks are minimized.

7. The rules will require facility owners and operators and local officials to closely analyze facility costs. This careful analysis is expected to encourage the development of least-cost solid waste management. This will lead, in many cases, to rationalization of solid waste management systems along regional lines.

Finally, the Agency believes the proposed rules will yield a more generalized set of benefits. These benefits derive from the service people receive from qualitative improvements in natural resources. Such benefits are very hard to measure because all natural resource services are not traded in commercial markets. For example, an electrical power plant receives valuable service from natural systems when it discharges residuals (smoke, ash, hot water) into the air, land and water. However, these activities decrease the services received by people who are affected by the diminished quality of the resources.

In the first instance, these are the people who actually use the resources. Further removed, but still holding valid interest, are people who may use the resources. Others have varied interests in resource quality, even though they are unlikely to derive any value-in-use from the resources.

Past practice allowed industrial and commercial resource users virtually free use of resources. More recently, environmental regulation has added to the cost of industrial and commercial natural resource use. Still, although industrial and commercial users pay extra cost, they seldom have to compensate directly the other people who have interests in resource quality. There is no market mechanism available to provide the interested groups with a way to make direct trades. There is no systematic, indirect measure of the value of environmental goods and services. This lack of independent value measures often reduces debates on natural resource questions to loosely supported assertions of good motives and clean conscience. Extreme positions on one side hold that natural resources have value beyond price. In opposition, others claim that markets already make adequate provision for environmental costs. A host of intermediate positions are also heard.

Economic theory provides a method known as benefit-cost analysis as a way to account for nonmarket values. This analytical method defines competing values in commensurate (monetary) terms and compares benefits with costs. Activities that yield net benefits (benefits > costs) are preferred. Benefit-cost analysts continue to add to the list of nonmarket elements of environmental value:

Value Element	Summary Definition
Option value	demand for an "option" on a future opportunity to have direct, personal use of a resource
Bequest value	demand for an "option" that accrues to future users (children, grandchildren, etc.)
Quasi-option value	demand for preservation of genetic material and the opportunity of future use
Vicarious consumption	demand for knowledge that others are using resources
Altruism	ethically-based demand for enhancing the welfare of others
Stewardship	demand for knowledge of the preservation of genetic diversity

Reference 140.

The value categories are not necessarily mutually exclusive. Determining exclusivity would require detailed analysis of operational definitions. The point to note is that benefit-cost theorists have mapped the conceptual boundaries of nonmarket environmental values. Others have taken these theoretical constructs a step further and applied them to specific policy questions. Applied analyses have been used to develop quantitative estimates of selected environmental values. For example, one such study recently conducted in Minnesota found that people "attach a substantial value to protecting aquatic resources from acid rain." Reference 141. This study identified environmental benefits as having recreational and nonrecreational components and assigned dollar values to these benefits.

These kinds of nonmarket values will be affected by adoption of the proposed rules. The rules will increase the nonmarket benefits that many current and potential resource users receive. The Agency believes these benefits will offset the costs incurred. This is not to say that benefits will outweigh incurred costs. Available data support no conclusion on the net economic benefits or costs of the proposed rules. Although costs can be estimated with acceptable accuracy, benefits defy quantification, particularly those benefits derived from ground water protection. Indeed, the Legislature has determined that:

> ". . . the waters of the state, because of their abundant quantity and high natural quality, constitute a natural resource of immeasurable value . . . ."

Minn. Stat. § 115.063 (1986).

Available data do support economic impact statements of a less grand nature. If the analysis is restricted to quantifiable values and if the analytical focus shifts from local conditions to the entire State economy, more definite findings of economic impact can be made. The following section presents an economic impact analysis conducted under constraints which limit the study to determinate and quantifiable variables.

A. INTRODUCTION

Minn. Stat. § 116.07, subd. 6 (1986) reads as follows:

> In exercising all its powers the pollution control agency shall give due consideration to the establishment, maintenance, operation and expansion of business, commerce, trade, industry, traffic, and other economic factors and other material matters affecting the feasibility and practicability of any proposed action, including, but not limited to, the burden on a municipality of any tax which may result therefrom,

> and shall take or provide for such action as may be reasonable, feasible and practical under the circumstances.

That law has general applicability to all actions of the Agency. In the rulemaking context, this statute has been interpreted by the Agency to mean that, in determining whether to adopt proposed rules or amendments, the Agency must consider, among other evidence, the impact which economic factors may have on the feasibility and practicability of the proposed rules or amendments. In Finding No. 4 of the Agency's Findings of Fact and Conclusions In the Matter of the Proposed Revision to Minn. Rule APC 1, 6 MCAR § 4.0001, Relating to Ambient Air Quality Standards, the Agency discussed the requirements of Minn. Stat. § 116.07, subd. 6 as follows:

> In order for the Agency to duly consider economic factors when it determines whether to adopt the amendments to Minn. Rule APC 1, the record upon which the Agency will make its determination must include data on the economic impacts of those amendments. These economic impacts, however, need not be quantified with absolute certainty in order to be considered. Further, these economic impacts may include costs other than the cost of complying with a proposed rule. For instance, material losses, crop losses, health costs, and impacts on tourism are also economic factors that should be duly considered by the Agency in determining whether to adopt the amendments to Minn. Rule APC 1.

Responsible public policy decisions must weigh the values of competing goals. The statute and administrative interpretation cited above demonstrate recognition by the Legislature and the Agency that policy choices must take many goals into account and proceed on a systematic basis. Budget constraints in all economic sectors and at all levels require decision makers to choose among programs and projects that compete for scarce budget resources.

A community uses a variety of resources to advance its preferred policies. Money is the most readily available and quantifiable of these community resources. Economic factors provide a ready measure of the analytical basis for policy decisions. This is not to say that other values do not or should not influence decisions. Rather, an analytical base defined in monetary terms can be used to make competing values commensurate.

Consider an example in which policy makers must choose between development projects, Oberon and Titania, which are to be located in two different regions. Assume that estimates show both projects will yield positive net returns and that project Oberon will provide the highest return. Policy makers should choose Oberon, if all other things remain equal. However, make a further assumption that Oberon will be located in a thriving region (e.g., Athens) and Titania will be located in a depressed region (e.g., Sparta). If easing the depressed region's troubles is an established policy goal, policy makers may have reason to choose Titania over Oberon. The difference between the net returns for the projects becomes a measure of the value policy makers place on regional development problems. This difference can also serve as a benchmark for judging the performance of alternative regional development plans. This procedure allows an explicit statement of values that are often hidden or given disproportionate weight because they are not held to a very stringent burden of proof.

Economic impact analysis may proceed from a number of different bases. The analyst's first problem is to define properly the limits of the analysis. Consider, for example, the problem a business management analyst confronts in deciding whether to make a capital purchase. Assume that the unit in question is a machine. The analyst will first have to determine what the machine will cost. This calculation must include not just the purchase price, but also operating costs, maintenance costs and salvage values. The analyst will compare this cost with current production costs and estimates of the costs implicit in other machines or production methods. The important point to note here is that the equipment purchase decision usually depends on factors limited to the plant or the production line. These are internal factors over which the firm holds significant control. Special conditions can require broader analysis, but the general limits described usually hold true.

Now consider what happens if the problem changes and the question is whether to build a new plant. This introduces a new set of external factors which are often beyond the firm's control. The analyst is now concerned with questions whose answers are not found in the firm's financial statements. If the project is very large, the analyst must consider the effects a new plant will have on demand for the firm's products and on demand for input materials. Local community factors begin to matter also -- labor force quality, cost and mobility, transportation networks, zoning ordinances, educational systems, etc.

The larger question compels the analyst to expand the limits of study beyond the data available in a single firm's accounting system. The Agency's legislative directive cited above also requires analysis of impacts broader than those felt by an individual firm, or even a group of firms. The analytical limits implied must include, at least, the entire State and all of its economic sectors. We will find that some parts of the analysis will reach beyond the State's borders.

The limits imposed on economic analysis apply to more than just geographic boundaries. The analyst must also limit the number of factors that will be considered to the ones that will matter most. Economic change, like any other social change, has widespread effects. If the analyst chooses, analytical limits can be expanded until the original issue is lost in the broad sweep of global events. For example, the Brazilian soybean harvest influences grain prices worldwide. These prices, in turn, affect farm income. This does not mean that a budget analyst working in the Corn Belt must include South American climatological data in a budget forecast model. Again, the analysis must be limited so that it is kept relevant and manageable.

The statutory directive cited above rather clearly requires that the present analysis be limited to factors that have determinate, though not necessarily quantifiable, economic impacts. This analysis does not cover the full range of effects that will result from the changes proposed for the State's solid waste management system. For example, other sections of this document have discussed physical effects. The administrative implications of the rules are implicit throughout the document. A concerted effort could likely develop a list of dozens of other factors associated with the proposed rules as either direct or indirect causes or effects. However, reasonable analysis must recognize the constraints imposed by data and resource limitations. This is why the present applied analysis strictly follows the statutory guidelines and considers only determinate economic impacts.

The remainder of this part is organized in sections that proceed from a general description of the forecasting/simulation model through more detailed treatments of applications and findings. Section B provides a conceptual description of the methodology used in this analysis. Section C describes the steps the Agency took in defining the variables to use in simulating the impact of the proposed rules. Section D presents estimated costs and their pattern of distribution among selected economic sectors. Section E presents the results of the simulation and the Agency's conclusions.

B. CONCEPTUAL DESCRIPTION OF ANALYTICAL METHODS

This analysis covers a rather broad range of factors, given the constraints described above. A statistical model of Minnesota's economy makes this possible. The Department of Revenue and other State agencies use this Minnesota Forecasting and Simulation Model (MNFS-53) to describe the economic effects of proposed projects, laws and rules. This model derives its findings by solving a set of equations that describe the interrelated activities of a local economy. Reference 142. It will prove useful to describe, in general terms, the model's basic structure. Appendix XVIII is provided for readers interested in a more technical description of the MNFS-53 model.

The model can best be understood as a series of linkages. For example, one factor of primary concern in this analysis, employment, is linked to a series of other factors (e.g., local and external wage rates, local and external demand, and local and external production costs). Three groups of linkages comprise the model's basic structure.

Demand and Supply Linkages

Local and external demand determine gross regional output. This means that a region's production of goods and services depends on the strength of consumers' desires for those goods and services. The model takes into account the goods and services each economic sector demands from all other sectors. These sectoral demands are further subdivided into the familiar elements of general equilibrium analysis: consumption, investment, government spending and the net of exports less imports. An accountant's presentation of gross output for each sector would look like this:

1.	Total consumption demand for the sector's goods and services.	+ C
2.	Total investment demand for the sector's goods and services.	+ I
3.	Total government spending on the sector's goods and services.	+ G
4.	Total exports of the sector's goods and services.	+ Ex
5.	Total imports of the sector's goods and services.	- Im
	TOTAL SECTORAL OUTPUT	Y

Cost Linkages

The costs (or prices) of goods and services have important effects on supply and demand. Every good and service competes with all other goods and services for a share of the consumer's budget. If all other things remain equal and a product's price goes up, consumers will demand less of the product. They will either find a preferable alternative supply or they will make do with less. The availability (relative cost) of alternatives and the strength (elasticity) of demand also matter.

Cost considerations matter because policy makers are often concerned with factors that go beyond total output. They want to know what changes in total output mean in terms of investment and employment outcomes. For example, increases in labor costs (e.g., payroll taxes) often mean that employers will substitute capital for labor.

The MNFS-53 incorporates these influences through the use of the Cobb-Douglas production function. Business firms employ factors of production (e.g., labor and capital) in the activities of making goods and providing services. The amount of each factor a firm hires depends on factor costs and the strength of demand for the firm's output. The variables in the MNFS-53 production functions include: sectoral demand, the relationship of local wage rates to national wage rates, the relative cost of capital, fuel costs, and the output/employment ratio. Production values further depend on relationships determined within the MNFS-53 that are referred to as regional purchase coefficients (RPC). The RPC measures the amount of total sectoral demand that is satisfied by local output. Local production depends on: production costs relative to the rest of the nation, local industry growth trends and the strength of sectoral export demand.

Wage Determination Linkages

Labor wage rates have a strong influence on relative factor costs. The MNFS-53 includes a separate set of equations that is used to determine wage rates. The MNFS-53 calculates wage rates for each industrial sector, depending on: wages for each occupational group within the industry (weighted by each occupation's share of industry employment), local trends and wage factors not related to occupational supply and demand. Local wages for occupational groups depend on: demand for labor in that occupation, population, and a wage growth factor that takes into account current and past wages.

The linkages describe the framework of the MNFS-53 and relate this framework to conventional economic theory. The next step is to make this framework operational. Survey data are compiled so that they can be manipulated within the MNFS equation system.

National data compiled by federal agencies provide the basic data for the model. Table 9 presents a list of the model's data sources. Input-output (I-O) tables, developed by the U.S. Commerce Department's Bureau of Economic Analysis (BEA), provide structure for the model of a local economy. The I-O tables present an information series on the way national economic sectors relate to each other.

TABLE 9

DATA SOURCES

Data Source	Use
Census of Transport, 1977 Commodity Transportation Survey Bureau of the Census (CTS)	percent shipped within state for RPC estimation
Regional Economic Information System Bureau of Economic Analysis Dept. of Commerce (BEA)	employment, wage, and personal income data U.S. 1967-1983
County Business Patterns Bureau of the Census U.S. Dept. of Commerce (CBP)	employment and wage data 1977
496 - Industry Input-Output Tables for the U.S., 1972 Interindustry Economics Division Bureau of Economic Analysis (BEA/IO)	1977 Input/Out Matrix
Bureau of Labor Statistics history U.S. Dept. of Labor (BLS) forecast	U.S. 3-digit employment 1967-83 U.S. 3-digit employment 1983-95: low, moderate, high occupation proportions by industry
Survey of Current Business BEA (SCB)	U.S.: consumer price index, investment series Dept. of Commerce
1977 Inforum Interindustry Table Interindustry Forecasting at the Univ. of Maryland Dept. of Economics College Park, MD (INFORUM)	1977 Input/Output Matrix

TABLE 9 (CONTINUED)

DATA SOURCES

Data Source	Use
Current Population Survey Bureau of the Census U.S. Dept. of Commerce (CPS)	micro data on individuals for wage determination estimation
DOE/HBB-0029 Vol. 1 of 2 State Energy Price System Vol 1: Overview & Technical Documentation, Nov. 1982 Energy Information Administration Office of Energy Markets & End Use U.S. DOE	relative fuel costs
1977 Census of Manufacturers Bureau of Census U.S. Dept. of Commerce (COM)	fuel weights capital weights
Philadelphia Regional Input-Output Study Working Papers Volumes III & IV T.W. Langford, Jr. & W. Isard Dept. of Regional Science, Wharton School, Univ. of Penn. and RSRI Published by RSRI (RSRI/IO)	wholesale and retail sector detail in input/output table
Consumer Expenditure Survey Diary Survey - July 1972, June 1974 Interview Survey - 1972, 1973 Bureau of Labor Statistics U.S. Department of Labor (CES)	relative consumption vector, and household consumption coefficients

TABLE 9 (CONTINUED)

DATA SOURCES

Data Source	Use
Basic Regional Input-Output for Transportation Import Analysis, Handbook One of Regional Economic Analysis for Transportation Planning Prepared under Project 8-15A National Cooperative Highway Research Program, National Academy of Sciences July 1982 RSRI, 256 N. Pleasant St. Amherst, MA 01001	household consumption coefficients
Census of Government Governmental Finances Bureau of the Census U.S. Department of Commerce (COG)	corporate profit tax rates and property tax rates
Data Resources, Inc.	U.S. history and forecast

Reference 143.

An economy, like a natural system, consists of identifiable groups that interact in complex and dynamic ways. Business firms, nonprofit organizations and governments produce goods and services (supplies) to meet the consumption needs (demands) of people and their organizations. A firm's output can satisfy final demand (e.g., groceries) or intermediate demand (e.g., paper stock), in which case the product is used to produce new goods or services.

Each economic sector in the I-O tables relates to every other sector in a way that is based on the resources it demands from other sectors in the form of goods and services. Likewise, each sector supplies some part of its final product to all other sectors and to final consumer demand. The strength of these interdependencies varies, depending on the specific relationship in question.

An example will help explain the workings of the I-O table:

HYPOTHETICAL I-O TABLE

	Agric.	Mfg.	Svcs.	Final Demand	Gross Output
Agriculture	60	60	20	60	200
Manufacturing	40	25	90	80	235
Services	10	70	55	105	240
Value Added	90	80	75	245	

Reference 144.

The values in the rows indicate the units of output from one sector that provide intermediate inputs for itself, other sectors and finished goods and services for final consumers. The service sector described in the table provides 10 units to agriculture, 70 units to manufacturing, 55 units to itself and 105 units to final demand. This adds up to a total of 240 units, which is referred to as gross output. The column values present the demands made by each sector and the value added produced in each sector. The service sector purchases (demands) 20 units of agricultural output, 90 units of manufacturing output and 55 units of its own output. Value added is the measure of the extra value economic activity within a sector has added to the inputs it purchases. Notice that value added is equal to gross output less the sum of the inputs demanded by the sector. Thus, value added for the service sector is $240 - (20 + 90 + 55) = 75$.

This example is kept simple for instructive purposes. The I-O table used for the MNFS-53 consists of nearly 500 economic sectors. The value of the I-O table for this analysis is that any change induced in one sector has effects in all other sectors. This feature means that the MNFS-53 methodology provides a comprehensive way to meet the statutory directive to consider "the establishment, maintenance, operation and expansion of business, commerce, trade, industry, traffic and other economic factors and other material matters affecting the feasibility and practicability of any proposed action . . . ." The MNFS-53 methodology also takes into account the relative strengths of inter-sectoral impacts, which depend on the extent to which sectors rely on other sectors for productive inputs or economic demand. Thus, changes induced in one specific sector will have only slight effects on another sector that either demands little of the changed sector's output or supplies few of the changed sector's inputs. Conversely, a heavily-dependent sector will be strongly affected by induced changes.

A series of calibration and "bridging" adjustments reconcile the data from the I-O tables and a number of other sources. These other sources are used for two reasons. First, the other surveys are more recent than the benchmark I-O study. Including the later surveys' data in the model provides the model with more current information. Second, many of the other surveys contain regional data. These data provide the means (RPCs) to translate a national economic model into a model that describes the economy of an individual state.

The MNFS-53 provides a wide array of outputs, including the areas of legislative concern. Forecasts are extended to the year 1995. Output tables can be made very brief or quite detailed. The data available from intermediate-level tables include:

1. <u>Employment data (by sectors)</u>:

Manufacturing
  Durables
  Nondurables
Nonmanufacturing
  Mining
  Construction
  Transportation and Public Utilities
  Finance, Insurance and Real Estate
  Retail trade
  Wholesale trade
  Services
  Agricultural, Forestry and Fisheries services
Government
  State and local
  Federal, civilian
  Federal, military
Farm employment
Total employment
Population

2. <u>Income data</u>:

Wage and Salary disbursements
Proprietors' income
Other labor income
Total labor and proprietary income:
  less social insurance
  plus residential adjustments
  plus dividend, interest and rents
  plus transfer payments
Total personal income:
  less taxes
Disposable personal income
Price index, personal consumption expenditures
Real disposable personal income (1977 base year)
Sources of income:

- Manufacturing
  - Durables
  - Nondurables
- Nonmanufacturing
  - Mining
  - Construction
  - Transportation and Public Utilities
  - Finance, Insurance and Real Estate
  - Retail trade
  - Wholesale trade
  - Services
  - Agricultural, Forestry and Fisheries services
- Government
  - State and local
  - Federal, civilian
  - Federal, military
- Farm

3. <u>Gross Regional Product (GRP), by final demand:</u>

- Total consumption:
  - Autos and parts
  - Furniture and household equipment
  - Other durables
  - Food and beverages
  - Clothing and shoes
  - Gasoline and oil
  - Fuel oil and coal
  - Other nondurables
  - Housing
  - Household operations
  - Transportation
  - Health services
  - Other services
- Total fixed investment:
  - Residential
  - Nonresidential
  - Productive, durable equipment
- Current business inventories
- Government:
  - Federal, military
  - Federal, civilian
  - State and local, education
  - State and local, health & welfare
  - State and local, safety
  - State and local, misc.
- Total exports
- Total imports
- Total GRP, by value added:

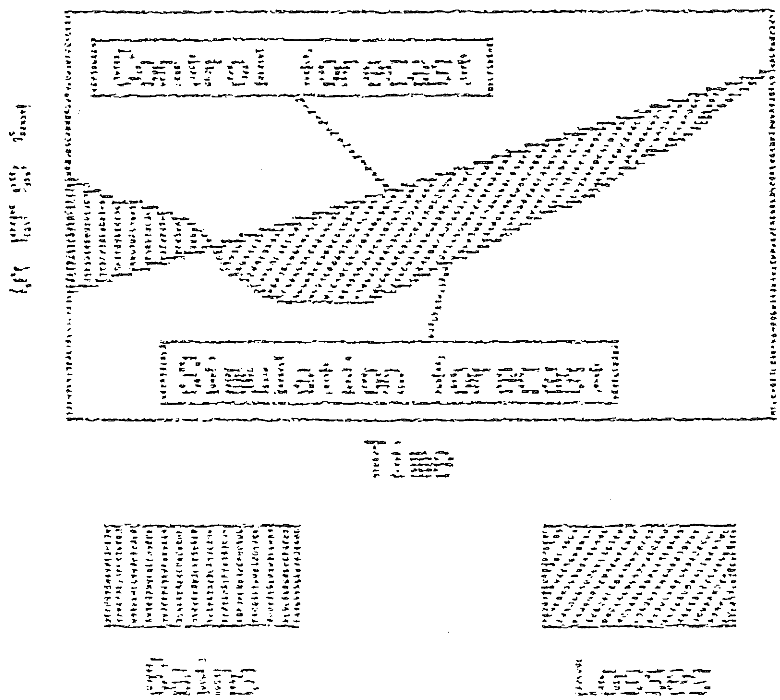
private, nonfarm
government compensation
farm

Some examples will illustrate how the simulation model is used. Consider a proposal to increase income taxes. The amount of the increase would be introduced into the model through a single policy variable, "Personal Taxes." The likely effects of this change would include a decrease in statewide demand leading to lower employment and income. Consider another example under which a large manufacturer proposes to build a new plant in the State. This change could be introduced through initial increases in demand for construction services, followed by employment increases in the manufacturer's sector. Appendix XIX provides an annotated list of the policy variables used to simulate changes and includes, in the special translation policy variable section, a full list of the model's economic sectors in which changes can be induced. Note that the sectoral list covers completely the areas described in the statutory directive that requires the Agency to develop this analysis.

The actual simulation of proposed changes is a three-step process. First, the economic model generates a "control forecast." Next, policy variables are changed to simulate the implementation of the proposal in question and the model is run under the changed conditions. This yields a "simulation forecast." Finally, the model presents the difference between the control forecast and the simulation forecast. This last value measures the impact of the simulated changes. Figure 12 illustrates the process.

FIGURE 12

EMPLOYMENT



The difference between the simulation forecast and the control forecast estimates the impact of the proposed change on statewide employment.

The MNFS-53 has been used effectively by the Minnesota Department of Revenue and by other State agencies. The basic model has also been adapted for use in other states, where it has received favorable evaluations. See Appendix XX. The model's comprehensive scope and interactive operations suit it very well to the analysis of economic impacts required by statute.

C. APPLICATIONS: VARIABLES CHOSEN TO SIMULATE THE IMPACT OF THE RULES

The simulation of the economic impact of the proposed rules proceeds in four stages. First, the basic MNFS-53 control forecast is considered as representative of conditions that existed before the process of upgrading facility permits began in 1981. This is because the changes induced by the upgraded permits began to have effect in 1984. The time between 1981 and 1984 was taken up with administrative reviews, investigations and negotiations. Since some of the basic national and regional surveys used to develop the model were conducted before 1984, the impacts of the permit upgrade process could not possibly be included in the control forecast.

The next stage of the simulation develops an estimate of the impacts of the permit upgrade process. This analysis balances the program's impacts among economic sectors. Resources diverted from one sector must be fully expended in other sectors. This means that the rules are simulated as a series of charges and revenues. A charge to one economic sector is balanced by revenues received in another sector.

Most of the charges remain in Minnesota. This requires some adjustment of the basic simulation model. The model's normal operations take interstate trade into account. The RPCs described above direct flows of goods and services to interstate trade. Experience derived from economic surveys determines the proportion of goods and services that remain in the State and the proportion of total demand that is satisfied by imports.

The Agency's experience with the State's solid waste management sector indicates that most of the primary economic impacts of the rules will remain in the State. Most solid waste management systems are local or, at most, sub-regional. There is narrative evidence that some Minnesota waste is taken to neighboring states. This diversion is now only about three percent of the State's total waste stream. Moreover, the diversion is not likely to continue, as local governments develop effective control of local waste streams and neighboring states increase solid waste regulatory efforts.

Most solid waste management facilities are owned by local governments or local private business firms. The contractors who provide services to the solid waste management sector (engineering, construction, laboratory services, etc.) are also Minnesota businesses, for the most part. The only major sector that will likely involve non-Minnesota firms is the financial sector, which is impacted through the financial requirements of upgraded permits and the new rules. Trustees and banks will hold in reserve funds dedicated to long-term care at solid waste facilities. These intermediaries will likely participate in national investment markets. The rules do not restrict investment policies beyond the constraints placed on trustees by the prudent man rule.

The first simulation considers most of the primary impacts of the permit upgrade program and the rules as local impacts. The simulation does not suppress changes in interstate trade that result from secondary impacts. These impacts will occur in sectors outside solid waste management. Their normal balance of intra- and interstate trade should not be changed. The sectors that experience secondary impacts are unlikely to buy waste disposal services from outside their local service area. However, interstate trade in these sectors could be affected as solid waste management costs increase.

Fifty-three economic sectors comprise the model of the state economy. These sectors correspond roughly to the two-digit level of the Standard Industrial Classification (SIC) codes. Table 10 below lists the sectoral classes the MNFS-53 uses.

TABLE 10

DETAILED SECTORS USED IN THE MNFS-53 MODEL

MANUFACTURING

1. Durable Goods
   (1) Lumber and wood products
   (2) Furniture and fixtures
   (3) Stone, clay, and glass products
   (4) Primary metal industries
   (5) Fabricated metal products
   (6) Nonelectrical machinery
   (7) Electric and electronic equipment
   (8) Motor vehicles and equipment
   (9) Transportation equipment except motor vehicles
   (10) Instruments and related products
   (11) Miscellaneous manufacturing industries

2. Nondurable Goods
   (12) Food and kindred products
   (13) Tobacco manufacturing
   (14) Textile mill products
   (15) Apparel and other textile products
   (16) Paper and allied products
   (17) Printing and publishing
   (18) Chemical and allied products
   (19) Petroleum and coal products
   (20) Rubber and miscellaneous plastics products
   (21) Leather and leather products

PRIVATE NONMANUFACTURING

3. Mining
   (22) Mining

4. Construction
   (23) Construction

5. Transportation and Public Utilities
   (24) Railroad transportation
   (25) Trucking and warehousing
   (26) Local and interurban passenger transit
   (27) Air transportation
   (28) Other transportation and transportation services
   (29) Communication
   (30) Electric, gas, and sanitary services

TABLE 10 (CONTINUED)

DETAILED SECTORS USED IN THE MNFS-53 MODEL

6. Finance, Insurance, and Real Estate
   - (31) Banking
   - (32) Insurance
   - (33) Brokers, credit, and other investment
   - (34) Real estate

7. Retail Trade
   - (35) Eating and drinking places
   - (36) Other retail trade

8. Wholesale Trade
   - (37) Wholesale trade

9. Services
   - (38) Hotels and other lodging places
   - (39) Personal and repair services
   - (40) Private households
   - (41) Auto repair, services, and garages
   - (42) Miscellaneous business services
   - (43) Amusement and recreation services not elsewhere classified
   - (44) Motion pictures
   - (45) Medical and other health services
   - (46) Legal and miscellaneous services
   - (48) Nonprofit membership organizations and museums

10. Agricultural Services, Forestry, Fisheries, and Other
    - (49) Agricultural services, forestry, fisheries, and other

GOVERNMENT

11. State and Local
    - (50) State and Local

12. Federal, Civilian
    - (51) Federal, civilian

13. Federal, Military
    - (52) Federal, military

FARM

14. Farm
    - (53) Farm

Some further aggregation was needed to get correspondence between the 53-sector MNFS-53 list and the nearly 90-sector two-digit SIC list. Table 11 describes the sectors chosen to simulate the impact of the permit upgrade program and the proposed rules.

TABLE 11

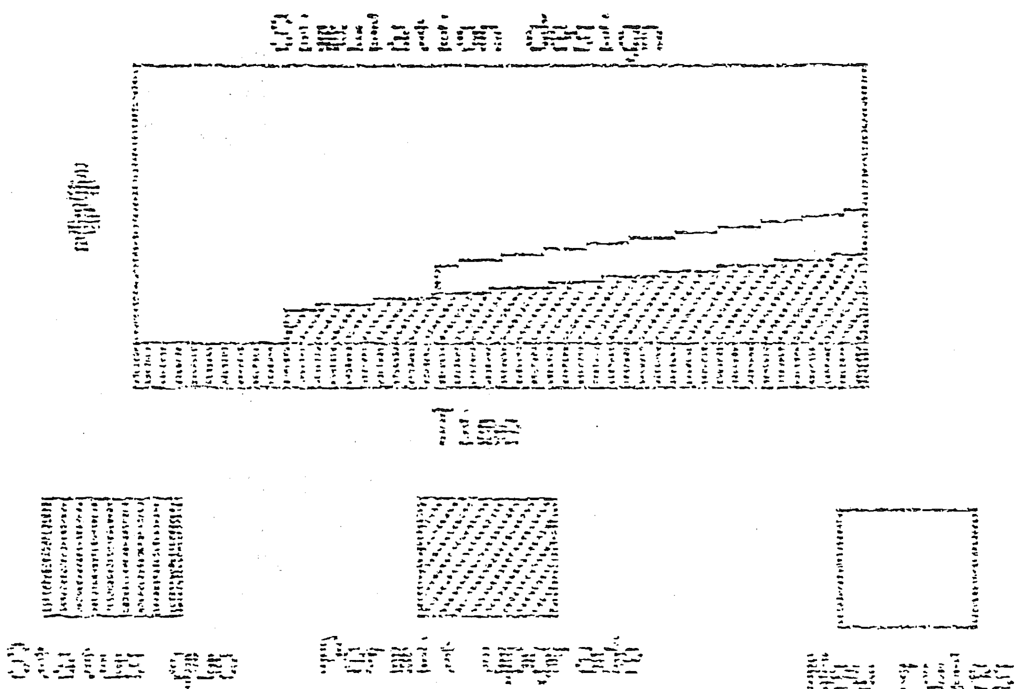
IMPACTED SECTORS

SERVICE REQUIRED	SECTOR	SIC (MNFS)
Engineering services: design, planning, cost estimates, etc.	Misc. Professional Svc. (MPS)	8911 (614/646)
Hydrogeologic studies	MPS	8911 (614/646)
Ground water monitoring system installation	Construction	1781 (591/623)
Added solid waste management services: training, industrial waste management, reporting to regulatory agency	Landfills or MPS	4953 (598/630) 8911 (614/646)
Operation of ground water protection systems: sampling, testing, QA/QC	Landfills or MPS	4953 (598/630) 8911 (614/646)
Site development: installation of liner systems, leachate collection systems, gas systems	Landfills or Construction	4953 (598/630) 1629 (591/623)
Financial intermediation	Banking	6025 (599/631) (DEMPOL)
Leachate collection and treatment (annual O&M)	Landfills & Munic. trt. facils.	4953 (598/630)
Corrective actions at waste disposal facilities	Landfills, MPS or Construction	4953 (598/630) 8911 (614/646) 1629 (591/623)
Final cover at waste disposal sites	Landfills or Construction	4953 (598/630) 1629 (591/623)
Postclosure care: inspections, sampling, laboratory tests, reporting	Landfills or MPS	4953 (598/630) 8911 (614/646)
Management of alternative waste disposal sites	Waste processing facilities	4953 (598/630)
Transport cost increases	Waste collection	4953 (598/630)

The sectors listed in the table above are the sectors that are expected to do the work the proposed rules will require of permittees. The activities listed are assumed to be paid for through increases in facility charges. In some cases, the owner or operator will perform the work, so that resources taken from this sector as costs are returned to this sector as revenues. Other conditions will require the permittee to hire someone else to do the required work, just as permittees now hire engineering firms and laboratories to carry out some of their responsibilities.

The next stage of the simulation describes the impact of the proposed rules. Administration of the new rules will require staff increases in the Agency. The need arises from the added responsibilities placed on permittees to report site conditions and to design and operate facilities in a different, more complex, manner. The Agency will require more people to oversee the expanded facility activity. The cost of adding to the Agency staff is simulated through a tax increase, the likeliest source of funding, all other things being equal. These costs are returned to the system through increases in a policy variable representing final demand from state and local government. These increases in demand are then distributed throughout the economy according to proportions observed in past surveys. The simulation induces changes in the sectors described in the table above. These changes reflect provisions of the rules that are not accounted for in the simulation of the permit upgrade program. For example, the permit upgrade program covers only mixed municipal solid waste land disposal facilities. All of the new rules' impacts on alternative facilities are included in this second simulation. Likewise, the second simulation includes financial assurance provisions which are now excluded from the permit upgrade program. Finally, the analysis compares the results of the two simulations with the values of the control forecast. This comparison yields the values that measure the impact of the proposed rules. Figure 13 presents a graphic demonstration of the measure.

FIGURE 13


Simulation design
Time
Status quo
Permit upgrade
New rules

The final statement of the rules' impacts includes both upgraded permits and new rules, since the proposed rules contain provisions that are now written in the upgraded permits.

D. DISTRIBUTION OF THE IMPACTS: COSTS

Recall that the analysis assumes that money is conserved. Costs incurred in one sector are balanced by revenues received in another sector. Most charges are incurred in the solid waste management sector. Table 12 describes how the charges to the solid waste management sector are distributed as revenues.

TABLE 12

COSTS INCURRED AND SECTORS IMPACTED

COST CATEGORY	IMPACTED SECTORS	SECTORAL SHARE
CAPITAL ELEMENTS:		
1. Closed sites:		
a. upgrade monitoring systems:		
water	Construction	.5
	Misc. Professional Services (MPS)	.5
gas	Construction	.5
	Landfills	.5
b. install final cover	Construction	.5
	Landfills	.5
c. engineering costs	MPS	
2. Operating sites:		
a. begin hydrogeological studies	MPS	
b. install liners	Construction	.5
	Landfills	.5
c. install monitoring system	Construction	.5
	Landfills	.5
d. corrective actions	MPS	.333
	Construction	.333
	Landfills	.333
e. land	Landfills	
f. engineering costs	MPS	
ANNUAL ELEMENTS:		
1. Closed sites:		
Postclosure care	MPS	.5
	Landfills	.5

TABLE 12 (CONTINUED)

COSTS INCURRED AND SECTORS IMPACTED

COST CATEGORY	IMPACTED SECTORS	SECTORAL SHARE
2. Operating sites:		
a. ground water sampling	MPS	
b. gas sampling	Landfills	
c. cover (not final)	Landfills	
d. training	Landfills	
e. industrial waste mgmt.	Landfills	.5
	MPS	.5
f. leachate treatment	Landfills	.5
	Water utilities	.5
g. liner maintenance	Landfills	
h. leachate testing	MPS	
i. financial assurance:	Banking	
j. corrective actions	MPS	.333
	Construction	.333
	Landfills	.333
k. alternative sites (composite)	Waste processing	
3. Administrative costs to State	Government demand	

The unit cost estimates are derived from a combination of required design criteria and the experience of local contractors, equipment suppliers and permit reviewers. The estimates are average values. They should not be considered as valid for any specific site. The estimates are more like a relationship between two aggregates: one, the total costs incurred at all sites under a given category and, two, the total number of units involved for all sites.

The Agency assumes a conservative bias in its estimation of unit costs. That is, given a reasonable choice between higher and lower values, the estimates assume the higher value. This prudent measure ensures that the estimate of the rules' economic impacts is not minimized.

The costs will likely be incurred at different rates at different sites.

This requires some assumptions about rates and schedules so that the analysis can be kept manageable. Table 13 presents the scheduling assumptions that inform the analysis.

TABLE 13

RATES OF COST INCIDENCE

ACTIVITY	SCHEDULE
Engineering services	Incurred whenever there is a construction activity (e.g., well installation, site development).
Hydrogeologic studies	* All needed projects have begun by 1990; and are completed by 1992; costs are evenly distributed over this period.
Ground water system installation	This construction activity is the last part of the hydrogeologic study; it occurs during the last phase of the two-year study.
Additional solid waste management responsibilities	These activities begin when the rules take effect and are incurred by all sites operating at this time.
Operations of ground water protection systems	- Costs are first incurred in 1988 for the sites that have systems. - Costs begin after installation for all other sites.

Site development (capital elements)	- For sites closing within 18 months, gas system installation costs are incurred in 1989.
	- For all other sites:
	  - some begin development work in 1988 (metropolitan sites and 25% of nonmetropolitan sites).
	  - the 75% remaining Nonmetro sites begin development work in 1989.

Financial intermediation	Charges are incurred for all operating sites one year after the rules take effect.

* Hydrogeologic study projects begin at some sites in 1988. Projects are scheduled only for the sites that require study.

TABLE 13 (CONTINUED)

RATES OF COST INCIDENCE

ACTIVITY	SCHEDULE
Leachate collection and treatment (operating elements)	Costs are incurred one year after installation of new design features.
Cover: a) operational	- Phased cover operations begin in 1988 for all sites.
b) final	- Costs are incurred in the year of the scheduled closure date.
Postclosure care	Costs are first incurred in the year of scheduled closure and continue for 20 years afterward.
Corrective actions	*

* The matter of developing an estimate for corrective action costs is complicated. These costs are simply not predictable by any analytical means other than application of random chance. The Agency chose instead to schedule these costs, with the expectation that some sites would require corrective action throughout the period analyzed. The schedule was developed in the following manner:

Forty-seven sites are now on the Superfund list. They can be categorized in terms of the extent to which they've completed the process:

1. Some sites have scored high, completed (two-year) RI/FS projects and begun remedial work.
2. The next set of sites have started the RI/FS projects, but not completed them.
3. The next set have gotten scores high enough to make the list, but the Agency hasn't begun administrative action.
4. When all these possibilities are exhausted, the only sites left are unlisted.

The protocol for scheduling the corrective action costs can thus be derived from the Agency's administrative experience. Record costs for the sites in item one above in years 1988 and 1989. Begin remedial work for the second set of sites in 1990 and, at the same time, schedule enough of the third group to optimize Agency staff resources. Follow this schedule until the forecast time slots are used up.

TABLE 13 (CONTINUED)

RATES OF COST INCIDENCE

ACTIVITY	SCHEDULE
Solid waste management at alternative sites	Costs are incurred when operations are scheduled to begin.
Transportation	- Costs are incurred only under an optimized schedule which presents a model of expected regional consolidation.

All costs will not be incurred on the same date or at the same rate. The analysis must take into account the current level of development in the solid waste management sector. Analysis must also consider expected changes in this sector so further assumptions must be made about the future pattern of facility closures. The analysis must include estimates of how many sites incur which costs at which time. Table 14 presents the Agency's current estimate of the near-term landfill closure schedule.

TABLE 14

CLOSURE DATE	SITES
Sites now scheduled to close by 1988	Cook, Crosby, NW Angle, LaGrande, Long Prairie, Koochiching, Anderson, Wadena, Winona, Olmsted, Lake, Pickett, NE Otter Tail, Fergus Falls, Sibley
Sites scheduled to close in 1989	Wabasha, McLeod, French Lake, Kluver, Iron Range
Sites scheduled to close in 1990	Hickory Grove, Yonak, Dodge, Becker
Sites scheduled to close in 1991	Lindala
(Sites not scheduled in county plans to close, but with diminished capacity.*)	
Capacity ends in 1988 or sooner	Battle Lake, City of McKinley, City of Wadena, Killian, Karlstad, Kummer, Lincoln, Lindenfelser, Mahnomen, Orr, Sibley, Waste Disposal Engineering, Brookston, Flying Cloud, Kanabec, Korf Brothers, Meeker County
Capacity ends in 1989	Anoka Municipal, City of Hoyt Lakes, Dakhue, Freeway, Northwoods, Pine Lane, Sauk Centre
Capacity ends by 1992	Aitkin Area, City of Benson, Chisago/Isanti, Leech Lake, Louisville, Pipestone, Polk County, Red Wing, Renville County, Salol, Tostensen

* Remaining capacity estimates assume: no change in existing capacity, continuation of current fill rates and no changes in local waste streams.

The table indicates that 58 landfill sites are either scheduled to close or likely to run out of capacity by 1992. The analysis makes two further assumptions about landfill capacity. First, an intermediate step assumes that any sites remaining after 1992 will continue to operate until 1995, the last year for which MNFS-53 can forecast. This amounts to an assumption that either the remaining sites will not use up their capacity or that new capacity will be developed in the same location to meet any shortfalls. Since both new and old facilities operating at this time will incur about the same costs, the assumption fits well with one set of expected developments; namely, that local areas that have landfill capacity after 1992 will continue to use local facilities.

Alternatively, another reasonable expectation is that some consolidation of regional land disposal needs will occur. The next step in the analysis makes some assumptions about further changes in the regional distribution of landfill capacity. Facility users will have to consider, at some point, whether continued use of local facilities makes sense. Local facilities will most often be relatively small sites. Many of the costs imposed by the new rules are lumpy, one-time costs that resemble capital improvements. They are incurred as lump sums, and even though most operators will amortize these costs they will likely follow the pattern common to capital expenditures throughout the economy. That is, the cost per unit of output of capital expenditures tends to fall as the size of the firm increases. This tendency is often referred to as an economy of scale. It is why large-scale firms enjoy many advantages over smaller firms. Economies of scale exist in landfill management. <u>See</u> Appendix XXI. The sector would be rather odd if scale economies could not be found. However, scale economies are not consistently reflected in the rates charged at Minnesota landfills. This is mostly because many landfills have not yet taken full account of long-term care costs.

The proposed rules will require landfill operators to include long-term care costs in their financial plans. This will encourage the search for scale economies. The regional decision to consolidate landfill capacity will depend on the relationship of capital costs to transportation costs. A decision of this sort was recently made in Lyon and Lincoln Counties. The operator of the Lyon County landfill also had a site in neighboring Lincoln County. The Lincoln County site was rather small and took in a relatively small amount of waste. The operator decided that it made sense to close the Lincoln County site and haul all the waste to Lyon County. Relative cost differences justified the decision. It makes no sense to consolidate if the savings in capital costs are smaller than the implicit transportation cost increases. The final stage of the analysis will induce some closures and add some transportation costs in limited cases that appear reasonable.

The outline below summarizes the procedures used to estimate the impacts of the proposed rules:

OUTLINE OF THE MNFS-53 PROCEDURE

1. Control forecast.
2. Simulate implementation of the permit upgrade program.
3. Simulate implementation of the proposed rules:
   a. assume the status quo prevails after 1992; and
   b. assume regional consolidation of landfill capacity after 1992.
4. Calculate differences between simulations and original control forecast - estimate the impact of both the permit upgrade program and the proposed rules.

E. SIMULATION OF REVENUES AND CHARGES

Table 15 below presents selected elements of the control forecast. The model treats as a forecast values for the years 1981 through 1983. This is because the latest update for the current version of the model consisted of 1983 data. So the model forecasts values associated with events that have actually occurred. This provides a means to check the forecast's performance against measured experience.

TABLE 15

SUMMARY OF CONTROL FORECAST VALUES

YEAR	EMPLOYMENT (thousands of jobs)	WAGE & SAL. DISBURSEMENTS ($ millions)	PERSONAL INCOME ($ millions)	REAL PERSONAL INCOME ($ millions)	POPULATION (thousands)
1984	1,896	32,972	55,111	14,432	4,162
1985	1,952	35,273	59,070	14,988	4,223
1986	1,993	38,006	63,393	15,511	4,256
1987	2,039	41,341	68,937	16,046	4,286
1988	2,092	45,128	75,049	16,540	4,316
1989	2,144	49,449	81,839	17,041	4,344
1990	2,181	54,126	89,051	17,454	4,372
1991	2,211	59,214	97,066	17,900	4,400
1992	2,240	64,644	105,641	18,324	4,427
1993	2,265	70,417	114,753	18,700	4,453
1994	2,289	76,686	124,542	19,048	4,478
1995	2,313	83,534	135,181	19,386	4,502

The MNFS-53 forecasts personal income levels of $59.07 billion in 1985 and $63.393 billion in 1986. The Department of Revenue reports that personal income was $59.341 billion in 1985 and $62.766 billion in 1986. Reference 145. The forecast overestimated 1985 personal income by 0.5 percent and underestimated 1986 personal income by one percent. The slight difference between forecast and measured values indicates that the MNFS-53 is sufficiently accurate for the present analysis. Recall that the statutory directive for this analysis, Minn. Stat. § 116.07, subd. 6, charges the Agency to consider the impact its rules will have on the State economy. This charge places less value on predictive accuracy and more value on consistency. It is not critically important that the forecast values for 1995 prove to be very precise. It is more important that the control and simulation forecasts are based on the same data and proceed from the same set of analytical constraints. In other words, if the MNFS contains errors, then the control forecast and the simulation forecast will likely err in the same direction and at nearly the same rate. The earlier comparison of MNFS-53 forecasts with measured values indicates that any errors in the MNFS-53 are slight and acceptable for the purposes of this analysis.

The simulation forecast derives from Agency estimates of the new costs the proposed rules will impose on solid waste management systems. Table 16 below lists the types of new costs the Agency believes will result from rule adoption. (Appendix XXII provides a more detailed description of these costs and their estimated values.)

TABLE 16

UNIT COSTS

ACTIVITY	SECTOR	UNIT COSTS	UNITS
Engineering services	MPS	(15% of construction)	
Hydrogeologic studies	MPS	$ 155,000	(lump sum)
Installation of ground water monitoring systems (+ engineering)	Construction	5,500	(wells)
Installation of gas monitoring systems (+ engineering)	Construction	3,000	(acres)
Additional solid waste management responsibilities	Landfills	7,000	(lump sum/yr.)
Operations of ground water protection systems	MPS, Landfills	16,500	(wells/yr.)
Operations of gas monitoring systems	MPS, Landfills	500	(acres/yr.)
Site development (+ engineering)	Construction, Landfills	120,000	(acres)
Financial intermediation: reserves	Banking	514,000	(lump sum/yr.)
service charges		(2% of above)	
Leachate collection and trt.	Landfills	0.09	(gal/yr.)
Corrective actions: capital (+ engineering)	MPS, Construction Landfills	1,438,000	(lump sum)
Corrective actions: O & M	MPS, Construction Landfills	1,380,000	(lump sum, 20-year period)

TABLE 16 (CONTINUED)

UNIT COSTS

ACTIVITY	SECTOR	UNIT COSTS	UNITS
Cover: a) operational	Landfills	24,000	(acres/yr.)
b) final (+ engineering)	Landfills Construction	32,000	(acres)
Postclosure care	Landfills	6,000	(acres/yr.)
Land	Landfills	500	(acres)
Liner maintenance	Landfills	100	(hours)
Leachate testing	MPS	200	(samples)
Solid waste management; alternative sites	Utilities	5,000	(lump sum/yr.)
Transportation	Utilities	0.10	($/T/mi.)

The table also lists the economic sectors that each cost element affects. For example, reserves developed to meet financial assurance requirements accrue as revenues to the banking sector, while corrective actions yield revenues for the landfill, construction and professional service sectors. This analysis distributes equal proportions of revenues to all affected sectors. The Agency does not have the data that would make possible a more discriminating distribution.

The final step in the compilation of the simulation forecast is to add up all the revenues and charges that are applied to each sector. Table 17 presents this compilation. The Agency applied a consistently conservative bias in the development of its cost estimates. That is, the assumptions that underlie the cost estimates are made so that higher values are chosen more often than lower values. These assumptions are, of course, subject to the constraints of reason and experience.

TABLE 17

SIMULATION FORECAST: Charges and Revenues
(In Thousands of Dollars)

	Revenues				Charges
YEAR	BANKING	CONSTRUCTION	MPS	LANDFILLS	TOTAL
1984	$ 0	$ 1,938	$ 1,683	$28,618	$32,238
1985	0	587	1,893	26,652	29,132
1986	0	2,730	3,562	28,505	34,798
1987	0	3,053	3,214	28,147	34,415
1988	0	26,870	19,339	34,328	80,537
1989	36,694	23,034	17,578	31,719	109,350
1990	34,598	17,636	16,156	26,566	94,956
1991	31,452	16,546	13,588	25,364	86,950
1992	28,831	15,847	13,815	24,587	83,080
1993	28,831	13,604	13,103	22,451	77,990
1994	28,831	13,742	13,241	22,589	78,404
1995	28,831	13,880	13,379	22,727	78,818
Total	218,069	149,466	130,554	322,252	820,341
(Changes reflecting regional consolidation)					
1993	23,065	16,241	14,849	25,574	79,729
1994	23,065	11,762	13,346	21,352	69,525
1995	23,065	11,900	13,484	21,490	69,939
Total	200,771	148,143	132,508	322,902	804,323

The entries in the landfill column include some revenues accruing to water treatment facilities and waste processing facilities. These entries are summed because the MNFS-53 includes all three types of firms in the same sector. The table includes a section that presents two sets of values for the years 1993 through 1995. The second set of values reflects the assumed impact of waste stream consolidation in some regions. The consolidation involves the development of three waste processing facilities and 11 landfill closures. These changes are assumed to occur in 1993. The charges offsetting the revenues listed in the table are incurred by the public utilities sector, which includes landfills, water treatment facilities and waste processing facilities.

A further series of changes simulates the effects of increased administrative costs imposed on the Agency. These changes begin in 1988 and continue through 1995. The simulation consists of an increase in personal taxes of $444,000 per year and an offsetting increase in local government demand for health and environmental services.

The economic simulation of the proposed rules consists of making changes in selected variables of the control forecast. For example, the simulation adds $26.87 million to sales in the construction sector in 1988. The simulation also adds $80.537 million to operating costs in the public utilities sector in 1988.

F. FINDINGS

The results of the simulation show that the rules will have only a negligible impact on the State economy. This finding is summarized in Table 18 below. (Appendix XXIII provides the results of the simulation analysis in more detail.)

TABLE 18

PROPOSED RULES: Summary of Simulation Results

	TOTAL EMPLOYMENT (thousands of jobs)		TOTAL DEMAND ($ billions)		PERSONAL INCOME ($ billions)	
YEAR	Control	Simulation	Control	Simulation	Control	Simulation
1984	1,896	105	95.321	.016	55.111	.006
1985	1,952	29	101.935	.010	59.070	.005
1986	1,993	43	109.935	.008	63.393	.005
1987	2,039	14	119.651	.007	68.937	.005
1988	2,092	530	130.394	.024	75.049	.024
1989	2,144	801	142.262	.012	81.839	.036
1990	2,181	498	154.646	(.007)	89.051	.032
1991	2,211	322	168.709	(.013)	97.066	.026
1992	2,240	194	184.040	(.021)	105.641	.021
1993	2,265	095	200.028	(.030)	114.753	.016
1994	2,289	048	217.136	(.036)	124.542	.014
1995	2,313	014	235.229	(.040)	135.181	.011
(Changes reflecting regional consolidation)						
1993	2,265	87	200.028	(.026)	114.753	.017
1994	2,289	(14)	217.136	(.036)	124.542	.010
1995	2,313	(58)	235.229	(.040)	135.181	.008

The values in the simulation column represent the net difference between the control forecast and the simulation forecast. They are the measure of the impact of the proposed rules on the variable associated with each value.

The results indicate that the rules will have only slight impacts on the State economy. The results show employment increases for all years of the first simulation analysis. The MNFS-53 forecasts slight employment declines in the later years of the simulation analysis that assumes some consolidation of regional waste streams. However, even the largest of the increases only amounts to 0.04 percent of total employment. Likewise, the largest of the changes indicated for total demand amounts to only 0.018 percent of control forecast demand. The largest of the personal income changes amounts to only 0.044 percent of the control forecast value.

The simulation indicates some positive economic effects, but they can hardly be considered as economic development. On the other hand, the simulation indicates some negative economic results, but these are so small they cannot be considered as signals of imminent recession.

The impacts are estimated to be slight because the factors being influenced are so large by comparison. The control forecast predicts that total demand will be $130 billion in 1988. Total demand is the dollar value of all goods and services traded in the State. Consider it as a simple measure of the size of the State economy. The conservative estimates the Agency developed set charges resulting from the proposed rules at $80 million in 1988. This amounts to less than one tenth of one per cent of total demand. Although the absolute value of the charges appears large, the relative value is not very great at all.

This important finding should not be minimized. Reviewers of the proposed rules who have criticized them often insist that the rules will impose an unbearable burden on regulated firms and local governments. These assertions have validity only if the critics' point of view is constrained to a very narrow economic sector and a limited time period. A limited point of view often makes problems, questions and issues seem simpler. Cutting back on the number of variables considered makes it easier to come to decisions. But accepting narrow limits constrains analysis, sometimes to the point that critical information is ignored. The results are flawed analyses and incorrect findings. This type of result often occurs when the proposed rules are criticized by people representing the business firms and local governments that will be regulated. The regulated community's interest lies in limiting the analytical focus to their own sector. This is as if to say that the proposed rules' financial impacts will be limited to raising solid waste management costs. This is not surprising, since people often stop analyzing problems when they run out of data. People in the "regulated community" usually have data gathered only from their economic sector and local market area. However, the Agency cannot limit its analysis to only the solid waste management sector. The legislative directive in Minn. Stat. § 116.07 quite properly forces the Agency to look beyond such narrow sectoral borders.

The new costs the rules will impose are associated with two general types of activities: procedural and substantive requirements. The procedural requirements involve reporting to the Agency on a number of matters; e.g., long-term care plans, sampling analyses, surveys, etc. These procedural requirements will be costly, but the Agency believes procedural costs will not be nearly as great as substantive costs.

The substantive requirements will cause landfill permittees to install and operate new system designs. Facilities will be lined and leachate will be collected and treated. Cover systems and long-term care procedures will be established to keep moisture from entering the fill area. The techniques are not themselves new, but their application to landfill operations is new. The increased level of capital investment, a condition usually associated with technological change, is also new to landfilling. These cost increases often shock people who are unprepared for change.

The findings of the simulation analysis offer some comfort to those who are shocked by the new capital and operating costs implicit in the proposed rules. The simulation indicates that the new costs imposed on landfills can be absorbed by the State's economy without causing sharp dislocations. The simulation forecast estimates that 1988 population will be about 4.3 million and personal income will be about $75 billion. The estimates imply that annual income per capita will be about $17,400. Recall that the Agency's conservative estimate of new landfill costs in 1988 is $80 million. This means annual new costs per capita will be about $19, which amounts to 0.1 percent of per capita income. (Note here that these values are averages. Actual costs incurred at individual households will likely be less because the estimates make no attempt to separate industrial and commercial costs from residential costs.)

The size of the cost increase is critical because the amount of the change will influence demand for waste disposal services. The economic decisions households and business firms make are constrained by budgets. No person or firm has an unlimited budget. Financial constraints require people to make constant adjustments in their purchasing behavior as the prices for individual goods and services change. The normal response to a price increase is to buy less of the good or service that becomes more costly. The consumer can either look for an alternative source or make do with less of the more expensive good or service.

The response rate to price changes is not the same for all goods and services. An increase in the price of an essential good will not lead to the same response as an increase in the price of a luxury good. The "responsiveness" of consumer demand to price changes is known as the price elasticity of demand. A good or service with an elastic demand schedule will be associated with large changes in demand if there are small price changes. The opposite is true for goods and services with inelastic demand characteristics; demand will not be greatly influenced by price changes.

Available research finds that the price elasticity for waste disposal services is inelastic. References 146 and 147. This means that price (cost) increases are not likely to cause great changes in the demand for waste disposal services. This inelastic demand characteristic and the relatively slight cost associated with the rules further explain why the simulation forecast estimated such a small impact. Rule adoption will cause relatively small cost increases in a service which people and business firms regard as essential.

Recall that the Agency's charge is to consider "the establishment, maintenance, operation and expansion of business, commerce, trade, industry, traffic and other economic factors" in its decisions regarding the proposed rules. The Agency's analysis considered these factors in the broadest possible context and with a conservative bias designed to highlight any possible negative impacts. The results of the analysis lead the Agency to conclude that the proposed rules will have no material effect on the economic operations listed in Minn. Stat. § 116.07, subd. 6.

VIII. IMPACTS ON AGRICULTURAL LANDS

The Agency is required to consider the impacts of proposed rules on agricultural lands:

> If the Agency proposing the adoption of the rule determines that the rule may have a direct and substantial adverse impact on agricultural land in the state, the Agency shall comply with the requirements of sections 17.80 to 17.84.

Minn. Stat. § 14.11, subd. 2 (1986).

The definition of "adverse impact" which applies in this case is:

> "Action which adversely affects" means any of the following actions taken in respect to agricultural land which have or would have the effect of substantially restricting the agricultural use of the land: (1) acquisition for a nonagricultural use except acquisition for any unit of the outdoor recreation system described in section 86A.05, other than a trail described in subdivision 4 of that section; (2) granting of a permit, license, franchise or other official authorization for nonagricultural use; (3) lease of state-owned land

> for nonagricultural use except for mineral exploration or mining; or (4) granting or loaning of state funds for purposes which are not consistent with agricultural use.

Minn. Stat. § 17.81, subd. 2 (1986).

The Legislature has set agricultural land policies that guide administrative agencies' rulemaking efforts and determinations of adverse impact:

> It is the policy of the state to preserve agricultural land and conserve its long-term use for the production of food and other agricultural products by:
>
> (a) Protection of agricultural land and certain parcels of open space land from conversion to other uses;
> (b) Conservation and enhancement of soil and water resources to ensure their long-term quality and productivity;
> (c) Encouragement of planned growth and development of urban and rural areas to ensure the most effective use of agricultural land, resources and capital; and
> (d) Fostering of ownership and operation of agricultural land by resident farmers.

Minn. Stat. § 17.80, subd. 1 (1986).

The first two policy goals apply to the proposed solid waste rules and are satisfied by them. They will be discussed below. First, some background. Many solid waste land disposal facilities are now sited on agricultural lands. These sites are favored because they are usually remote and they often have desirable soil characteristics. The Agency believes that future siting decisions will also favor agricultural lands. However, the proposed rules will not create the tendency to site in agricultural lands. In fact, the proposed rules will likely have a dampening effect on this tendency.

Adoption of the proposed rules will not increase the demand for agricultural lands that can be used as solid waste land disposal facility sites. Compliance with the proposed rules will require that solid waste land disposal facility owners and operators install and operate systems that protect the quality of air, ground water and surface water. Facility owners and operators will also have to accumulate financial reserves in anticipation of expenses for facility closure, postclosure care and corrective action. These requirements will raise both fixed and operating costs at solid waste land disposal facilities.

The increase in fixed costs will influence future solid waste land disposal facility design. Each unit of solid waste disposed of produces revenue for the disposal facility. Liner and cover system costs are fixed for specific areas and time periods. Putting more waste in a given area lowers fixed costs per unit of waste received. The Agency believes facility owners and operators will favor cost-efficient designs. This will tend to lower the demand for agricultural land because available space will be more intensively used.

Increases in both fixed and operating costs will raise solid waste land disposal facility costs relative to the costs of other solid waste management facilities. The change in relative costs will induce some shift away from solid waste land disposal facilities and toward other solid waste management facilities. Other factors (e.g., transportation costs) will constrain the shift, so that demand will not completely erode. Still, the changes in relative costs will likely have some dampening effect on demand for sites that can be used for solid waste land disposal facilities.

The first policy goal of Minn. Stat. § 17.80, subd. 1, relates to protection of agricultural lands from conversion to other uses. The net effect of the proposed rules will likely be to impede, indirectly, the conversion of agricultural lands to other uses.

The second policy goal of Minn. Stat. § 17.80, subd. 1, relates to resource protection. The proposed rules will advance this goal. The requirements of the proposed rules fit in well with statutory guidelines, which read in relevant part:

> The legislature finds that the policy in subdivision 1 will be best met by:
>
> . . . .
>
> (i) Guiding the orderly development of solid and hazardous waste management sites to meet the needs and safety of rural and urban communities and preserve agricultural land to the greatest possible extent by minimizing the use of agricultural land for waste management sites.

Minn. Stat. § 17.80, subd. 2 (1986).

Earlier discussion noted that cost increases will lower demand for agricultural lands that can serve as solid waste land disposal facility sites. The proposed rules will also help protect natural resources that are located near solid waste land disposal facilities. The proposed rules will require that solid waste land disposal facility owners and operators install and operate systems that protect the quality of ground water, surface water and air. The proposed fules will further require that solid waste land disposal facility owners and operators be prepared, physically and financially, to take corrective measures if any of the protective systems fail. These precautionary measures will greatly reduce impacts on nearby agricultural lands from solid waste land disposal facilities.

The Agency concludes that the proposed rules if adopted, will not have a direct and substantial adverse impact on agricultural land in the State.

IX. CONCLUSION

The Agency staff has in this document and its exhibits made its presentation of facts establishing the need for a reasonableness of the proposed rules governing solid waste facility permits and the design, operation and construction of solid waste facilities. This document constitutes the Agency's statement of need and reasonableness for the proposed rules.

Based on the foregoing, the proposed Minn. Rules pts. 7001.00200 to 7001.0190, 7001.3000 to 7001.3550 and 7035.0300 to 7035.2875 are both needed and reasonable.

Dated: February 12, 1988

for Barbara Lindsay Sims
Gerald L. Willet
Commissioner

X. LIST OF EXHIBITS

In drafting the proposed rules, the Agency relied on technical documents prepared by a number of sources. The following documents were utilized by Agency staff in developing these rules and are relied on by the Agency as further support for the reasonableness of the proposed rules. These documents are available for review at the Agency's Public Information Office at 520 Lafayette Road North, St. Paul, MN 55155

I. List of Landfills in the Open Dump Inventory: 1980 - 1985.

II. Position Papers on Solid Waste Management in Minnesota.

III. Responsiveness Summary of Discussions on Rule Development Issues.

IV. Summary of Response to Opinion Survey: October 1983.

V. Written Comments on November 22, 1983 Action Plan.

VI. Minnesota Pollution Control Agency Staff Comments on proposed solid waste legislation, April 2, 1984.

VII. General Mailings Soliciting Statements of Interest in Rulemaking Process: May 7, 1984 and December 27, 1984.

VIII. "Outside Opinion Sought Regarding Rules for Solid Waste Management Facilities," State Register Notices, May 14, 1984 and January 28, 1985.

IX. General Mailing Soliciting Opinions on Solid Waste Plans, Certificates of Need and Financial Assurance October 1, 1984; Written Responses.

X. General Mailing Soliciting Opinions on Ground Water Standards October 1, 1984; Written Responses.

XI. General Mailing Transmitting Revised Draft Rules and Soliciting Opinions, January 29, 1985.

XII. General Mailings Soliciting Opinions on Draft Industrial Waste Rules; June 18, 1985, July 1, 1985, and August 1, 1985.

XIII. General Mailing Announcing Public Information Meetings on Proposed Solid Waste Rules, July 23, 1985; Meeting Summaries.

XIV. Notice to Solid and Hazardous Waste Committee of the Minnesota Pollution Control Agency Board, August 23, 1985.

XV. Summaries of Public Information Meetings Held in February and March of 1986.

XVI. General Mailing Transmitting Revised Draft Rules and Soliciting Opinions, September 5, 1986.

XVII. Hydrological Assessment at a Sandplain Landfill. Eugene A. Hickock and Associates. February 1983.

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XIX. Minnesota Pollution Control Agency. "Guidelines for Hydrogeologic Investigations of Solid Waste Landfills." February 1985.

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XXXXV. Federal Register. "List (Phase 1) of Hazardous Constituents for Ground-Water Monitoring; Final Rule." vol. 52, no. 131. July 9, 1987. pp. 25942-25953.

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APPENDIX I.

MONITORING FOR VOLATILE ORGANIC COMPOUNDS AT MINNESOTA SANITARY LANDFILLS
BY BRUCE R. NELSON AND PAUL R. BOOK

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WASTE DIVISION

MONITORING FOR VOLATILE ORGANIC HYDROCARBONS AT MINNESOTA SANITARY LANDFILLS

Bruce R. Nelson1/ and Paul R. Book2/

In 1980, the Minnesota Pollution Control Agency (MPCA) initiated sampling and analysis for selected volatile organic hydrocarbon compounds (VOHs) at sanitary landfills. Samples from approximately half of Minnesota's 131 mixed municipal solid waste landfills have been analyzed for VOHs. Minnesota's sanitary landfills are almost exclusively unlined first generation landfills. The size of the studied sanitary landfills range from 2,000 to 1.6 million cubic yards per year. Most sites received mixed municipal solid waste only, although some have accepted hazardous waste. The hydrogeological settings of the sampled sanitary landfills include outwash, glacial till, lacustrine clay and bedrock. VOH data have been compiled and evaluated with respect to variables such as size and location of the facility. Individual VOHs were ranked according to their percent occurrence in all hydrogeologic settings and the data indicate that VOHs are ubiquitous in ground water downgradient of the studied sanitary landfills.

INTRODUCTION

Prior to the 1970's, the bulk of Minnesota's mixed municipal solid waste was disposed of in approximately 1,600 open dumps throughout the state. In 1970, the Minnesota Pollution Control Agency (MPCA) promulgated solid waste rules which required the closure of open dumps by 1972. In order to provide disposal capacity for solid waste, counties and large cities established sanitary landfills. A small number of the open dumps were converted to sanitary landfills. Since the early 1970's, the MPCA has permitted 131 mixed municipal solid waste sanitary landfills. These landfills are, with few exceptions, unlined facilities constructed directly in or on in-situ native soils.

Since the mid-1970's, monitoring of ground water near sanitary landfills has been a regulatory requirement of the MPCA. Initially, the MPCA required quarterly sampling and analysis for pH, specific conductance, chemical oxygen demand, chloride and nitrate as indicators of landfill leachate. Beginning in 1980, the MPCA sampled for volatile

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organic hydrocarbons (VOHs) at selected major metropolitan sanitary landfills to assess the usefulness of VOHs as indicators of landfill contamination (Sabel and Clark, 1984). In 1982, ammonia, sulfate and dissolved iron were added to the quarterly monitoring list. The MPCA also began to require sampling and analysis for an expanded list of inorganic compounds, metals and VOHs in alternate years.

LANDFILL CHARACTERISTICS

The sanitary landfills, for which VOH analytical data are available, range in size from 2,000 cubic yards per year for a rural site to 1,700,000 cubic yards per year for a facility serving the Minneapolis - St. Paul metropolitan area. The relative size of the landfills has been characterized by the average annual gate volume of mixed municipal solid waste received between 1980 and 1984. For sites which closed prior to or during this period, average annual gate volumes were calculated from available operational reports.

The size distribution of the landfills under study are shown in the Figures 1 and 2. Thirty-seven (61%) of the sites have an average annual gate volume of less than 100,000 cubic yards and serve predominantly rural areas (Figure 2.). Sites which serve the Minneapolis - St. Paul metropolitan area and those which receive solid waste from towns with a population greater than 25,000 are designated as metropolitan sites in Table 1.

Since 1973, MPCA regulations have prohibited the disposal of hazardous wastes in sanitary landfills other than those quantities generated in normal household use. Table 1 indicates whether a sanitary landfill is likely to have received hazardous waste in addition to mixed municipal solid waste. Sites are designated as either known to have received hazardous waste (21%), suspected of having received hazardous waste (21%), or not known to have received hazardous waste (57%). Sites were assigned to a catagory based on a review of MPCA files and discussions with MPCA inspectors and technical staff.

The predominant surficial geologic materials at each landfill are characterized in Table 1. Sites are designated as underlain by coarse granular materials, typically alluvium (54%); fine-grained soils, typically clay-rich glacial tills (16%); mixed stratified coarse-and fine-grained soils, typically morainal deposits (23%); and other geologic materials (7%). The surficial geology of each landfill was characterized through review of available geotechnical files and discussions with MPCA technical staff.

ANALYTICAL DATA

Of the 131 permitted mixed municipal sanitary landfills, ground water samples from 61 (47%) have been analyzed for VOHs. Samples were collected from landfill monitoring wells and, in several instances, from adjacent domestic wells. MPCA staff conducted the ground water sampling at 46 (75%) of these 61 sites. The Minnesota Department of Health (MDH) analyzed all the MPCA samples. The remaining 15 (25%) sites have been sampled and analyzed by independent analytical laboratories for compliance with MPCA permits or other regulatory actions. A total of 9 different independent laboratories have performed analyses for these 15 landfills. In general, analyses were performed using gas chromatography following USEPA methods 502.1, 503.1, 601 and 602, or variations thereof. Method detection limits were typically several micrograms per liter (parts per billion) or less.

Data for 51 VOHs are presented in Table 2. Because several laboratories did not distinguish between the different isomers of xylene and Cis-1,2-Dichloroethylene and Trans-1,2-Dichloroethylene, data for the individual isomers are compiled as either Total Xylenes or Cis/Trans-1,2-Dichloroethylene, respectively. Due to different monitoring requirements for different landfills, analytical data for all 51 VOHs are not available for all 61 sites. Data for all 51 VOHs exist for 38 (62%) of the landfills.

EVALUATION OF DATA

VOH analytical data were compiled for each of the 61 landfills to determine which VOHs had been detected in ground water samples for any sampling event. VOHs which were present in laboratory, travel or field quality assurance blanks were not tabulated. Maximum concentrations of individual VOHs have not been tabulated for this paper. The VOH analytical data have been evaluated for correlation between specific gravity and percent occurrence of each VOH compound (Figure 3) and number of VOH compounds detected versus average annual waste volume at the landfill site (Figure 4). In addition, population means were computed and compared to determine if hazardous waste at the landfill is associated with significantly more VOH compounds; if the underlying geology plays a significant role in detecting more VOH compounds; and if significantly more VOH compounds were found at either metropolitan or rural landfill sites (Table 3).

RESULTS

By examination, the correlation between data presented in Figures 3 and 4 is poor. Numerically, this observation is borne out. The correlation coefficient (r) between the specific gravity of the VOh compound and percent occurrence has a value of r=0.42. The correlation coeficient between the number of VOH compounds detected and average annual waste volume has a value of r=0.03.

Independence of population means was examined by t-test analysis at the 0.05 level and the estimated power of the t-test was calculated (Zar, 1982). Coefficients used in the t-test and for the estimated power test are listed in Table 3. For example, case 1 compares the VOHs found at those sites underlain by coarse-grained and fine-grained sediments. T-test analysis indicates there is a significant difference between the number of compounds found under these two hydrogeologic conditions. The estimated power of the t-test indicates there is an 80 percent chance of detecting a difference of at least 7.19 VOH compounds between the two population means.

For the underlying geology, Table 3 shows that there is a significant difference between the number of VOH compounds found at landfill sites underlain by coarse sediments and those underlain by fine sediments. There was no significant difference between the number of VOH compounds found at landfill sites underlain by coarse and mixed sediments and fine and mixed sediments. The similar number of VOH compounds found at fine and mixed sediment landfill sites is evident in Table 3. The absolute difference between the two population means is 1.24 and the estimated power of the t-test indicates only a six percent chance of detecting 1.24 additional VOH compounds.

T-test analysis has also shown that there was no significant difference in the number of VOHs detected between those landfills known to have taken hazardous wastes and those suspected of taking hazardous wastes. However, there were significantly more VOH compounds at sites with known or suspected hazardous wastes than those that did not receive these wastes. The estimated power of the t-test indicates the significance is greatest for those sites known to have taken the wastes.

There was no significant difference in the number of VOH compounds at metropolitan and non-metropolitan landfills. The lack of significantly different numbers of VOHs is emphasized by the 30 percent estimated power of the t-test.

CONCLUSIONS

Figure 3 shows a poor correlation between the specific gravity and the percent occurence of a given VOH compound. By observation, Figure 3 also indicates that the densest VOH compounds are rarely found. Monitoring wells at Minnesota's landfills are predominantly constructed to intercept the water table. The lack of dense VOH compounds in the data base may point to a need for more monitoring well nests.

The poor correlation between number of VOH compounds and average annual volume of waste at the landfill indicates that these compounds are ubiquitous to all landfill sites regardless of size. Similarly, there is no significant difference between the number of VOH compounds found at metropolitan area landfills and those in rural settings. This points to the large impact that household hazardous wastes may play in degrading the water quality at all landfills.

Significantly greater numbers of VOH compounds found at landfills underlain by coarse materials versus those underlain by fine materials, is most likely explained by the enhanced ability for these compounds to migrate in these higher permeable strata. From the powers testing, it would appear that the mixed and fine-grained sediments behave similarly in attenuating VOH compounds. Greater care in designing and installing monitoring wells to enhance recharge from coarser lenses in the mixed sediments may increase the number of VOHs to levels similar to those of wells constructed solely in coarse materials.

Regardless of the landfill setting, VOH compounds have been found at the vast majority of Minnesota landfills under study. Because of their presence in ground water, their mobility, their limited chemical interaction with the environment and their low analytical detection limits, VOHs serve as excellent indicators of ground water contamination at sanitary landfills.

SOURCES OF ERROR

Analytical data for samples collected from monitoring wells constructed of various materials are compiled in this study. Thus, in some cases, reported VOHs may be artifacts from a well's construction. Most notably, data from some PVC solvent-welded wells are included. This may cause VOHs, which are contained in solvent glues such as tetrahydrofuran, methyl isobutyl ketone and methyl ethyl ketone (Sosebee et al., 1982), to appear to be more common in ground water near landfills than is actually the case.

For many of the landfills, only one VOH sampling event has occurred. In these instances the presence of VOHs has not been confirmed by resampling and some reported VOHs may be false positives.

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KEYWORDS/INDEX

Ground Water Monitoring
Volatile Organic Hydrocarbons
Municipal Solid Waste Landfills
Ground Water Contamination Indicators
Household Hazardous Waste

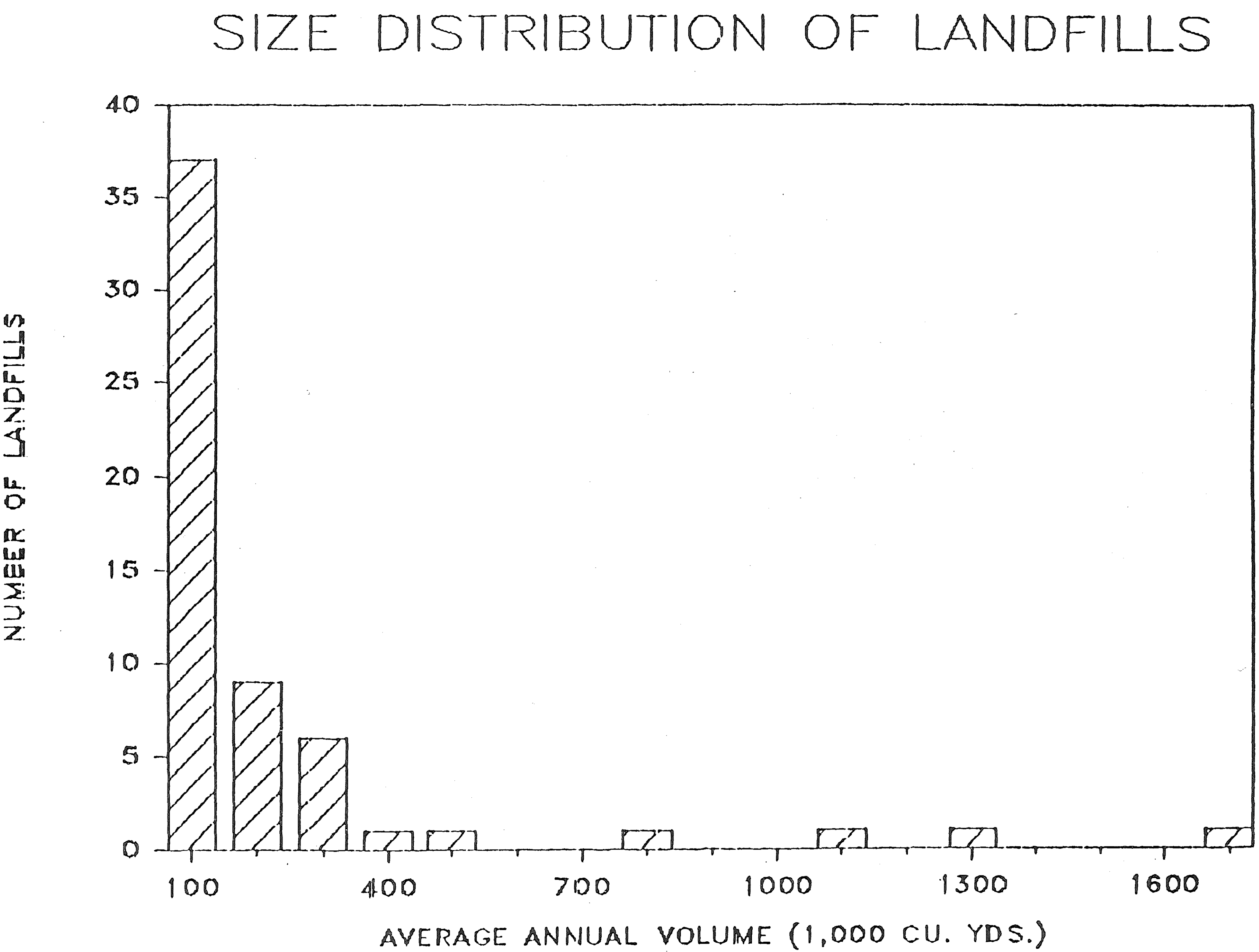
TABLE 1	TOTAL LANDFILLS	SURFICIAL MATERIALS			DISPOSAL OF HAZARDOUS WASTE			METRO AREA	
		COARSE	MIXED	FINE	YES	SUSPECTED	NO	YES	NO
NUMBER OF LANDFILLS (%)	61 (100%)	33 (54%)	10 (16%)	14 (23%)	13 (21%)	13 (21%)	35 (57%)	19 (31%)	42 (69%)
MEAN NUMBER OF VOHS DETECTED	12.66	15.55	9.60	8.36	19.77	15.23	9.06	15.95	11.17
STANDARD DEVIATION OF NUMBER OF VOHS DETECTED	8.15	8.63	6.55	5.65	8.26	7.15	6.32	8.98	7.39

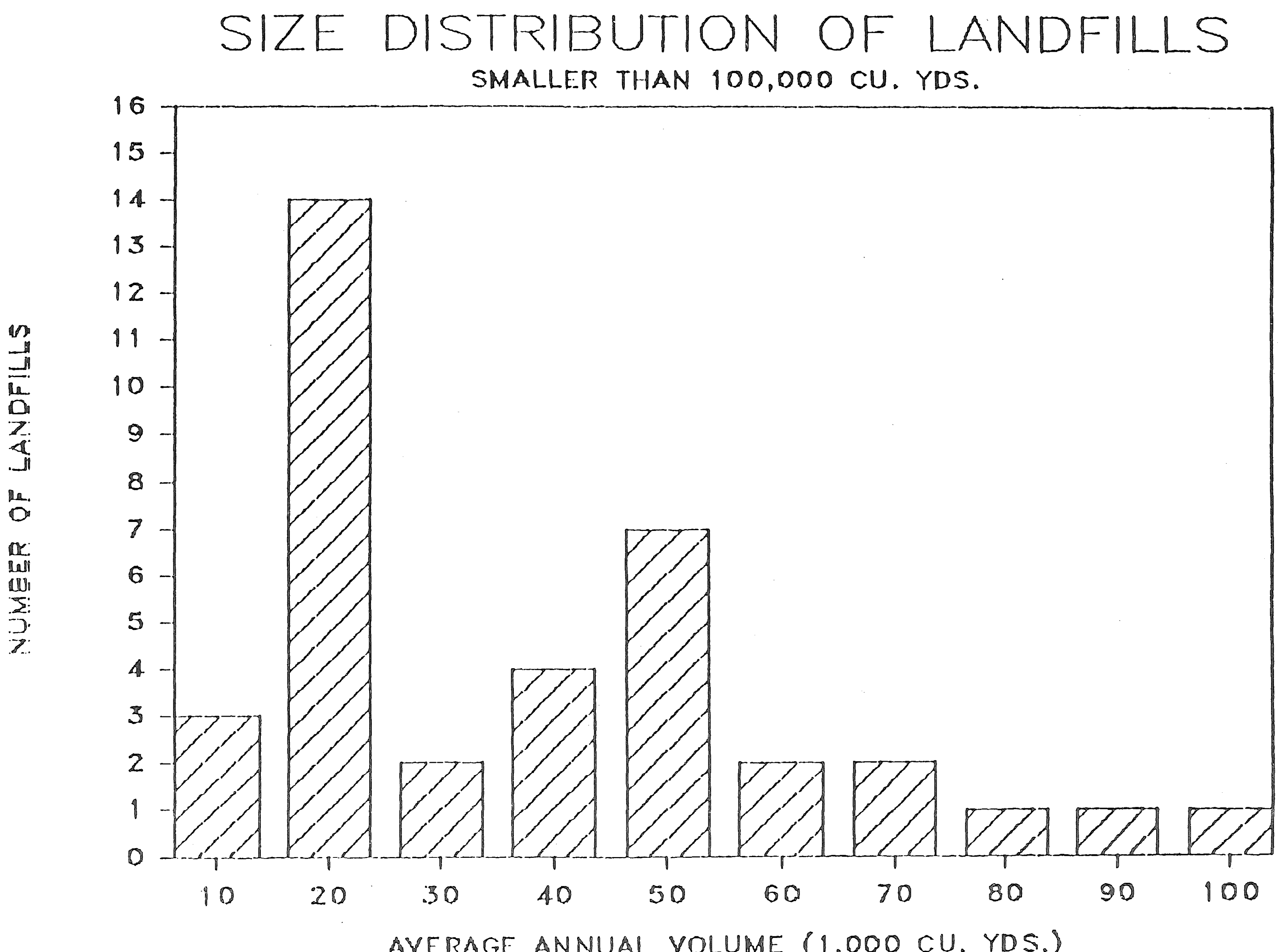
TABLE 2

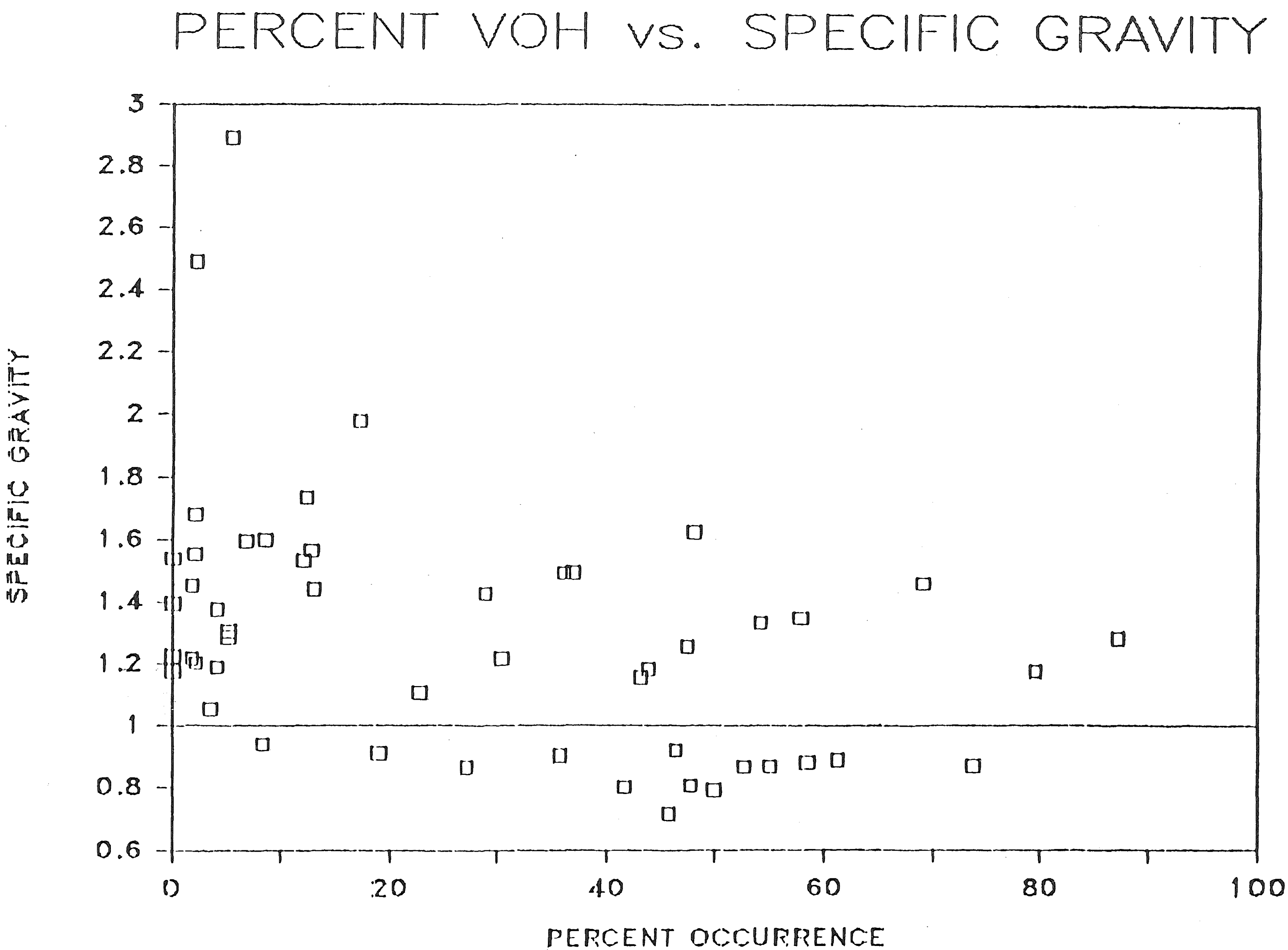
		Sites Present	Sites Tested	Calculated Percent Occurence	DENSITY
	1,2-Dibromoethane	0	52	0.00	1.5389
	1,2,3-Trichloropropane	0	49	0.00	1.394
*	Trans-1,3-Dichloro-1-Propene	0	58	0.00	1.224
	1,1-Dichloro-1-Propene	0	48	0.00	1.1764
*	Cis-1,3-Dichloro-1-Propene	1	58	1.72	1.217
*	Chlorodibromomethane	1	56	1.79	1.451
	Pentachloroethane	1	49	2.04	1.6796
	1,1,1,2-Tetrachloroethane	1	49	2.04	1.5532
	Dibromomethane	1	48	2.08	2.4921
	2,3-Dichloro-1-Propene	1	48	2.08	1.204
*	2-Chloroethyl Vinyl Ether	2	57	3.51	1.0525
*	1,3-Dichloropropane	2	49	4.08	1.1896
	Dichloroacetonitrile	2	48	4.17	1.374
*	1,2-Dichlorobenzene	3	58	5.17	1.3048
*	1,3-Dichlorobenzene	3	58	5.17	1.2881
*	Bromoform	3	55	5.45	2.8899
*	Carbon Tetrachloride	4	59	6.78	1.5942
	Allylchloride	4	48	8.33	0.9397
*	1,1,2,2-Tetrachloroethane	5	58	8.62	1.5964
	1,1,2-Trichlorotrifluoroethane	6	47	12.77	1.5635
*	1,4-Dichlorobenzene	7	58	12.07	1.533
*	Bromomethane	7	57	12.28	1.732
*	1,1,2-Trichloroethane	8	61	13.11	1.4405
*	Bromodichloromethane	10	58	17.24	1.98
*	Vinyl Chloride	11	58	18.97	0.9106
*	Chlorobenzene	13	57	22.81	1.1064
	Cumene	13	48	27.08	0.864
	Dichlorofluoromethane	13	45	28.89	1.426
*	1,1-Dichloroethylene	18	59	30.51	1.218
*	Chloroethane	20	56	35.71	0.9028
	Methyl Isobutyl Ketone	20	48	41.67	0.801
*	Trichlorofluoromethane	21	57	36.84	1.494
	Ethyl Ether	21	46	45.65	0.714
*	Chloroform	22	61	36.07	1.4916
	Methyl Ethyl Ketone	23	48	47.92	0.8054
	Acetone	24	48	50.00	0.7908
*	1,2-Dichloropropane	25	58	43.10	1.1558
*	Dichlorodifluoromethane	25	57	43.86	1.1834
*	Chloromethane	26	56	46.43	0.92
*	1,1,2,2-Tetrachloroethylene	26	54	48.15	1.623
*	1,2-Dichloroethane	28	59	47.46	1.256
	Total Xylenes	28	38	73.68	0.8684
*	Ethylbenzene	30	57	52.63	0.8672
	Tetrahydrofuran	30	49	61.22	0.888
*	Methylene Chloride	33	61	54.10	1.335
*	Toluene	33	60	55.00	0.8669
*	1,1,1-Trichloroethane	34	59	57.63	1.3492
*	Benzene	35	60	58.33	0.8787
*	1,1,2-Trichloroethylene	40	58	68.97	1.462
	Cis/Trans-1,2-Dichloroethylene	41	47	87.23	1.2837
*	1,1-Dichloroethane	47	59	79.66	1.1776

Key:

TABLE 3		Composite Sample Size	Degrees of Freedom	Absolute Difference Between Population Means	Conventional 5% Significance Level	T-test Significance	Estimated Power of T-test
1	Coarse-grained Sediments / Fine-grained Sediments	19.66	45	7.19	2.021	2.85	0.20 (80%)
2	Coarse-grained Sediments / Mixed Sediments	15.35	41	5.95	2.021	2.01	0.51 (49%)
3	Mixed Sediments / Fine-grained Sediments	11.67	22	1.24	2.064	0.50	0.94 (6%)
4	Hazardous Wastes—Yes / Hazardous Wastes—No	18.96	46	10.71	2.021	4.81	0.03 (97%)
5	Hazardous Wastes—Yes / Hazardous Wastes—Suspected	13	24	4.54	2.064	1.52	0.72 (28%)
6	Hazardous Wastes—Suspected / Hazardous Wastes—No	18.96	46	6.17	2.021	2.89	0.19 (81%)
7	Metropolitan Area / Non-metropolian (Rural) Area	26.16	59	4.78	1.671	2.19	0.70 (30%)

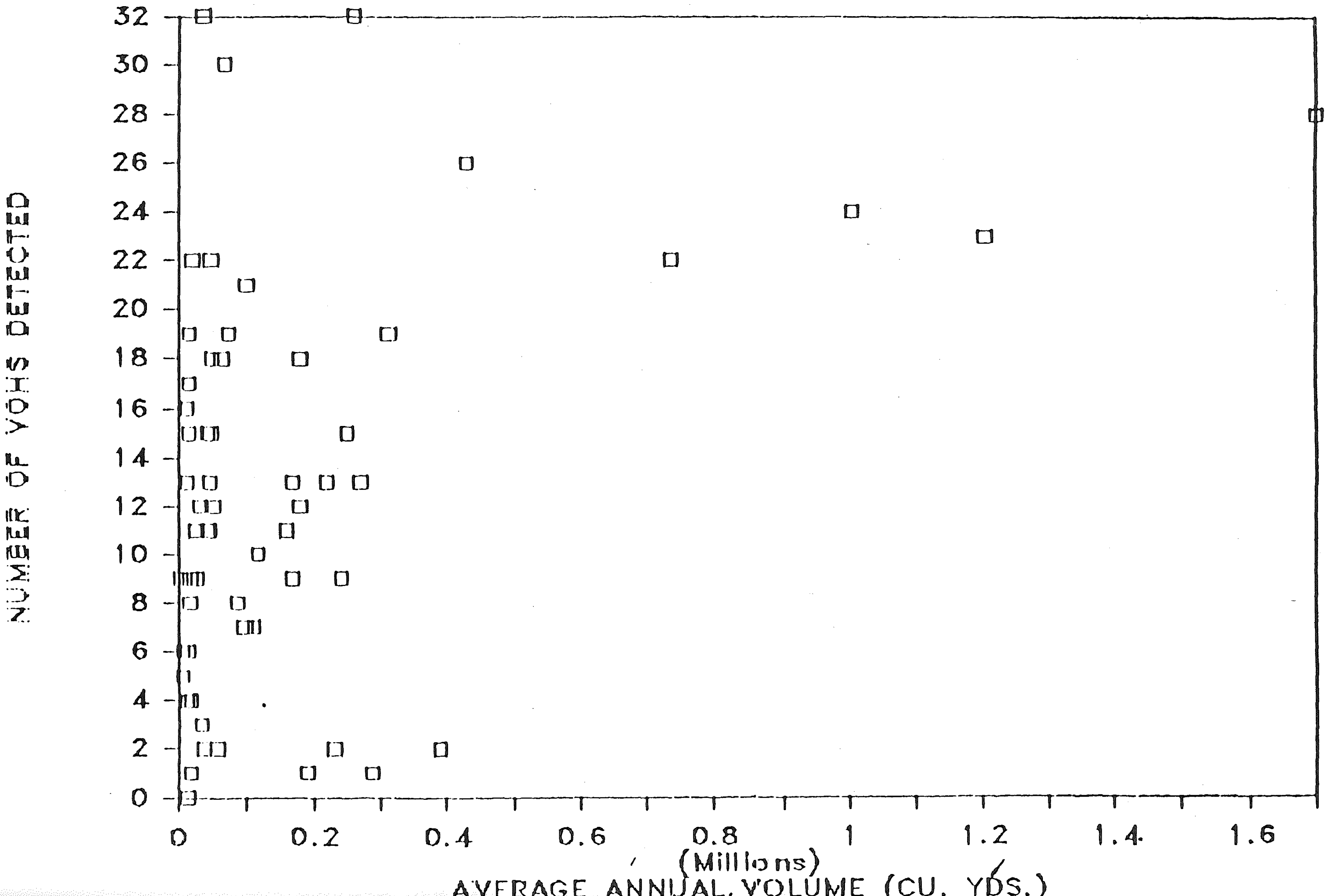

SIZE DISTRIBUTION OF LANDFILLS
40
35
30
25
20
15
10
5
0
NUMEER OF LANDFILLS
100
400
700
1000
1300
1600
AVERAGE ANNUAL VOLUME (1,000 CU. YDS.)


SIZE DISTRIBUTION OF LANDFILLS
SMALLER THAN 100,000 CU. YDS.
NUMBER OF LANDFILLS
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
10
20
30
40
50
60
70
80
90
100
AVERAGE ANNUAL VOLUME (1,000 CU. YDS.)



PERCENT VOH vs. SPECIFIC GRAVITY
SPECIFIC GRAVITY
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0
20
40
60
80
100
PERCENT OCCURRENCE

VOH OCCURRENCE vs. LANDFILL SIZE



APPENDIX II.

SCHEDULE OF PUBLIC INFORMATION MEETINGS HELD FOR DISCUSSION OF PROPOSED SOLID WASTE RULES

October 2, 1987

SOLID WASTE MANAGEMENT PROGRAM DEVELOPMENT HISTORY

Permit/Facility Standards/Financial Assurance

Date	Party	Action	Response
August 18, 1983	Interested Parties (mailing list)	Request for input in analyzing solid waste issues in Minnesota. Questionnaire enclosed.	Meeting summary Issues responsiveness summary
August 31, 1983	Metropolitan Council	Meeting on solid waste issues and questionnaire.	Meeting summary Issues responsiveness summary
September 2, 1983	Minnesota Waste Association and Landfill Operators	Meeting on solid waste issues and questionnaire.	Meeting summary Issues responsiveness summary
September 7, 1983	State Planning Agency: Water Planning Board, Southern Minnesota Rivers Basin Council	Meeting on solid waste issues and questionnaire.	Meeting summary Issues responsiveness summary
September 8, 1983	Citizens League	Meeting on solid waste issues and questionnaire.	Meeting summary Issues responsiveness summary
September 9, 1983	Minnesota Association of County Planning and Zoning Administrators (St. Cloud)	Meeting on solid waste issues and questionnaire.	Meeting summary Issues responsiveness summary
September 12, 1983	Recycling Association of Minnesota	Meeting on solid waste issues and questionnaire.	---
September 13, 1983	League of Cities	Meeting on solid waste issues and questionnaire.	Meeting summary Issues responsiveness summary
September 14, 1983	Waste Management Board	Meeting on solid waste issues and questionnaire.	Meeting summary Issues responsiveness summary

Date	Party	Action	Response
September 16, 1983	County Chairpersons	Request for input in analyzing solid waste issues in Minnesota. Questionnaire enclosed.	Issues responsiveness summary
September 16, 1983	County Zoning Administrators	Request for input in analyzing solid waste issues in Minnesota. Questionnaire enclosed.	Issues responsiveness summary
September 16, 1983	Selected Mailing (mailing list)	Request for input in analyzing solid waste issues in Minnesota. Questionnaire enclosed.	Issues responsiveness summary
September 20, 1983	Minnesota Department of Health	Meeting on solid waste issues and questionnaire.	Meeting summary Issues responsiveness summary
September 22, 1983	Minnesota Soft Drink Association	Meeting on solid waste issues and questionnaire.	Meeting summary Issues responsiveness summary
September 22, 1983	Dr. Ray Thron Minnesota Department of Health	Request for input in analyzing solid waste issues in Minnesota. Questionnaire enclosed.	Issues responsiveness summary
September 28, 1983	Scott County Solid Waste Officer	Meeting on solid waste issues and questionnaire.	Meeting summary Issues responsiveness summary
September 28, 1983	MICA	Meeting on solid waste issues and questionnaire.	---
September 29, 1983	Hennepin County Solid Waste Officials	Meeting on solid waste issues and questionnaire.	Meeting summary Issues responsiveness summary
October 4, 1983	Dakota County Solid Waste Officer; Washington County Planning	Meeting on solid waste issues and questionnaire.	Meeting summary Issues responsiveness summary

Date	Party	Action	Response
November 21, 1983	Browning Ferris Industries	Meeting on solid waste issues and questionnaire.	Meeting summary Issues responsiveness summary
December 16, 1983	Interested Parties (mailing list)	Request for comments on proposed MPCA solid waste management program changes.	Issues responsiveness summary
January 19, 1984	Interested Parties (mailing list)	Copy of MPCA board item regarding MPCA position on State solid waste legislation.	---
May 7, 1984	Selected Parties (mailing list)	Soliciting comments on rulemaking activities asked to reaffirm interest in rulemaking by returning form with areas of interest marked.	Solid waste rules interested party mailing list
May 14, 1984	State Register	Notice of Intent to Solicit Outside Opinion.	---
June 25, 1984	Tri-County Solid Waste Planning Group: Stearns-Sherburne-Benton (Foley)	Meeting on proposed financial assurance rule.	---
July 15, 1984	Metropolitan Inter-County Association	Meeting on proposed financial assurance rule.	---
October 1, 1984	Selected Mailing (mailing list)	Soliciting comments on draft ground water policy and its application to landfill rules. Draft copies of policies attached.	---

Date	Party	Action	Response
October 1, 1984	Solid Waste Rules Mailing List	Soliciting comments on issues and options for the financial assurance draft rule.	Rule responsiveness summary
October 2, 1984	Waste Management Board	Meeting on rough draft of rule and issues and options for draft rule.	Rule responsiveness summary
October 3, 1984	Metropolitan Council	Meeting on rough draft of rule and issues and options for draft rule.	Rule responsiveness summary
October 14, 1984	Selected Mailing	Meeting on rough draft of rule and issues and options for draft rule.	Rule responsiveness summary
November 6, 1984	Waste Management, Inc.	Meeting on issues and options for the draft financial assurance rule.	Rule responsiveness summary
November 9, 1984	Minnesota Chapter - GRCDA	Presentations of all rules as envisioned.	---
November 19, 1984	Waste Management Board Insurance Committee	Financial assurance draft rule discussed.	---
December 4, 1984	Crow Wing County Board (Brainerd)	Meeting on solid waste rule development.	Meeting summar Rule responsiveness summary
December 5, 1984	Metropolitan Inter-County Association	Meeting on solid waste rule development.	Meeting summar Rule responsiveness summary
December 6, 1984	East Central Multi-County Task Force: Isanti, Pine, Chisago, Kanabec, and Mille Lac Counties (Cambridge)	Meeting on financial assurance draft rule.	Meeting summar Rule responsiveness summary

Date	Party	Action	Response
December 11, 1984	Winona County Board (Winona)	Meeting on proposed financial assurance rule.	---
December 12, 1984	Mower County Incinerator Committee (Austin)	Meeting on solid waste rule development.	Meeting summary Rule responsiveness summary
December 12, 1984	Selected Mailing	Soliciting meeting for rule discussion.	---
December 21, 1984	Earth Protector, Inc.	Meeting on solid waste rule development.	Rule responsiveness summary
December 27, 1984	Selected Mailing - Environmental Groups	Soliciting comments on rulemaking activities. Ask to reaffirm interest in rulemaking by returning form with areas of interest marked.	---
January 10, 1985	Solid Waste Planning Committee: LeSueur, Brown, and Nicollet Counties (Le Center)	Meeting on financial assurance draft rule.	Meeting summary Rule responsiveness summary
January 17, 1985	Southwest RDC - Lincoln, Pipestone, Rock, Lyon, Murray, Nobles, Redwood, Cottonwood, and Jackson Counties (Slayton)	Meeting on financial assurance draft rule.	Meeting summary Rule responsiveness summary
January 24, 1985	Pennington, Marshall, Red Lake, Roseau and Polk Counties (Thief River Falls)	Meeting on financial assurance draft rule.	Meeting summary Rule responsiveness summary
January 24, 1985	Mahnomen, Beltrami, Hubbard, Clearwater Counties (Bemidji)	Meeting on financial assurance draft rule.	Meeting summary Rule responsiveness summary

Date	Party	Action	Response
January 25, 1985	Clay, Otter Tail, Wilkin, Grant, Pope and Douglas Counties (Fergus Falls)	Meeting on financial assurance draft rule.	Meeting summary Rule responsiveness summary
January 28, 1985	State Register	Notice of Intent to Solicit Outside Opinion.	---
January 29, 1985	Rules Mailing List	Request for comments on enclosed draft financial assurance rule.	Written comments received
February 1, 1985	Martin, Watonwan, and Faribault Counties, City of Fairmont, Emmet County, Iowa (Fairmont)	Meeting on financial assurance draft rule.	Meeting summary Rule responsiveness summary
February 20-21, 1985	Second Annual MPCA Solid Waste Seminar (Bloomington)	Presentation of all draft rules.	---
February 27, 1985	Technical Review Panel Financial Assurance Rule (panel was composed of bankers, insurance company representatives, and surety representatives)	Meeting on financial assurance rule.	Meeting summary Rule responsiveness summary
March 20, 1985	Waste Management, Inc.	Meeting on draft financial assurance rule.	---
March 20, 1985	County Board Chairpersons and Solid Waste Officers	Notice of meeting of Board Rules Committee.	---
March 21, 1985	Tri-County Solid Waste Management Commission: Benton, Sherburne, and Stearns Counties (Foley)	Meeting on draft financial assurance rule.	Meeting summary Rule responsiveness summary
March 22, 1985	National Solid Wastes Management Association	Meeting to discuss draft financial assurance rule.	---

Date	Party	Action	Response
March 23, 1985	National Solid Wastes Management Association (Bloomington)	Presentation on draft financial assurance rule.	---
April 8, 1985	Anoka County Solid Waste Officer, County Attorney (Anoka)	Meeting on draft financial assurance rule.	---
April 11, 1985	Inter-Agency Toxics Committee	Discussion of ground water performance standards.	---
April 11, 1985	Metalcasters	Meeting on technical, codisposal rules.	---
April 25, 1985	Inter-Agency Toxics Committee	Discussion of ground water performance standards.	---
May 2, 1985	Evensen-Dodge, Inc.	Meeting on draft financial assurance rule.	
May 14, 1985	Inter-Agency Toxics Committee	Discussion of ground water performance standards.	---
May 22-23, 1985	Wisconsin DNR (Madison, Wisconsin)	Discussion of financial assurance, technical rules.	---
June 11, 1985	Inter-Agency Toxics Committee	Meeting to discuss ground water performance standards.	---
June 14, 1985	Agency Mailing List	Notice of Meeting of Solid and Hazardous Waste Committee (June 24, 1985).	---
June 24, 1985	MPCA Solid and Hazardous Waste Committee Meeting	Overview of financial assurance rule.	---
June 27, 1985	Legislative Commission on Waste Management	Financial assurance rule.	---

Date	Party	Action	Response
July 1, 1985	City of Sauk Centre (Sauk Centre)	Meeting on draft financial assurance rule.	
July 1, 1985	Rules Mailing List	Request for comments on enclosed draft permit rule.	Written comments received
July 16, 1985	Local Chapter of National Solid Wastes Management Association	Meeting to discuss financial assurance.	---
July 16, 1985	Inter-Agency Toxics Committee	Meeting to discuss ground water performance standards.	---
July 17, 1985	Local Chapter of National Solid Wastes Management Association	Meeting to discuss financial assurance.	---
July 19, 1985	National Solid Wastes Management Association, (Bloomington)	Solid waste seminar, presentation on solid waste program (Dale Wikre)	---
July 22, 1985	Minnesota Health Department Analytical Services	Meeting to discuss monitoring of ground water at mixed municipal landfills.	---
July 23, 1985	Rules Mailing List	Notice of regional public information meetings (Aug./Sept.).	---
July 25, 1985	Selected Well Drillers/ Geotechnical Companies	Meeting to discuss monitoring of ground water at mixed municipal landfills.	---
July 29, 1985	Selected Analytical Laboratories	Meeting to discuss monitoring of ground water at mixed municipal landfills.	---

Date	Party	Action	Response
August 1, 1985	Rules Mailing List	Request for comments on enclosed draft technical standards, codisposal, and financial assurance rules. Notice of August/September informational meetings.	Written comments received
August 8, 1985	Local Chapter of National Solid Wastes Management Association	Meeting to discuss financial assurance rule.	---
August 13, 1985	General Public, Consultants, Solid Waste Officers, County Commissioners, Facility Operators (Roseville)	Public information meeting to review permit, facility standards, codisposal, and financial assurance rules.	---
August 14, 1985	Consultants, Facility Operators, Others Technically Inclined (Roseville)	Meeting to discuss facility standards, codisposal, and financial assurance.	Meeting summary Rule responsiveness summary
August 14, 1985	Waste Management, Inc.	Meeting to discuss financial assurance legislative proposal.	---
August 15, 1985	Anoka County Solid Waste Officer, County Attorney (Anoka)	Meeting on draft financial assurance rule.	---
August 16, 1985	AMC Physical Development/Environmental Committee (Brooklyn Park)	Meeting to discuss all rules.	---
August 21, 1985	Local Elected Officials, County Commissioners, Solid Waste Officers, Consultants, Facility Operators (Owatonna)	Public information meeting on draft solid waste rules.	Meeting summary Rule responsiveness summary

Date	Party	Action	Response
August 22, 1985	Local Elected Officials, County Commissioners, Solid Waste Officers, Consultants, Facility Operators (Marshall)	Public information meeting on draft solid waste rules.	Meeting summary Rule responsiveness summary
August 28, 1985	Local Elected Officials, County Commissioners, Solid Waste Officers, Consultants, Facility Operators (Thief River Falls)	Public information meeting on draft solid waste rules.	Meeting summary Rule responsiveness summary
August 29, 1985	Local Elected Officials, County Commissioners, Solid Waste Officers, Consultants, Facility Operators (Fergus Falls)	Public information meeting on draft solid waste rules.	Meeting summary Rule responsiveness summary
September 5, 1985	Inter-Agency Toxics Committee	Meeting to discuss ground water performance standards.	---
September 11, 1985	Local Elected Officials, County Commissioners, Solid Waste Officers, Consultants, Facility Operators (St. Cloud)	Public information meeting on draft solid waste rules.	Meeting summary Rule responsiveness summary
September 12, 1985	Local Elected Officials, County Commissioners, Solid Waste Officers, Consultants, Facility Operators (Grand Rapids)	Public information meeting on draft solid waste rules.	Meeting summary Rule responsiveness summary
September 18, 1985	Minnesota Association of Commerce and Industry Environmental Committee	Meeting to discuss codisposal, planning/ certificate of need rules.	---

Date	Party	Action	Response
September 23, 1985	Agency Mailing List	Notice of meeting of MPCA Board Solid and Hazardous Waste Committee (Oct. 3 & 4, 1985).	---
September 24, 1985	Trust Companies	Meeting to discuss financial assurance rule.	---
September 25, 1985	General Public Consultants, Solid Waste Officers, Facility Operators, County Commissioners (Roseville)	Public information meeting on draft solid waste rules.	Meeting summary Rule responsiveness summary
September 30, 1985	Waste Management, Inc.	Meeting to discuss financial assurance legislative proposal.	---
October 3-4, 1985	MPCA Solid & Hazardous Waste Committee (Grand Rapids)	Discussion of financial assurance, facility standards, permit rules.	Meeting summary Rule responsiveness summary
October 16, 1985	Minnesota Association of Commerce and Industry	Meeting to discuss facility standards, financial assurance, codisposal, permit rules.	---
October 29, 1985	Metropolitan Council Staff	Discussion of compost rule.	---
October 31, 1985	Metropolitan Council Staff	Discussion of financial assurance, facility standards, permit rules.	
October/November, 1985	Attendees of public information meetings August/September, 1985	Phone conversations to solicit comments about the meetings and the rules.	Evaluation summary.
November 5, 1985	Legislative Commission on Waste Management	Meeting to discuss financial assurance legislative proposal.	---

Date	Party	Action	Response
November 6, 1985	Inter-Agency Toxics Committee	Meeting to discuss ground water performance standards.	---
November 7, 1985	Waste Management, Inc.	Meeting to discuss financial assurance legislative proposal.	---
November 18, 1985	McLeod County Solid Waste Advisory Committee (Glencoe)	Meeting to discuss financial assurance rule.	---
November 21, 1985	National Solid Wastes Management Association/ Waste Management, Inc.	Meeting to discuss proposed financial assurance legislation.	---
December 12, 1985	Association of Minnesota Counties/ National Solid Wastes Management Association (Arden Hills)	Presentation of MPCA solid waste program directions, including rules (Ed Meyer).	---
December 19, 1985	Association of Minnesota Counties	Meeting to discuss financial assurance legislation.	---
January 7, 1986	Association of Minnesota Counties	Meeting to discuss financial assurance legislation.	---
January 8, 1986	Metropolitan Inter-County Association	Meeting to discuss financial assurance legislation.	---
January 9, 1986	National Solid Wastes Management Association	Meeting to discuss financial assurance legislation.	---
January 10, 1986	Waste Management Board Solid Waste Advisory Committee	Meeting to discuss financial assurance legislation.	---
January 10, 1986	Waste Management, Inc.	Meeting to discuss financial assurance legislation.	---

Date	Party	Action	Response
January 13, 1986	Association of Minnesota Counties	Meeting to discuss financial assurance legislation.	---
January 14, 1986	Inter-Agency Toxics Committee	Meeting to discuss ground water performance standards.	---
January 15, 1986	Legislative Commission on Waste Management	Hearing for financial assurance legislation.	---
January 22, 1986	Southwest Regional Development Commission (Slayton)	Meeting on draft financial assurance rule, proposed legislation.	---
January 23, 1986	Agency Mailing List	Notice of meeting of MPCA Board Solid and Hazardous Waste Committee on codisposal rule.	---
January 23, 1986	Legislative Commission on Waste Management	Meeting to discuss proposed financial assurance legislation.	---
January 27, 1986	Association of Minnesota Counties Annual Convention	Presentation of MPCA position on financial assurance (Dale Wikre).	---
January 27, 1986	MPCA Board Solid and Hazardous Waste Committee Meeting	Discussion of codisposal rule.	---
January 28, 1986	Inter-Agency Toxics Committee	Meeting to discuss ground water performance standards.	---
February 5, 1986	County Commissioners, Solid Waste Officers, Solid Waste Professionals (Rochester)	Solid waste working session.	Session Summary

Date	Party	Action	Response
February 6, 1986	County Commissioners, Solid Waste Officers, Solid Waste Professionals (Eveleth)	Solid waste working session.	Session Summary
February 7, 1986	County Commissioners, Solid Waste Officers, Solid Waste Professionals (Walker)	Solid waste working session.	Session Summary
February 12, 1986	County Commissioners, Solid Waste Officers, Solid Waste Professionals (Mankato)	Solid waste working session.	Session Summary
February 19, 1986	Agency Mailing List	Notice of MPCA Solid and Hazardous Waste Committee meeting on codisposal and permit rules.	---
February 19-20, 1986	Third Annual MPCA Solid Waste Seminar (Bloomington)	Update of all draft rules. Presentation of adopted planning/ certificate of need rule.	---
February 24, 1986	MPCA Board Solid and Hazardous Waste Committee	Discussion on permit and codisposal rules.	---
March 5, 1986	County Commissioners, Solid Waste Officers, Solid Waste Professionals (St. Cloud)	Solid waste working session.	Session Summary
March 6, 1986	County Commissioners, Solid Waste Officers, Solid Waste Professionals (Thief River Falls)	Solid waste working session.	Session Summary
March 6, 1986	Landfill Operators, County Solid Waste Officers	Request for comments on redraft of codisposal rule.	---

Date	Party	Action	Response
March 7, 1986	County Commissioners, Solid Waste Officers, Solid Waste Professionals (Fergus Falls)	Solid waste working session.	Session Summary
March 13, 1986	County Commissioners, Solid Waste Officers, Solid Waste Professionals (Slayton)	Solid waste working session.	Session Summary
March 14, 1986	County Commissioners, Solid Waste Officers, Solid Waste Professionals (Montevideo)	Solid waste working session.	Session Summary
March 20, 1986	County Commissioners, Solid Waste Officers, Solid Waste Professionals (Roseville)	Solid waste working session.	Session Summary
April 7, 1986	Browning-Ferris, Inc. (Eden Prairie)	Discussion of all technical rules.	---
April 9, 1986	Consulting Engineers Council	Discussion of all technical rules.	
April 15, 1986	McLeod County Board (Glencoe)	Meeting on draft financial assurance rule.	---
April 17, 1986	Waste Management, Inc.	Discussion on codisposal rule.	---
April 17, 1986	Consulting Engineers Council	Discussion of all technical rules.	---
April 21, 1986	Association of Minnesota Counties (Montevideo)	Financial assurance rule.	---
April 23, 1986	Contingency Action Pool Policy Group	Meeting to discuss financial assurance legislation.	---

Date	Party	Action	Response
May 5, 1986	Metropolitan Inter-County Association Environment Committee	Meeting to discuss technical, codisposal, and financial assurance rules.	---
May 8, 1986	Minnesota Association of County Solid Waste Officers	Financial assurance/ risk pool meeting.	---
May 21, 1986	Contingency Action Pool Policy Group	Meeting to discuss financial assurance legislation.	---
June 20, 1986	Association of Minnesota Counties Policy Committee	Financial assurance/ risk pool and rules.	---
June 26, 1986	Contingency Action Pool Policy Group	Meeting to discuss financial assurance legislation.	---
July 30, 1986	Jim Morgan, Attorney for Waste Management, Inc.	Meeting to discuss the rules.	---
July 31, 1985	Contingency Action Pool Policy Group	Meeting to discuss financial assurance legislation.	---
August 31, 1986	Contingency Action Pool Policy Group	Meeting to discuss financial assurance legislation.	---
September 5, 1986	Rules Mailing List	Request for input into draft solid waste rules and notice of October meetings.	---
September 5, 1986	Risk Pool Work Group	Risk pool meeting.	---
September 11, 1986	Risk Pool Work Group	Risk pool meeting.	---
September 19, 1986	National Solid Wastes Management Association	Rules update meeting.	---

Date	Party	Action	Response
September 23, 1986	Browning Ferris Industries	Risk pool meeting.	---
September 24, 1986	Risk Pool Work Group	Risk Pool meeting.	---
October 2, 1986	Minnesota Association of County Solid Waste Officers (St. Cloud)	Rules update meeting.	---
October 5, 1986	Buhler-Miag (Eden Prairie)	Meeting on compost rule.	---
October 8, 1986	Rules Mailing List (Duluth)	Public information meeting on final draft of solid waste rules.	Meeting Summary
October 9, 1986	Rules Mailing List (Brainerd)	Public information meeting on final draft of solid waste rules.	Meeting Summary
October 15, 1986	Rules Mailing List (Marshall)	Public information meeting on final draft of solid waste rules.	Meeting Summary
October 16, 1986	Rules Mailing List (Detroit Lakes)	Public information meeting on final draft of solid waste rules.	Meeting Summary
October 20, 1986	Minnesota Department of Natural Resources Staff	Meeting to discuss the rules.	---
October 22, 1986	Rules Mailing List (Rochester)	Public information meeting on final draft of solid waste rules.	Meeting Summary
October 23, 1986	Rules Mailing List (St. Paul)	Public information meeting on final draft of solid waste rules.	Meeting Summary
October 28, 1986	Risk Pool Work Group	Risk Pool meeting.	---

Date	Party	Action	Response
November 14, 1986	Rules Mailing List	Letter extending comment period for rules and explaining rulemaking process.	---
November 17, 1986	Agency Mailing List	Notice of November 24, 1986, MPCA Solid and Hazardous Waste Committee meeting on rules.	---
November 20, 1986	Risk Pool Work Group	Risk pool meeting.	---
November 24, 1986	MPCA Board Solid and Hazardous Waste Committee	Update on final draft of all proposed rules, discussion of ground water performance standards.	---
November 26, 1986	Minnesota Waste Management Board	Discussion of compost rules.	---
December 5, 1986	Rules Mailing List	Notice of December 15, 1986 MPCA Solid and Hazardous Waste Committee meeting on rules.	---
December 15, 1986	MPCA Board Solid and Hazardous Waste Committee	Discussion of financial assurance rules.	---
December 17, 1986	Hubbard County Board of Commissioners	Explanation of financial assurance rules and financial instruments.	---
January 14, 1987	Consulting Engineers Council	Update on rules schedule, discussion of technical rules.	---
January 20, 1987	Association of Minnesota Counties Annual Meeting	Presentation on rules, focusing on financial assurance and rulemaking history.	---
January 23, 1987	BFI, Inc.	Discussion on rules.	---

Date	Party	Action	Response
January 28, 1987	MPCA Landfill Ad Hoc Committee	Discussion on rules.	---
February 19, 1987	Fourth Annual MPCA Solid Waste Seminar (Bloomington)	Solicit comments on rules before finalizing.	---
March 3, 1987	People Having Submitted Written Comments	Letter inviting to a last meeting on draft rules.	---
March 16, 1987	Larry Johnson (AIPG)	Hydrogeologist certification.	Work on Language Change
March 18-19, 1987	Commentors	Solicit comments on language of draft rules.	Meeting Summary
March 24, 1987	NSWMA	Rules.	---
July 15, 1987	League of Cities/ Association of Minnesota Counties	Financial assurance.	---
July 22, 1987	Consulting Engineers Council	Leachate treatment.	---
August 31, 1987	E.I. du Pont de Nemours and Company	Liner design.	Work on Language
September 25, 1987	GRCDA	Rules.	---
September 30, 1987	Consulting Engineers Council	Financial assurance.	---

APPENDIX III.

SOLID WASTE MANAGEMENT: INTRODUCTION TO ISSUES AND STAFF ACTIONS

COLOR CODE:
Blue = DWQ
Yellow = DAQ
Green = DSHW
Pink = Other
Gold = Info

MINNESOTA POLLUTION CONTROL AGENCY

Agenda Item Control Sheet

AGENDA # i

Board/Staff Retreat
MEETING DATE: September 16, 1983

APPEARANCE REQUESTED - Yes: ____ No: X
SCHEDULED TIME: 8:30 a.m.

PREPARED BY: Myrna Halbach

DATE PREPARED: September 6, 1983
DATE MAILED : September 8, 1983

SUBJECT: Solid Waste Management: Introduction to Issues and Staff Actions

LOCATION: Roseville (City) Ramsey (County)

TYPE OF ACTION:

Permit		Request for hearing		New	
Stipulation		Request for legal action		Modification	
Contract		Variance request		Extension	
Policy		Rulemaking		Revocation	
Information	X	Administrative order		Other	

RECOMMENDED ACTION:

Issuance		Approval		No action needed	X
Denial		Authorization			

ISSUE STATEMENT: The Solid and Hazardous Waste Division is currently reviewing the status of solid waste management in Minnesota. This effort entails the review of proposed legislation as well as the Agency's existing solid waste policies and rules. The proposed legislation addresses procedures for encouraging recycling and resource recovery through waste abatement techniques including planning, market development, and education. Additionally, closure, post-closure, and contingency funds would be established. In the ensuing weeks and months, the Agency will need to form positions on proposed legislation and on new rules and policies reflecting the latest advances in solid waste technology.

ATTACHMENTS:

1. Solid Waste Insights and Issues, July 20, 1983
2. House File 695
3. House File 1361
4. Solid Waste Issues Questionnaire
5. Mailing List

Attachment 1

SOLID WASTE INSIGHTS AND ISSUES

July 20, 1983

MINNESOTA
POLLUTION CONTROL
AGENCY

1935 West County Road B2
Roseville, Minnesota 55113

FOREWORD

The fact sheets as presented in this package represent the staff effort to provide a condensed summary of major solid waste issues in terms of the present status, current trends, anticipated actions, and current problems. Legislative issues are presented in a tabular format to allow efficient comparisons. It is intended that these critical evaluations will be thought provoking and will break the ground for much needed creative discussion to help establish the direction for an improved solid waste program. The reader is encouraged to critically examine these issues, develop a sense for resolving the inherent problems, and provide guidance in defining the Agency goals and objectives in the solid waste arena.

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Enforcement	16
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Potential Legislative Issues - 1984	24

Addenda: Proposed Legislation and Summaries

SF 697 Waste Tires
HF 683 Container Deposit
HF 695 Solid Waste Abatement
SF 1312 Solid Waste Abatement

SOLID WASTE FACT SHEET
Solid Waste Management

Issue: Technology for improving Minnesota's management of solid waste problems exists, but economic, political, and social constraints are holding up progress in implementing what we have learned. We need to change our attitude towards waste disposal if we are to apply new know-how to our solid waste management problems.

Present Status: Solid waste management consists of the managing of the handling, processing, and disposal of solid waste materials. Each day approximately 10,600 tons of solid waste are generated statewide. See Table 1 for a breakdown on what constitutes solid waste. In accordance with Minnesota Statutes Chapter 400, the county shall take the primary role in solid waste management for their area of jurisdiction. The counties use a county solid waste management plan for planning purposes, and a county solid waste ordinance for enforcement purposes. The county shall also by statute enforce any and all Agency rules. In theory, the Agency then assumes a position of leadership throughout the state to assist the county authorities in solid waste matters. The Agency possesses a level of expertise greater than that found in most communities and make it available when appropriate. Other regulatory authorities are scarce, but the legislature allowed the Western Lake Superior Sanitary District to be created and has provided for the creation of other waste management districts in the future under the Waste Management Act, provided that the waste will be directed to a waste reduction type facility.

In theory, this method of solid waste management sounds ideal, however, in practice it falls apart. There is a wide variance as to what degree each county participates in solid waste management, resulting in numerous discrepancies throughout the state. As an example, there are still more than 200 active unpermitted dumps throughout the state of which 60 were published in the Federal Register under the RCRA open dump inventory. Additionally, some counties have failed to enact or update county solid waste ordinances or in practice fail to enforce their ordinance. This situation is especially important since Chapter 400 requires each county to provide financial assurances for land disposal facilities and most have failed to do so. The poor track record of counties was exemplified in 1982 when Blue Earth County failed to act on a bond they had with Hansen Landfill to initiate proper closure of the facility. Furthermore, most county solid waste management plans were enacted prior to 1973 and are now ten years old or more. During this period, many existing permitted facilities throughout the state approached or have reached permitted capacity. This has resulted in a "near" crisis situation in the Duluth and St. Cloud areas as well as the Rochester and metropolitan Agency regions.

Current Trends: Solid waste management in Minnesota is approaching a crisis situation. The popular belief of the early 1970s that a sanitary landfill designed and operated in accordance with Minnesota Rule SW-6 will not pollute the environment has come into widespread dispute by the monitoring data facts. Based on this, the Agency is now writing new or upgraded permits which may cost from $10,000 to $100,000 or more for engineering design and implementing costs and an unknown but substantial amount during the life of the permit. The private operator, when faced with such costs, routinely threatens to close unless the county buys the facility or at least subsidizes it. Additionally, about half of the 103 active permitted landfills are owned by the public sector, mostly by the counties themselves. It is a poor management technique to have the "fox guard the chicken coop" since the county has the theoretical primary responsibility for enforcement at their own facility!

The trend is for the counties to not bother with solid waste management unless there is an imminent "danger" that there will "not be a hole in which to dump their garbage." Such "dangers" exist in the St. Cloud and Duluth areas as well as in the metropolitan and Rochester Agency regions. When faced with this prospect, the counties will participate in the siting or other alternative aspects of solid waste management, but even then, most will not get involved with peripheral solid waste management issues such as dump closures or enforcement at existing sanitary landfills.

The trend is for the Agency to make up the difference, but this task may easily overwhelm existing solid waste or Attorney General staff. Additionally, the Agency has not been mandated the specific authority or given the resources to provide financial assurances from the landfills.

Anticipated Actions:

Rules - The Agency needs to publish new solid waste rules. The new rules may touch marginally on some of the problems discussed above, but will not be able to infringe to a great deal on county mandates which have failed to be enacted.

Legislative actions - Bills have been introduced to tax the landfills to provide for financial assurances for closure/post-closure activities. Should this bill pass, Chapter 400 which requires counties to provide this assurance may be changed.

Agency policy - Agency policy will probably be much the same until such time as new rules such as the above-mentioned are implemented.

Current Problems:

1. Although a two tier solid waste management system has solved many problems, a number of inequalities throughout the state exist in planning and enforcement actions. How best can this problem be minimized?

2. The costs of solid waste disposal will likely rise tenfold or more in the next decade should many proposed changes in our permits and rules become fact. How best can we educate the public in the need for this increase to protect Minnesota's valuable resources?

Table 1

Breakdown of Solid Waste
by Kind, Composition, and Source

Kind	Composition	Source
Garbage	Wastes from preparation, cooking, and serving of food; market wastes; wastes from handling, storage, and sale of produce.	Households, restaurants, institutions, stores, markets.
Rubbish	Combustible: paper, cartons, boxes, barrels, wood, excelsior, tree branches, yard trimmings, wood furniture, bedding, dunnage.	Same as garbage.
	Noncombustible: metals, tin cans, metal furniture, dirt, glass, crockery, minerals.	
Ashes	Residue from fires used for cooking and heating and from on-site incineration.	Same as garbage.
Street refuse	Sweepings, dirt, leaves, catch-basin dirt, contents of litter receptacles.	Streets, sidewalks, alleys, vacant lots.
Dead animals	Cats, dogs, horses, cows.	Same as street refuse.
Industrial wastes	Food-processing wastes, boiler-house cinders, lumber scraps, metal scraps, shavings.	Factories, power plants.
Demolition wastes	Lumber, pipes, brick, masonry, and other construction materials from razed buildings and other structures.	Demolition sites to be used for new buildings, renewal projects, expressways.
Construction wastes	Scrap lumber, pipe, other construction materials.	New construction, remodeling.

SOLID WASTE FACT SHEET
Solid Waste Authorities and Responsibilities in Minnesota

Issue: A number of organizations have responsibilities in solid waste management at the state and local level. However, the responsibilities are not coordinated, resulting in fragmented and conflicting solid waste management strategies.

Present Status: Solid waste authorities and responsibilities are depicted in the chart attached. Clearly, the number of organizations involved in any particular responsibility of solid waste management results in a greater need for a unified policy and coordinated approach.

The Agency has primary regulatory and planning responsibility from the federal perspective. However, the implementation of solid waste management practices takes place primarily at the local level. The Agency's duties are similar to the Metropolitan Council, the Waste Management Board, and the counties (metropolitan and non-metropolitan), in solid waste planning, enforcement, siting, and regulation authorities. Problems have occurred from staff operating similar programs at the state, regional and local levels. Often, one level of government may refuse to operate a program, citing a similar program at another level of government. Primarily, the problem stems from the enabling legislation which inadequately describes the specific responsibilities of the authorities, resulting in fragmented programs.

Current Trends: Each level of government - state, regional, and local - has designated staff to be responsible for solid waste management. In some cases, particularly at the Waste Management Board, the Department of Administration and the local level, the staff is also assigned other major responsibilities which leaves the staff very little time to acquire a significant level of expertise in solid waste management.

In addition, the trend has been to devote less staff and resources to solid waste management as budget restrictions occur. This trend comes at a time when increasing resources and staff are needed to upgrade or close sites and implement alternatives.

Legislation has been introduced, HF 695, which further defines the waste abatement responsibilities of the Waste Management Board, the Department of Administration, the Metropolitan Council and the Agency. However, the legislation also creates an additional entity, the Waste Abatement Board. This board would utilize three Agency staff for administration of programs. For further discussion of this legislation, refer to the fact sheet on HF 695.

A move for consolidation of waste abatement activities has also occurred at the executive level of state government. A private consultant was asked to prepare a proposal which would establish a "Renewable Resources Commission" (or Board) which would consolidate many programs now under the Department of Energy, Planning and Development, the Waste Management Board, the Pollution Control Agency, and the Department of Administration with respect to energy recovery, recycling and composting.

Current Problems: The primary problem from the staff's view is failure of local units of government and regional governments to fulfill their responsibilities for planning, inspections, enforcement and financial requirements for solid waste management. Questions arise on the level of responsibility which each authority should have. For example, should mandatory planning for counties be required under certain conditions? Currently SW-11 requires plans to be amended as conditions change, but the Agency and counties have ignored that provision. Similarly, Chapters 400 and 473 require the counties to become involved in inspections, enforcement, and financial requirements for solid waste disposal facilities. Some counties have undertaken their responsibilities, but there is no coordination in the act to enforce the provisions for those who have not acted. The Agency's role should be as primary regulator and planner in solid waste management. This role is affected by each authority which has responsibility for a portion of solid waste management. Since no single authority has taken responsibility for coordination of all organizations involved in solid waste management, the Agency administration should decide if the Agency will accept this role as leader.

At the state level, the Waste Management Board's authority on high tech abatement alternatives are similar to the Agency's. HF 695 gives high tech alternatives to the Waste Management Board and low tech alternatives to the Agency. For example, conflicts exist because coordination does not occur between the local units of government (which are implementing the projects), the Agency (which is interested because energy recovery impacts our enforcement and planning functions), and the Waste Management Board (who distributes money for energy recovery projects).

The Agency also has a keen interest in the Department of Administration Resource Conservation Program. The Agency has little coordination with the Department of Administration other than to comment on their biennial report to the Legislative Commission on Waste Management. The result has been a minimal recycling and procurement program for the state. Should the Agency ask the legislature for more authority in this area?

The Agency's role should be as primary regulator and planner in solid waste management. This role is affected by each authority which has responsibility for a portion of solid waste management. Since no single authority has taken responsibility for coordination of all organizations involved in solid waste management, the Agency administration should decide if the Agency will accept this role as leader.

SOLID WASTE RESPONSIBILITIES AND AUTHORITIES
IN MINNESOTA (July, 1983)

	MPCA	Waste Management Board	Metro Council	Metro Counties	Non-metro Counties	Solid Waste Management Districts	RDC's	Cities	Townships	Indian Reservations	Landfill Authorities	Miscellaneous
1. Siting of solid waste and sewage sludge facilities	x (intrinsic suitability)		x (if necessary)	x	x	x		x	x	x	x	x(federal lands - U.S. Forest Service; WLSSD)
2. Preparing solid waste and sewage sludge plans			x	x	x	x	x			x		x(WLSSD)
3. Review/Approval of county solid waste plans												
a. Metro Counties	x		x									
b. Non-metro counties	x	x								x		
4. Solid waste management districts												
a. requested				x	x			x	x			
b. approval												
1. Metro counties		x	x(reports to WMB)									
2. Non-metro counties		x										
5. Implementation, owning/operating solid waste facilities				x	x	x		x	x	x	x	x(WLSSD)
6. Flow control implementation				x	x	x				x		x(WLSSD)
a. ordinances (approval)												
1. metro counties			x(reports to WMB)									
2. non-metro counties		x										
3. SWM districts		x										
b. ordinances (adopted)				x	x					x	x	
		Waste										
7. Permitting of:												
a. compost fac.	x			x	x			x		x		
b. landfills	x			x	x			x				
c. resource recovery fac.	x			x	x			x		x		
d. transfer stat.	x			x	x			x	x(zoning)	x		

	MPCA	Management Board	Metro Council	Metro Counties	Non-metro Counties	Solid Waste Management Districts	RDC's	Cities	Townships	Indian Reservations	Landfill Authorities	Miscellaneous
8. Require financial responsibility	x(through permitting process)			x	x					x		
9. Service charges for solid waste management (taxes, levies, tipping fees)				x	x	x		x	x	x	x	x(WLSSD)
10. Enforcement of solid waste rules												
a. legal action	x			x	x	x				x(initiate)		x(WLSSD)
b. inspections	x			x	x	x		x	x	x		
11. Regulation of solid waste												
a. rule	x					x						x(WLSSD)
b. ordinance				x	x			x	x	x		
12. Operation of abatement programs	x			x	x	x		x	x	x	x	x(Dept. of Administration; WLSSD)
13. Regulation of recycling	x	x(flow control)		x	x	x		x	x	x	x	x(Dept. of Administration; WLSSD)
14. Solid waste grants/loans												
a. planning	x(non-metro)		x(metro)									x(Dept. of Energy Planning and Development)
b. capital expenditures		x(statewide)										
c. demonstration	x(statewide)											
15. Regulation or implementation of sewage sludge programs (as relates to composting)	x			x	x	x		x		x		x(MWCC implementation; WLSSD)

SOLID WASTE FACT SHEET
Staffing

Issue: Since the Agency's formation in 1968, the staff complement of the Solid and Hazardous Waste Division has grown from two to seventy-four. The number of staff working on solid waste has shifted almost yearly due to reorganizations and changes in priority. These shifts have often depleted staff in programs like enforcement and permitting to the point it was difficult to maintain programs.

Present Status: The Solid and Hazardous Waste Division presently has a staff complement of 72, 19 of who are directly concerned with solid waste. The solid waste staff is further divided into the following areas:

1. Program Development - five staff plus one vacancy.
2. Enforcement - three staff plus 1 vacancy.
3. Permits - seven staff.
4. Technical Assistance - 2.5 staff.

The main responsibilities of the various units include:

1. Program Development - review existing solid waste programs and legislation, choose the necessary corrective actions, and implement these actions (rulemaking, legislative, procedural).

2. Enforcement - inspect permitted solid waste disposal facilities, respond to complaints, initiate mitigative measures (stipulation agreements, Board action, etc.) to ensure corrective actions are taken.

3. Permits - review permit applications for new disposal sites (mixed-municipal, demolition, and industrial wastes), review and upgrade existing permits in conjunction with present Agency policies, and assist enforcement personnel with technical issues.

4. Technical Assistance - assist counties in developing management plans, assist in public education efforts regarding solid waste management, and assist developers of resource recovery systems.

In addition, the Waste Management Act required that the Agency develop training and certification programs for operators and inspectors of waste disposal facilities. The Agency was allocated two full time positions for this purpose, and they are located in the Water Quality Division, Operator Training Unit. The positions were filled in 1981.

Current Trends: The Solid Waste Division, when initiated in 1968, had a technical staff of four (two in enforcement and two in permits). The main function of the Division at this time was to close open dumps and permit sanitary landfills in the state. From 1970 to 1976, the total staff complement increased from 11 to 22, however, the permitting and enforcement staff increased only from five to eight even though permits had now been issued for disposal sites and required monitoring by staff. By 1982, the Division had grown to include 64 staff members, six of who worked directly with permitting and enforcement of solid waste disposal facilities. In August 1982, the Division reorganized and from 72 staff members charged 12 with the management of solid waste - enforcement, permitting, and technical review. Waste management assistance (county planning programs and resource recovery projects) at its maximum consisted of nine persons with only 2.5 currently involved in these tasks.

As indicated earlier, 19 staff are currently involved with solid waste management. The Division is currently moving to upgrade existing permits, issue new permits, and bring existing facilities into compliance with their permits. Data from ground water studies completed in the state and elsewhere in the country indicates solid waste disposal facilities are having a significant affect on ground water. Organics as well as heavy metals have been detected in the leachate from mixed-municipal waste disposal facilities, for example, which readily degrade the surrounding ground water quality. With this information and knowledge of improved design and construction techniques for solid waste disposal facilities, the Division is putting forth concerted effort to ensure landfills are properly designed and monitored. In order to accomplish this task, the Division has divided solid waste into four areas of expertise, as listed on page one, and staffed them with the numbers of people as appropriate to accomplish the goals of the solid waste program. Of course, the limited number of staff available does somewhat dictate the size of any unit designed to work in this area.

Legislation introduced in 1983 proposes to tax landfills in order to establish closure/post-closure funds along with a remedial action fund. Should this legislation be approved, additional staff will be necessary to properly manage the funds and ensure landfills meet the requirements to receive funds.

Anticipated Actions: New solid waste rules, reflecting the best technology for landfill design, and new legislation may cause the need for expanded solid waste staff in the areas of permitting, enforcement, and technical assistance. The commitment to proper solid waste management will become more important as data continues to be generated showing the detrimental affects of leachate on ground water. Agency policy will need to reflect the Division's commitment to upgrade facilities to the best practical technology by enforcement action, technical assistance, and strong rules.

Current Problems:

1. Sites have not been adequately forced to install ground water monitoring systems. Many sites do not have monitoring systems as required by SW-6.

2. Ground water monitoring reports have not been evaluated and the appropriate follow-up actions instigated.

3. Permits have not been reissued in such a manner as to ensure that the practice of designing and operating a landfill stays up with techological advancements.

4. Reinspections at problem sites have not always occurred in the appropriate intervals to document problems needed for enforcement action.

5. Special handling and design considerations for wastes such as bioinfectious, industrial, demolition, ash, etc. are minimal due to the lack of staff available to determine the proper disposal techniques.

6. Construction and closure inspections are not completed in a timely manner. This means a landfill may start operations wrong from the start due to poor construction or the landfill owner will have left a site unproperly closed.

7. Unpermitted sites have not been closed or permitted.

8. Staff is required to make decisions outside the realm of their expertise, as there are not enough specialized personnel to evaluate the hydrogeologic conditions of a site, for example.

SOLID WASTE FACT SHEET
Permitting

Issue: The prime objectives of the Solid and Hazardous Waste Division, when formed, was to permit open dumps and offer technical assistance. Presently, open dumps still remain to be closed or permitted. Likewise, those permits issued in the early 1970s are outdated and need to be upgraded to include ground water monitoring and rigid closure requirements.

Present Status: The Division has started to reissue permits which currently have no end dates in their existing permit. In addition to specifying an end date, the reissued permit requires the permittee to install a ground water monitoring system, develop a closure/post-closure care manual, and show some financial capabilities to complete landfill operations through the post-closure care period. The Division is also handling permit applications for new sites. This review may require an initial review of a number of prospective sites for their suitability as well as the final application review.

At the present time, open dumps are being handled by the enforcement staff at the central office and regional offices. Little incentive has been given to the dump owners to properly close their sites since legal action has not been applied to these cases.

Few industrial permits have been issued. Demolition landfill permits are issued but the requirements of a permit application vary with each application.

As of June 1983, 251 solid waste disposal permits have been issued by the Division. In 1982, six permits were issued and fourteen permits have been issued in the first six months of 1983.

Current Trends: The Division is moving toward five-year permits for all solid waste disposal facilities. Under this type of permit, the facility will be reviewed on a regular basis to discover any problems which the landfill may be having or causing. The newer permits also require the applicant to consider the true cost of operating a landfill and to set aside moneys for operations whether it be closure, post-closure care, or implementation of a remedial contingency plan.

By using a guidance manual, the Division is requiring more evaluation and design considerations of a disposal site prior to permitting rather than after problems arise. This has made perspective landfill owners more cautious in deciding to proceed with a permit application. The process being used now encourages a permittee to charge a fee which not only covers the current operations but will provide funds for post-closure care. This has caused concern among the landfill owners/operators, especially county owned facilities, in that the higher tipping fees may cause the public to throw their trash along the roadside causing litter control problems.

The Division is currently evaluating the need to permit demolition landfills since the waste accepted at these landfills should be inert. The limited number of staff available for permitting sanitary, industrial, and demolition landfills has caused the Division to reevaluate what type of waste disposal sites should be permitted. Some counties such as St. Louis County are working with cities and townships to close open dumps by forming sanitary landfill authorities and locating one landfill for a large area.

Anticipated Actions: New solid waste rules are anticipated to be needed. These rules will incorporate the latest information concerning the design of landfills and their affects on ground water. These rules will be more explicit than current rules particularly in the areas of closure, post-closure, and financial assurance.

Needed legislation includes the requirement for financial assurance to ensure landfills are properly closed and maintained after closure. Financial assurance will also make money available to implement remedial actions, if necessary. Legislative action should also provide incentives for reducing the amount of land disposal by taxing such practices.

The Division needs to finalize the decision to permit demolition landfills and how to handle special wastes which are currently being handled through the codisposal program. The decision on how and on what time frames permits will be reissued and brought into conformance must be made.

Current Problems:

1. Permits issued in the first years of the Division's existence are outdated and often do not contain specific requirements for ground water monitoring and closure at the site.

2. Current solid waste rules do not specifically cover special wastes such as fly ash, industrial byproducts, and biohazardous. The rules are written very general causing problems for a permit applicant in submitting the proper information needed by the Division to approve/disapprove an application.

3. Insufficient staff is available to permit all waste disposal sites, review current literature, and upgrade existing permits.

4. Education on landfill technology is needed to assist the public in understanding the problems associated with a landfill.

5. Insufficient funds are maintained by most landfill owners to properly operate and maintain their sites.

SOLID WASTE FACT SHEET
Technical Permitting

Issue: The Division's solid waste permitting program has changed dramatically in the last two years. How has the program changed, and what further changes are needed?

Present Status: A comprehensive permit format is now being used for land disposal facilities. The permit is effective for five years. It contains detailed requirements governing engineering, hydrogeologic investigations, monitoring, closure/post-closure, financial assurance, and a contingency plan.

Existing permitted facilities have been ranked mainly according to their potential environmental significance; as staff time allows, those facilities with non-expiring permits are being issued upgraded permits in order of ranking. The Division is also attempting to either close or upgrade and permit a number of unpermitted industrial and demolition sites, but for a variety of reasons, little has been done with respect to other open dumps.

In addition to permits, the Division issues approvals for certain activities -- mainly codisposal of nonhazardous industrial waste at permitted sanitary landfills. Because of limited staff time, the Division is trying to develop policies for minimal review of certain kinds of facilities and specific wastes that have little environmental impact. These include demolition landfills, solid waste transfer stations, foundry wastes, and power plant fly ash.

Current Trends:

In the Division - A solid waste review manual has been developed to provide for a consistent level of staff review, consistent procedures for processing permit applications, and a written base for continuous review and updating of permit requirements.

In response to perceived inadequacies in the solid waste regulations, the entire solid waste program is currently under review by the newly formed Solid Waste Unit in the Program Development Section. This review, together with concurrent development of an overall ground water strategy by the Ground Water Unit, probably will result in major changes in the solid waste program.

The technical state of the art in waste disposal is rapidly changing, and there is a corresponding increase in the sophistication we are beginning to require in all technical areas, from hydrogeologic investigations to quality control testing in construction. These changed requirements are imposed only in response to actual technical deficiencies, but by boosting the costs of land disposal, they unintentionally tend to make waste abatement and alternative methods of waste disposal economically more competitive.

Finally, as existing facilities are issued upgraded permits, the required hydrogeologic investigations will sometimes show that these landfills are not suitably sited. Thus far, this has not led to any forced closures where permittees were otherwise cooperative. In the case of Rochester/Olmsted County, the Division has advised the county that an adjacent expansion area is unsuitable, and it is likely we will have more such "bad news" for other permit-holders in the future.

Other parties - As the costs of land disposal rise, we are seeing more multi-county solid waste planning efforts and more interest in waste reduction and waste-to-energy systems. The increased public awareness of the environmental consequences of land disposal and the 1980 Waste Management Act have contributed to this trend.

In the Twin Cities metropolitan area, the Metropolitan Council is considering a moratorium on all landfill expansions in an effort to reduce reserve landfill capacity and promote alternatives to landfilling.

Another trend that may be beginning due to increased costs is the transfer of ownership to larger concerns -- from private owners and cities to counties or larger private firms (e.g., Olmsted and Winona Counties). We will probably see smaller facilities close in preference to larger central sites where costs of equipment, staffing, and monitoring can be controlled more effectively.

Smaller operators, acting through the Minnesota Waste Management Association, have become concerned about the cost and availability of insurance for long-term liability for environmental cleanup. House bills 695 and 1391 in part are attempts to address the liability issue.

Finally, even some of the recently-proposed landfills in less populous counties are beginning to incorporate less primitive designs and better monitoring well construction. The fact that a few of these smaller counties are taking some initiative spending the additional funds necessary for an acceptable design indicates that our requirements do not impose an unacceptable burden.

Anticipated Actions: The Program Development Section is beginning its review of the solid waste rules. It is too early to foresee any likely outcomes of this review.

In the interim, the Division will continue to use and update the recently developed Solid Waste Review Manual for processing permit applications and upgrading existing permitted facilities.

Current Problems: Areas that constitute major unresolved "problems" in the permitting arena generally can be categorized as technical or administrative. All of these issues (and many more) will be dealt with in the program review now underway.

Technical -

1. Design vs. performance standards for disposal facilities. Neither is adequate by itself. What is the appropriate way to combine them?

2. Engineering is becoming more elaborate, complex, and exacting. How can quality construction be assured, given that MPCA does not have the resources to conduct adequate construction inspections? How can we ensure these constructed systems, mainly buried and out of sight, remain functional over the long term?

3. What are appropriate design standards for liners, covers, and leachate and methane collection systems? When scrutinized, many "good" designs probably don't work very well.

4. The criteria for suitability of a site for land disposal, apart from engineering measures, are nebulous and subjective, and vary from staff person to person. They will probably largely remain so.

Administrative -

1. How can solid waste management planning at the local (county) level be better integrated with the permit application and review process?

2. How do we apply our higher standards for facility siting, design, and monitoring to existing facilities? Will we reach impasses in the hydrogeologic investigations, and have to close numerous existing facilities?

3. The more detailed, complex permits are more difficult and time-consuming for compliance monitoring and enforcement. What procedures must be implemented to track and follow up on all the submittals and data now required in these permits? Presumably, many more compliance/enforcement staff will be needed, as well as computer-assisted tracking and data storage.

4. The costs of complying with the recent permits is high -- better reflecting the "true" costs of land disposal. This is unavoidable but obviously creates problems for most facility owners. It raises the question of whether we should have different expectations for small vs. large facilities, rural vs. urban, etc., or let only those owners with larger financial resources remain in business.

SOLID WASTE FACT SHEET
Enforcement

Issue: How best can staff achieve a maximum degree of compliance with those rules which most preserve Minnesota's valuable surface and ground water resources. What is the best way to eliminate unnecessary enforcement steps and utilize the mechanism(s) or procedure(s) which result in the most immediate return to compliance status.

Present Status: At present the Agency and the counties share enforcement responsibility for solid waste matters. The present Agency enforcement scheme revolves upon the following actions.

1. Inspections noting violation.
2. Follow-up letter.
3. Enforcement meeting.
4. Notice of Violation.
5. Stipulation Agreement.
6. Order to Show Cause.
7. Agency Board order.
8. Agency litigation.

A detailed discussion of each of these mechanisms/procedures can be found in a position paper written by Jeff Harthun of the Agency, and is beyond the scope of this fact sheet.

The present county enforcement scheme varies, but in general may consist of:

1. Inspections noting violation.
2. Follow-up letter.
3. Enforcement meeting.
4. Notice of Violation of license or ordinance condition.
5. Possible appearance before county board.
6. County litigation or revocation of license.

Unfortunately, many counties are not actively involved in solid waste enforcement matters, but will concentrate on other aspects of solid waste management such as siting new facilities.

Anticipated Actions:

Rules - New solid waste rules are needed. It is anticipated that the new rules will be more enforceable than the old ones. But it is not anticipated that new rules will assist in recalcitrant situations where the eight enforcement mechanisms must still be employed.

<u>Legislative actions</u> - New proposed legislation may provide a tax on landfills to provide for closure and post-closure remedial action activities. This will certainly help when enacted.

<u>Agency policy</u> - Change in Agency policy is anticipated regarding the mechanisms and procedures for enforcement.

At present, the county enforcement program could be somewhat more expedient and less cumbersome than the Agency's. For example, all counties may and many will renew landfill license(s) on an annual basis. This presents the counties with an ideal time to review or seek compliance from the licensee. Unfortunately, most counties do not normally take a lead role or even sometimes any role in solid waste enforcement issues. This is especially true at facilities where the county is the permittee.

Under either of the two mechanisms involved, if the noncomplier is recalcitrant, eventual compliance may not take place for a number of years during which time the environment and possibly public health may be at peril.

For perspective, this should be contrasted to the ability of the Minnesota Department of Natural Resources to make immediate arrests and or cofiscation of equipment for an infringement of environmental laws regarding the taking of game.

<u>Current Trends</u>: The present trend of the Agency is to be more demanding in permit conditions for the 103 active modified/sanitary landfills and not do much with the approximately 200 open dumps around the state (of which 60 made the RCRA open dump inventory). These permit conditions are very expensive, and recalcitrant reaction has been increasing. Table 1 notes that in recent years there has been a refusal of the recalcitrants to sign stipulation agreements and a reluctance on the Agency's part to pursue the matter to the next level of enforcement action.

In such situations, the Agency may reissue a modified permit to the permittee. This may be an advantage since it is a unilateral means of imposing conditions upon a solid waste facility, unlike the stipulation agreement which requires mutual agreement among the parties involved. The disadvantages of this mechanism are: it only applies to facilities which already have permits, can only be implemented when existing permit conditions are some how changed, modified, or rescinded, and the conditions imposed in the permit may some day have to be enforced by one of the eight mechanisms listed above.

The current trend for landfills is to voluntarily close should Agency enforcement pressure increase rather than to comply with increasingly expensive Agency requirements. To date, the Agency has not vigorously pursued facilities once they have closed even if closure was not in accordance with Minnesota Rule SW-12.

Current Problems:

1. How could the Agency encourage the counties to share in their responsibility for solid waste enforcement activities?

2. It is not clear who should enforce Chapter 400 which requires the counties to do certain solid waste activities. Should we go back to the legislature asking them to make Chapter 400 clearer?

3. How could we shorten the time frame for compliance from a recalcitrant permittee?

4. Should the Agency selectively enforce certain solid waste rules to the maximum and not bother about the others?

Table 1

Solid Waste Enforcement Actions

Fiscal Year	Notices of Noncompliance or Violation	Stipulations	Orders to Show Cause	Legal Actions	Staffing Level
1971	0	0	0	0	2
1972	0	0	0	0	2
1973	0	26	16	1	2
1974	0	4	1	0	2
1975	0	3	0	1	2
1976	0	3	2	1	2
1977	0	1	0	1	2.5
1978	0	0	0	0	3.5
1979	6	5	0	0	11
1980	13	3 (+ 4 not signed)	1	0	11
1981	15	5 (+ 3 not signed)	0	1	3
1982	5	0	0	0	3
1983	7	3 (+ 2 not signed)	0	0	3

SOLID WASTE FACT SHEET
Solid Waste Abatement and Planning/Technical Assistance

Issue: Alternatives to land disposal are often not considered or disregarded due to the lack of a coordinated waste management strategy at the state level and the corresponding lack of knowledge of the true costs of alternatives vs. land disposal.

Present Status: Each day approximately 10,600 tons of solid waste are generated statewide. Of that, only 900 tons per day are recovered (about 10 percent of sanitary landfill receipts). Of the state's 103 active permitted sanitary and modified landfills, 41 have less than five years remaining capacity. Depletion of landfill capacity is one of four driving forces that lead local units of government to look at their solid waste management system. Local decision makers are also finding that many areas are geologically unsuitable or difficult for landfilling, disposal costs are rising rapidly, and new landfill sites are remote or politically inaccessible.

The Agency currently has 2.5 employees which are responsible for assisting local units of government and other persons in developing, implementing, and evaluating alternatives in solid waste management. At its peak, the planning section consisted of eight full time employees (1980-1982). The Agency no longer has a solid waste demonstration grant program or planning grant money (four planning grants are uncompleted).

The Agency has recently allocated the regional staff more hours in their work plan for promoting alternatives to land disposal, by reducing hours in other regulatory functions. This is a very significant step in improving the climate for integrated solid waste management systems.

Current Trends: The Solid and Hazardous Waste Division administration, in its last reorganization (1983) has stated one goal is to encourage Regulatory Compliance staff (permitting and enforcement) to devote more efforts toward comprehensive planning. Staff have suggested in position papers that one waste abatement planning person be placed at the regional level or assigned to a region (based at the central office).

Some local units of government, landfill operators, and members of the general public are finally beginning to understand the long term costs and environmental problems associated with land disposal. They look to the Agency to assume a leadership role in the proper management of solid wastes.

Legislation specifically aimed at developing alternatives to land disposal has been introduced and will be discussed in hearings during late August and September, 1983.

Anticipated Actions: The Agency will be asked to support legislation which would improve the climate and intrastructure for solid waste abatement. This legislation may require the Agency to assume a leadership role in the coordination of solid waste activities. (See fact sheets on HF 695 and HF 1321.)

A move for consolidation of waste abatement activities, which is occurring at the executive level of state government, may affect the Agency's programs. A private consultant has been asked to prepare a proposal which would establish a "Renewable Resources Commission" (or Board) to consolidate many programs now under the Department of Energy, Planning, and Development, the Waste Management Board, the Pollution Control Agency, and the Department of Administration with respect to energy recovery, recycling, and composting.

Current Problems: The Waste Management Act of 1980 formally recognized and stated the importance of reducing our dependence on landfills. However, the Waste Management Act did not establish a lead organization to promote coordination of solid waste management among those with such authorities. The orderly development of an effective solid waste management strategy results in reducing the quantity of refuse being buried in the ground. Unfortunately, decision makers find it is difficult to select the components of waste for special handling such as recycling and composting. This lack of knowledge has not only resulted in a lack of motivation for exploring "low technology" alternatives, but has also promoted the "all or nothing" approach. The entity responsible for disposal simply treats anything in the system in solid waste to be disposed of in a landfill, a waste-to-energy plant, (or a magical black box).

The Agency has not promoted the orderly development of a coordinated solid waste disposal system. The Agency must first develop goals and objectives in solid waste management before it can reduce land disposal and assure the coordinated development of new alternatives. Management must be dedicated to planned development of a total solid waste management strategy. As well, the Agency has not produced or promoted legislation for funding and staffing solid waste management - particularly waste abatement.

The Agency must also change its internal policies and procedures in waste abatement. Currently, problems exist in procurement and use of recycled paper for copying and printing and in the reduction and recycling of office paper. A commitment by Administration is needed to remove institutional barriers within the Agency. The Agency should promote waste reduction and recycling to other state agencies and businesses.

Part of the difficulty of determining an effective solid waste management system also stems from the lack of understanding of economics of solid waste disposal. Decision makers use land disposal as the basis for comparison of alternatives. However, the costs of land disposal are artificially low, because most landfills are not operated up to state standards and do not assess the cost of closure and long term care. Worse, in some areas the alternatives are compared to the cost of open dumping.

The Agency, by integrating planning and abatement into the regulatory process could establish a mechanism to properly evaluate the true costs of landfills and to modify the evaluative progress of waste alternatives. As a first step, the Agency should request authority from the legislature to require a local unit of government and other persons which request funds or a permit for land disposal to prepare a waste management (abatement) plan or be included in such a plan. This rule would ensure that the local government or other persons should make a good faith effort toward development and implementation of an integrated solid waste management system.

Estimated Recovery of Selected Waste Materials
July, 1983

Material	Generated (tons/year)		Recovered (tons/year)		%
Glass	314,000	(1978)@	3,500	(1978)@	3
Ferrous metal	127,000	(1978)@	3,000	(1978)@	2.4
Plastic	117,000	(1978)@	negligible@		-
Paper (news and corrugated)	341,406	(1983)*	199,000	(1983)*	51
Aluminum	35,000	(1983)*	18,400	(1983)*	53
Leaf Composting	146,990	(1978)@	12,890	(1978)@	9

@Minnesota Resource Recovery Plan, September 1978.
*Industry supplied data.

Note: These figures are rough estimates. Before any further work is done in this area, a detailed survey of generation and recovery rates will have to be initiated.

SOLID WASTE FACT SHEET
Potential Legislative Issues - 1984

-Need to establish requirements for financial responsibility at solid waste facilities.

- -Operation
- -Closure
- -Post-closure
- -Remedial action

-Need to establish fund for state to take remedial actions at solid waste facilities.

- -What constitutes remedial action or what is fund used for?
- -How to finance fund

-Need fund to promote waste reduction.

- -Encourage recycling, i.e., container deposit
- -Develop markets for recycled goods, i.e., scrap tires

-Need fund to promote alternatives to landfilling.

- -Resource recovery
- -Incineration
- -Composting

-Alternatives and responsibilities for landfill management.

- -Solid waste management districts' role
- -Regional government role
- -Agency role

-Authorities and responsibilities for alternative solid waste management.

- -County
- -Regional
- -Agency
- -Waste Management Board
- -New governmental bodies

-Resources to carry out legislation.

SOLID WASTE FACT SHEET
Potential Legislative Issues - 1984

Establishes Financial Requirements at Solid Waste Facilities	HF 695	HF 1361 - SF 1312
a. Operation	No requirements.	No requirements.
b. Closure	Operator required to contribute \$.30/cubic yard in escrow account (\$3 million/year).	Operator contributes \$3.00/ton or \$.90/cubic yard to state fund. One third is used for closure, post-closure, and remedial action. Tax reduced by one third upon proof of financial capability. Has no section disbursing funds for closure care of permitted facilities.
c. Post-Closure	May be covered through escrow account.	Operator contributes \$3.00/ton or \$.90/cubic yard to state fund. One third is used for closure, post-closure, and remedial action. Tax reduced by one third upon proof of financial capability. Fund will pay for all post-closure care after five years of compliance with post-closure care rules of the Agency.
d. Remedial Action (Contingencies)	Operator required to contribute \$.15/cubic yard in state fund (\$1.7 million/year). Fund can be used to pay for any actions (construction, studies, replacement of water supply) the Agency deems necessary to mitigate direct or indirect damages.	Operator contributes \$3.00/ton or \$.90/cubic yard to state fund. One third is used for closure, post-closure, and remedial action. Tax reduced by one third upon proof of financial capability. Fund will pay all remedial action for facilities which the operator is unwilling or unable to take the action. Fund will pay one half of closure, post-closure and remedial action for those facilities which are not permitted or couldn't meet the financial capability requirements.

Establish Fund for Waste Abatement	HF 695	HF 1361 - SF 1312
a. Funding Mechanism	Operator contributes $.15/cubic yard into state fund.	Operator contributes $3.00/ton or $.90/cubic yard into state fund. Two thirds is used for waste abatement. Tax is reduced by one third upon proof of financial capability.
b. Market Development	50-60% of fund for research and development for market development and development of material processing facilities (Agency and Department of Energy Planning and Development (DEPD)). Funds one Agency position, three DEPD positions.	Grants for research and development in market development (Agency - Metropolitan Council).
c. Materials Recovery	7% of fund for encouraging systems for recovery of materials, including low interest loans to recyclers and grants for materials recovery to political subdivisions. Funds three Agency positions and a total of 4% of this portion for administration. 1% of fund for tax credits to businesses, which purchase products composed of recycled materials. 1% of fund for investment tax credit.	Grants for demonstration projects under existing rules and to complete county abatement plans (Agency - Metropolitan Council). 10% of fund for administration.
d. Energy recovery	No funds dedicated for this purpose.	Funds development of markets for energy and grants money for building and operating energy recovery projects (five years) (Agency - Metropolitan Council).
e. Composting	1% of fund used for research and development, planning, and program implementation for co-composting (Agency - outstate waste districts).	No funds dedicated for this purpose.
f. County Planning	3% of funds for county planning in metropolitan and non-metropolitan counties (Metropolitan Council and Agency). Funds one Agency position and 2% of this portion for administration.	Funds planning assistance grants under existing rules (non-metropolitan counties only - Agency). 10% of fund for administration.

Establish Fund for Waste Abatement	HF 695	HF 1361 - SF 1312
g. Public Education	3% of fund used for media campaigns, cash awards, and outstanding achievement awards in waste abatement. Funds two positions and a total of 7% of this portion of the fund for administration.	No funds dedicated for this purpose.

Authorities and Responsibilities in Solid Waste Management	HF 695	HF 1361 - SF 1312
a. County	No change in authority.	No change in authority.
b. Regional (Metropolitan Council)	Must delay regional abatement plan by one year after provisions of the law take effect.	No change in authority.
c. Agency	Agency assumes responsibilities for all solid waste reduction and material recovery systems. Agency must develop rules for distribution of funds and report to Legislative Commission on Waste Management on its activities yearly. Agency must delay enforcement of pretreatment rules for Twin Cities metal platers and circuit board manufacturers until centralized metal recovery operation is in place.	Agency must develop rules for the disbursement of funds for closure, post-closure, and remedial action, for proof of an operator's financial capability; and for disbursement of the landfill abatement fund.
d. Waste Management Board	Waste Management Board assumes responsibilities for all energy recovery systems.	No change in authority.
e. New Governmental Bodies	Creates a Waste Abatement Board which is composed of parties which are influenced by processing and collection grants for recovery of secondary material. They oversee low interest loans to recyclers and the grant program (Agency). Involves Department of Energy Planning and Development in development of markets for secondary materials.	No new governmental bodies created.

Note: Alternatives and responsibilities for landfill management have not changed.

Attachment 2

3-1-83 [REVISOR] MVH/CB 83-1495

Introduced by D. Nelson, Munger, Norton, Forsythe, Onnen
March 14th, 1983
Ref. to Com on Environment & Natural Resources

H.F. No 695

Companion S F No ________
Ref to S. Com on ________

Reproduced by PHILLIPS LEGISLATIVE SERVICE, INC.

A bill for an act

relating to environment; providing a comprehensive program for recovery of solid waste; imposing taxes; imposing criminal penalties; amending Minnesota Statutes 1982, sections 116J.06, by adding subdivisions; 290.06, by adding a subdivision; proposing new law coded in Minnesota Statutes, chapter 116F.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF MINNESOTA:

Section 1. [116F.35] [DEFINITIONS.]

Subdivision 1. [SCOPE.] For the purpose of sections 1 to 22 the terms defined in this section have the meanings given them.

Subd. 2. [AGENCY.] "Agency" means the Minnesota pollution control agency.

Subd. 3. [CLOSING COSTS, CLOSURE.] "Closing costs" or "closure" means activities and costs associated with the design, purchase, construction, or maintenance of all measures required by the agency, pursuant to law, to prevent, minimize, or monitor pollution or health hazards resulting from land disposal facilities subsequent to the termination of operations at any portion of the land disposal facilities, including, but not limited to, the costs of the placement of earthen or vegetative cover, and the installation of methane gas vents or monitors and leachate monitoring wells or collection systems at the site of any land disposal facility.

Subd. 4. [COMMISSIONER.] "Commissioner" means the commissioner of revenue.

Subd. 5. [DISTRIBUTOR.] "Distributor" means a person who sells litter-stream products to retail dealers in this state.

Subd. 6. [LAND DISPOSAL FACILITY.] "Land disposal facility means sanitary landfills, modified landfills, demolition landfills, and unpermitted landfills.

Subd. 7. [LIQUOR.] "Liquor" means ethyl alcohol and distilled, fermented, spiritous, vinous, and malt beverages containing in excess of 3.2 percent of alcohol by weight.

Subd. 8. [NONREFILLABLE BEVERAGE CONTAINER.] "Nonrefillable beverage container" means an individual hermetically sealed bottle, can, jar, or carton that (1) consists of at least 50 percent glass, paper, metal, or plastic by weight; (2) is used to contain liquor, beer, or soft drinks in liquid form intended for human consumption; and (3) is not designed or constructed to be returned, refilled, and resold after the beverage which it contained has been consumed.

Subd. 9. [OTHER LITTER-STREAM PRODUCTS.] "Other litter-stream products" means (1) liquid noncarbonated nondairy drinks including spring water, fruit or vegetable drinks, and other similar drinks whether naturally or artificially flavored, sold in an individual hermatically sealed bottle, can, jar, or carton that consists of at least 50 percent glass, paper, metal, or plastic by weight and that is not designed or constructed for return, refill, and resale after the beverage which it contained has been consumed; (2) cigarettes; (3) candy and gum; and (4) take-out and fast foods.

Subd. 10. [OWNER OR OPERATOR.] "Owner or operator" means, in addition to the usual meanings, the owner of record of an interest in land where a land disposal facility is or has been located, and a person or corporation that owns a majority interest in a corporation that is the owner or operator of any land disposal facility.

Subd. 11. [SOFT DRINKS.] "Soft drinks" means soda waters, mineral waters, and any other carbonated nonalcoholic beverages

Subd. 12. [TAX PERIOD.] "Tax period" means a calendar month or other period prescribed by rule adopted by the commissioner, on the basis of which the owner or operator of a land disposal facility is required to report to the commissioner.

Subd. 13. [TAXPAYER.] "Taxpayer" means the owner or operator of a land disposal facility subject to the tax provisions in sections 3 to 22.

Sec. 2. [116F.36] [DUTIES OF WASTE MANAGEMENT BOARD, AGENCY, AND METROPOLITAN COUNCIL.]

All grants, loans, and solid waste technical assistance programs operated by the state of Minnesota for the assistance and development of resource recovery systems for recovering energy shall be operated by the waste management board. All grants, loans, and technical assistance programs to assist and develop solid waste reduction and material recovery from solid waste by state government shall only be operated through the agency and the metropolitan council. The metropolitan council shall delay completion of the regional waste abatement plan by one year to allow the provisions of sections 1 to 22 to take effect. All appropriations made to the waste management board program for solid waste, including appropriations earmarked for materials recovery projects, shall be appropriated towards programs and projects that recover energy from solid waste, including, but not limited to: mass burn technologies, alcohol conversion, refuse-derived fuel production, pyrolysis, other combustion technologies, methane digestion, and clay digester technology.

Sec. 3. [116F.37] [RECYCLING TAX.]

Subdivision 1. [TAX LEVY.] There is levied upon the owner or operator of a land disposal facility a recycling tax of 15 cents per compacted cubic yard of all solid waste accepted for disposal at the facility during the period from January 1, 1984 to December 31, 1987. Waste accepted for disposal on or after January 1, 1988, shall be taxed at the rate of ten cents per compacted cubic yard. In the event that waste is measured upon acceptance for disposal by other than compacted cubic yards, the tax shall be levied on the equivalents of computed cubic yards as the agency determines.

Subd. 2. [PURPOSE.] The money collected from the tax levied in subdivision 1 shall be used to manage solid waste through waste reduction, reuse, recycling, composting, and other forms of materials recovery.

Subd. 3. [REGISTRATION.] An owner or operator of a land disposal facility that accepts waste for disposal and that is subject to the tax under subdivision 1 shall, within 20 days after the effective date of sections 1 to 22, register with the commissioner on prescribed forms.

Subd. 4. [TAX PERIOD REPORT AND PAYMENT OF TAX.] An owner or operator of a land disposal facility shall, on or before the 20th day of the month following the close of each tax period, (1) render a return under oath to the commissioner on prescribed forms indicating the number of compacted cubic yards of waste accepted for disposal, and (2) pay the full amount of the recycling tax due.

Subd. 5. [DETERMINATION OF TAX BY COMMISSIONER; HEARING.] If the return required in subdivision 4 is not filed, or if a return when filed is incorrect or insufficient in the opinion of the commissioner, the commissioner shall determine the amount of tax due from available information. Notice of the determination shall be given to the taxpayer who is liable for the payment of the tax. The determination shall finally and irrevocably fix the tax unless the person against whom it is assessed, within 30 days after receiving notice of the determination, applies to the commissioner for a hearing or unless the commissioner on his or her own motion redetermines the tax. After the hearing, the commissioner shall give notice of the determination to the person against whom the tax is assessed.

Subd. 6. [PENALTIES; INTEREST.] A taxpayer who fails to file a return when due or to pay a tax when due, shall be subject to penalties and interest as provided in Minnesota Statutes, section 290.53. If the commissioner determines that the failure to comply with a provision of this section was excusable under the circumstances, the commissioner may remit part or all of the penalty as appropriate under the circumstances.

Subd. 7. [CERTIFICATE; PRESUMPTIVE EVIDENCE.] A certificate of the commissioner indicating that a tax has not been paid, that a return has not been filed, that information has not been supplied, or that inaccurate information has been supplied as required in this section or in rules adopted under this section is presumptive evidence of its contents.

Sec. 4. [116F.38] [WASTE ABATEMENT AND RECYCLING FUND.]

By July 1, 1984, the department of finance shall establish a fund in the state treasury for the purposes of sections 1 to 22 to be known as the waste abatement and recycling fund. The fund shall be administered by the agency, and shall be credited with all tax revenue collected by the commissioner pursuant to sections 3 and 10. Interest received by the commissioner on money in the fund and sums received as repayment of principal and interest on outstanding loans made from the fund shall be credited to the fund. The money in the fund shall be used for the purposes contained in section 5.

Sec. 5. [116F.39] [WASTE ABATEMENT AND RECYCLING FUND ALLOCATIONS.]

Subdivision 1. [MARKET DEVELOPMENT.] The agency and the department of energy, planning and development shall be allocated not less than 50 percent nor not more than 63 percent of the waste abatement and recycling fund to be used to encourage and assist in the development of markets for reusable or recyclable solid waste materials, including glass, newsprint, ferrous metals, plastic, rubber, and raw organic materials. Creation of statewide markets shall be a high priority in the market development activities. Creation of markets in the areas of the state where local markets do not exist shall also be a high priority of development activities funded.

Subd. 2. [RULES; EDUCATIONAL GRANTS.] The agency shall create rules governing the use of this portion of the waste abatement and recycling fund to provide research and development grants for the University of Minnesota and other higher education institutions and private enterprise. The rules shall also govern the use of consultants to complete project feasibilities and provide other project development services to include, but not be limited to, legal counseling and bond counseling.

Subd. 3. [MATERIAL PROCESSING FACILITIES.] In the first two years of funding, the agency shall provide funds for research, development, and creation of the following secondary materials processing facilities: animal bedding, co-composting facilities, crumb rubber mill, de-tinning mill, ferrous mini mill, glass processing facility, and newsprint mill.

Subd. 4. [STATE AGENCY JOBS.] (a) State positions shall be created from the market development portion of the fund, including increasing the state complement of the department of energy, planning and development by three and the state complement of the agency by one.

(b) Not more than four percent of this portion of the fund may be used for staff and administration for the agency and the department of energy, planning and development.

(c) No further positions may be maintained by the agency and the department of energy, planning and development and no further expenditures may be made to develop markets for materials from solid waste if for any two consecutive years the following conditions are met:

(1) the recovery of paper, glass, metal, rubber, and plastic is reducing the mixed municipal solid waste stream by 15 percent statewide; and

(2) 500,000 tons of wastes from the mixed municipal solid waste stream in the state is annually composted and finds final uses.

Subd. 5. [LITTER PATROL PROGRAM.] The department of transportation shall be allocated not more than 11 percent of the fund to be used for a litter patrol program to employ unemployed and underskilled workers from the state to remove litter from places and areas that are most usable to the public.

Subd. 6. [RESOURCE RECOVERY SYSTEMS.] The agency shall be allocated not more than seven percent of the fund to be used to promote and assist in the development of resource recovery systems for the recovery of materials from solid waste or for the collection, transportation, separation, sorting, processing, or storing of solid materials that aid in the recovery of materials.

Subd. 7. [WASTE ABATEMENT BOARD.] The allocation of funds to promote and assist recovery of materials as provided in subdivision 6 shall be governed by a waste abatement board to be appointed by the legislative commission on waste management. This board shall include one representative from the metropolitan inter-county association, one representative from the agency, one representative of the metropolitan council, one representative from the Minnesota association of counties, one representative from the Minnesota league of cities, two representatives from industries that use secondary materials as a raw material, one representative from organized labor, one representative from the waste hauling industry, two representatives from the recycling processing industry, and seven citizen members.

The agency shall furnish staff time and supplies for the orderly functioning of the waste abatement board. The board shall coordinate its fund allocations with the market development staff at the agency and the department of energy, planning and development, to ensure that no more materials will be collected than can be economically marketed.

Subd. 8. [LOANS, DEMONSTRATION PROGRAMS, AND GRANTS.] In the first two years of operation, the waste abatement board shall use not less than 50 percent of its funds to provide low interest loans, and to establish a sufficient reserve for a loan guarantee program for recycling businesses and industries. Not more than 25 percent of the board's funds may be allocated for demonstration programs in the first two years of the board's operation. For two years following the creation of the board, not more than 45 percent of the estimated balance of the waste abatement board funds may be allocated for the annual expenses of grants based on quantity of material recovered. The amount of these grants shall be calculated, for the purposes of the first grant, to a particular unit of government or Indian reservation, on the basis of the total number of tons of materials annually recycled from the residential and commercial sources within that municipality, county, or Indian reservation. Subsequent grants to a municipality, county, or Indian reservation shall be calculated on the basis of the increase in the total number of tons of materials from the total in the preceding year, except that no grant shall exceed $25 per ton of materials recycled.

To be eligible for an annual grant pursuant to this subdivision, a municipality, county, or Indian reservation shall demonstrate that the materials recycled by the recycling programs were not diverted from a recycling program already in existence.

To be eligible for a subsequent annual grant pursuant to this subdivision, a municipality, county, or Indian reservation shall demonstrate that at least three types of materials are currently recycled, or will be recycled in the succeeding grant year by the recycling program. A recycling grant to a municipality, county, or Indian reservation may be used for construction or operation of any facility for collecting and processing recyclables or co-compost from solid waste or sewage sludge.

Subd. 9. [STAFF.] The agency and the waste abatement board shall maintain a complement of three staff persons over the next seven years to fulfill the purposes of subdivision 8. Not more than four percent of the waste board funds should be allocated to staff and administration.

Subd. 10. [ALLOCATION OF FUNDS AFTER TWO YEARS.] After two years of existance the waste abatement board shall allocate funds for loans, demonstrations, and recovery programs, as it deems appropriate. The cost of administration and staff for the waste abatement board and agency shall not exceed four percent of the portion of the fund described in subdivision 8.

Subd. 11. [COUNTY AND MUNICIPAL PLANNING AND PROGRAM FUNDING.] Not more than three percent of the estimated annual balance of the funds shall be used for county and municipal recycling program planning and program funding, including administrative expenses. The funds shall be evenly divided between the agency and the metropolitan council. The metropolitan council and the agency shall develop a plan for permanent financing of the waste abatement systems. After seven years of appropriations, no funds shall be expended under this subdivision for county planning and program funding. The agency shall, during the seven year duration of this program, maintain a state complement of one position. The agency may deduct the cost of this position and the cost of program administration from this fund, however, not more than two percent of this portion of the fund may be used for agency staff and administration.

Subd. 12. [EMPLOYEE REEMPLOYMENT ASSISTANCE.] The department of labor and industry shall be allocated not more than six percent of the fund to be used for employee reemployment assistance. The reemployment assistance shall include, but not be limited to, retraining and relocation allowances, employment assistance, and educational training programs. The state complement of the department of labor and industry shall be increased by one for a four-year period or until all claims and retraining of affected workers are complete, if sooner than four years. The department of labor and industry shall only request funds from the agency that are necessary to serve the specific claims and retraining of individuals affected by sections 1 to 22 as described in section 12. The cost of staff and administration by the department of labor and industry shall be deducted from this portion of the fund and it shall not exceed 1-1/2 percent of this portion of the fund.

Subd. 13. [PUBLIC INFORMATION AND EDUCATION PROGRAM.] Not less than three percent of the estimated annual balance of the fund may be used for public information and education programs concerning waste reduction, recycling, and anti-litter activities. The agency shall allocate not less than one-third of this portion of the fund to developing media campaigns to inform the public. The agency may create rules to promote and establish annual cash awards to Indian reservations, school boards, public and private nonprofit groups, and charitable organizatons for local public or school education and participation programs, in addition to outstanding achievement awards in recycling nonrefillable beverage containers, other waste material, and waste reduction efforts. The complement of the agency shall be increased by two positions and the cost of staff and administration shall not exceed seven percent of this portion of the fund.

Subd. 14. [CO-DISPOSAL OF SOLID WASTE AND SEWAGE SLUDGE.] Not more than one percent of the estimated balance of the fund may be used by the metropolitan council, the metropolitan waste control commission, and waste districts for research, development, planning, and program implementation of co-disposal of solid waste with sewage sludge, land application of sewage sludge and solid waste-derived products, mine reclamation using sewage sludge and solid waste-derived products, fly ashfill reclamation using sewage sludge and solid waste-derived products, and other land reclamation projects using sewage sludge and solid waste-derived products. Not more than 60 percent of this portion of the fund may be used by waste districts that do not have jurisdiction over waste that is generated in the metropolitan area. The agency shall establish rules for allocating money to outstate waste districts. The metropolitan council shall establish rules for allocating funds to waste districts that generate waste within the metropolitan area and the metropolitan waste control commission. All waste districts that generate waste from both inside and outside the metropolitan area shall apply for funding with the metropolitan council. The metropolitan council shall develop a study to implement co-composting in the metropolitan area. The council shall submit the plan for approval to the legislative commission on waste management no later than June 1, 1984. The metropolitan council shall be allocated at least 40 percent of this portion of the fund and is entitled to any unused part of the agency's allocation of this portion of the fund. The metropolitan council shall not be allocated any money from this portion of the fund until the council approves rules by the metropolitan waste control commission that will allow competition for sludge disposal between private business and the commission. These rules shall award the service of sludge disposal to enterprises that can demonstrate that proposed costs will be less than waste control commission costs.

When comparing bids against its own costs, the waste control commission shall compare the total capital and operating costs of each individual facility being bidded upon with the capital and operating cost of proposed operations. Bidders may require that the commission use alternative treatment, dewatering, and processing equipment. The cost of this additional equipment shall be included in the cost assessment. The metropolitan waste control commission cannot include the cost of amortizing existing equipment in comparing the costs of competing bids with the costs associated with existing capital and operating costs at commission facilities.

The agency and metropolitan council shall cease to receive allocations through this portion of the fund if ten percent of the mixed municipal solid waste stream is recovered through co-disposal technologies such as co-composting and co-digestion and if the end material is successfully marketed or used.

Subd. 15. [BUSINESS TAX CREDIT.] The agency shall allocate not more than one percent of the fund to the department of revenue for use in providing tax credits to business for the purchase of commodities manufactured with secondary materials recovered from solid waste.

The state complement of the department of revenue shall be increased by one to accommodate this tax credit program. Not more than 1.5 percent of the funds allocated to the department of revenue may be used for staff and administration.

A business shall receive as much as five percent of the total price paid for any commodity that is comprised of more than 50 percent post consumer municipal solid waste, if the commodity is in the following schedule. The business shall receive as much as five percent of the purchase value of the following products if the percentage of post consumer municipal solid waste is equal to, or exceeds, the percentage list in the following schedule:

SCHEDULE OF COMMODITIES ELIGIBLE FOR A BUSINESS TAX CREDIT

Federal Specification Number	Commodity	Minimum Percent Recovered Material
UU-C-1229	Cover, toilet seat	40
UU-T-450D	Tissue, facial	20
UU-T-595B	Towel, wiping, paper, institutional and industrial	20
UU-T-00598	Towel, paper (plastic-wiping)	20
UU-B-838D	Butter chip, paper	25
UU-C-806H	Cups and lids, paper, disposable	15
UU-P-670D	Plate, paper, rectangular and round	15
UU-P-202D	Graph paper	50 (grade C only)
UU-P-320B	Looseleaf paper, ruled and blank	30
UU-P-547J	Teletypewriter paper	20 (grade B only)
UU-P-561H	Paper, tracing	100 (except type B)
UU-P-663	Paperboard, drawing	85 (core only)
UU-T-110C	Computing machine tape	60 (type II

		only)
UU-C-95B	Guide cards	50 (except pressboard -35)
UU-D-650A	Doily, paper	50
UU-E-522E	Mailing, envelope	25 white bond; light colors -20 brown hued colors -30
UU-F-1206A	File folder	Grade A-35; Grade B, C and D -20
UU-L-0049C	Label, paper, gummed	25
UU-P-12C	Columnar pad	sheets - 20
UU-P-0016B	Pad, desk blotter	pad - 100; sheets - 20
UU-P-21F	Pad, writing paper (memo pad)	pad - 20; backing - 100
UU-P-63J	Blotting paper	35
UU-P-00556K	Paper, toilet tissue	80 (post consumer waste)
UU-T-591F	Towels, paper	80 (post consumer

		waste)
Xerographic and bond papers	50	
Raw organic materials	50	(post consumer waste

If requests for the business tax credit exceed the allocation of the fund to the department of revenue, the agency shall transfer the necessary unbudgeted portion of the fund to the department of revenue so that requests for the tax credit can be met. If the unbudgeted portion of the fund is insufficient to cover the cost of the business tax credit program, the department of revenue shall allocate the credit proportionately to businesses according to the purchase price of the approved commodities containing post consumer waste.

Subd. 16. [INVESTMENT TAX CREDIT FOR PRODUCTION OF NEW GOODS.] The agency shall allocate not more than one percent of the fund to the department of revenue to provide investment tax credits to facilities that use at least 50 percent secondary materials in the production of new goods.

Sec. 6. [116F.40] [SANITARY LANDFILLS; LIABILITY AND TAX.]

Subdivision 1. [LIABILITY FOR OPERATION, CLOSURE, AND DAMAGES.] An owner or operator of a land disposal facility shall be jointly and severally liable for the proper operation and closure of the facility, as required by law, and for damages, no matter by whom sustained, proximately resulting from the operations or closure.

Subd. 2. [TAX LEVY; PURPOSES.] There is levied upon the owner or operator of a land disposal facility a tax to ensure proper closure of the facility and to provide funds to compensate for damages resulting from the operations or closure of the facility. The tax shall be levied on waste accepted for disposal at the rate of 15 cents per compacted cubic yard. In the event that solid waste is measured, upon acceptance for disposal, by other than compacted cubic yards, the tax shall be levied on the equivalents of compacted cubic yards as the agency determines.

Subd. 3. [REGISTRATION.] An owner or operator of a land disposal facility that accepts waste for disposal and that is subject to the tax under this section shall, within 20 days after the effective date, register with the commissioner on prescribed forms.

Subd. 4. [TAX PERIOD REPORT AND PAYMENT OF TAX.] An owner or operator of a land disposal facility shall, on or before the 20th day of the month following the close of each tax period, (1) render a return under oath to the commissioner on a form that the commissioner prescribes indicating the number of compacted cubic yards of waste accepted for disposal; and (2) pay the full amount of tax due.

Subd. 5. [DETERMINATION OF TAX BY COMMISSIONER; HEARING.] If a return required in subdivision 4 is not filed, or if a return when filed is incorrect or insufficient in the opinion of the commissioner, the commissioner shall determine the amount of tax due from available information. Notice of the determination shall be given to the taxpayer who is liable for the payment of the tax. The determination shall finally and irrevocably fix the tax unless the person against whom it is assessed, within 30 days after receiving notice of such determination, applies to the commissioner for a hearing, or unless the commissioner on his or her own motion redetermines the tax. After the hearing, the commissioner shall give notice of the determination to the person against whom the tax is assessed.

Subd. 6. [PENALTIES, INTEREST.] A taxpayer who fails to file a return when due or to pay a tax when due, shall be subject to penalties and interest as provided by Minnesota Statutes, section 290.53. If the commissioner determines that the failure to comply with a provision of this section was excusable under the circumstances, the commissioner may remit part or all of the penalty as appropriate under the circumstances.

Sec. 7. [116F.41] [SANITARY LANDFILL FACILITY CONTINGENCY

FUND.]

Subdivision 1. [REVOLVING FUND CREATED.] The sanitary landfill facility contingency fund is established as a nonlapsing, revolving fund. The fund shall be administered by the agency and shall be credited with all tax revenue collected by the commissioner, pursuant to section 6. Interest received on money in the fund shall be credited to the fund.

Subd. 2. [PURPOSE.] The fund shall be used only to pay all direct and indirect damages, no matter by whom sustained, proximately resulting from the operations or closure of any land disposal facility, and administrative costs incurred under this section. Expenses for which the fund may be used include, but are not limited to:

a. the cost of restoration and replacement, where possible, of any natural resource damaged or destroyed, including any potable water supply; and

b. the costs of the design, construction, installation, operation, and maintenance of any device or action deemed necessary by the agency to cleanup, remedy, mitigate, monitor, or analyze any threat to the public health, safety, or welfare of the citizens of this state, including the installation and maintenance of methane gas monitors and vents and leachate monitoring wells and collection systems, and the sampling and analysis of a public or private potable water supply.

Subd. 3. [PRORATED PAYMENT OF CLAIMS.] If the total amount of claims awarded exceeds the current balance of the fund, the immediate award shall be paid on a prorated basis, and all claimants paid on a prorated basis shall be paid as determined by the agency, on a pro rata share of all money received by the fund until the total amount of the proven damages is paid to the claimants. The agency may provide by rule a priority for the payment of claims based on extreme hardship or extreme existing or imminent hazard.

Subd. 4. [LIMITATIONS ON CLAIMS.] Claims against the fund shall be filed within one year of the date of discovery of damage, and in the manner the agency prescribes.

Subd. 5. [ESCROW DEPOSIT.] An owner or operator of a land disposal facility shall deposit, on a monthly basis in an interest-bearing escrow account with an accredited financial institution, an amount equal to 30 cents per compacted cubic yard of waste accepted for disposal during the preceding month at the land disposal facility. If waste is measured by other than compacted cubic yards, the amount to be deposited shall be calculated by using the equivalents of compacted cubic yards as the agency determines.

Subd. 6. [CRIMINAL PENALTY.] An owner or operator of a disposal facility who fails to deposit funds into an escrow account as provided in subdivision 5, or who uses escrow funds for a purpose other than closing costs approved by the agency commits a gross misdemeanor.

Subd. 7. [ANNUAL AUDIT OF ESCROW ACCOUNT.] An owner or operator of a land disposal facility shall file with the commissioner an annual audit of the escrow account. The audit shall be conducted by a certified public accountant, and shall be filed no later than October 31 of each year.

Subd. 8. [MONEY REMAINING IN ESCROW ACCOUNT.] Money remaining in the escrow account of a land disposal facility five years after proper and complete closure, as determined by the agency, shall be paid by the owner or operator into the fund.

Subd. 9. [SUBROGATION OF RIGHTS.] The fund shall pay damages if the agency acquires by subrogation all rights of the claimant to recovery of the damages from an owner or operator of a land disposal facility.

Sec. 8. [116F.42] [IMPOSITION OF SURCHARGE.]

Notwithstanding the provisions of any law to the contrary, the owner or operator of a land disposal facility may collect the taxes and escrow payments imposed by sections 6 and 7 as a surcharge for the waste disposal operations of the facility.

Sec. 9. [116F.43] [OTHER REMEDIES; DOUBLE RECOVERY PROHIBITED.]

Nothing in section 6 or 7 precludes the pursuit of any other civil or injunctive remedy by any person. The remedies provided in sections 6 and 7 exist in addition to those provided by statutory or common law, but no person who receives compensation for damages pursuant to any other state or federal law shall be permitted to receive compensaton for the same damages or cleanup costs under sections 6 and 7.

Sec. 10. [116F.44] [SALE OF LAND DISPOSAL FACILITY.]

No person shall contract to sell land which has been used as a land disposal facility at any time prior to the effective date of sections 1 to 22, unless the contract of sale for the land states the fact and the period of time that the land was so used. The agency shall provide, upon written request, to a prospective purchaser of such land a history of the compliance by the facility with all applicable statutes and rules administered by the agency. A contract made in violation of this section is voidable.

Sec. 11. [116F.45] [LANDFILL PERMIT FEE.]

Subdivision 1. [ANNUAL FEE.] An owner or operator shall annually deposit with the commissioner the following fees:

(a) unpermitted site, $5,000;

(b) sanitary landfill:

(1) over 100,000 cubic yards per year, $20,000;

(2) between 50,000 to 100,000 cubic yards per year, $10,000;

(3) between 10,000 to 50,000 cubic yards per year, $5,000;

(4) between 5,000 to 10,000 cubic yards per year, $2,500; and

(5) less than 5,000 cubic yards per year, $1,000;

(c) demolition landfill, $500; and

(d) modified landfill, $500.

Subd. 2. [ALLOCATION.] The commission shall allocate 25 percent of the fees collected to the agency and the county where the facility is located.

Subd. 3. [PURPOSE.] This money shall be used by the agency and the counties for the sole purpose of defraying costs incurred through solid waste management programs.

Subd. 4. [WASTE ABATEMENT AND RECYCLING FUND.] The remainder of the fund shall be placed into the waste abatement and recycling fund for the purposes contained in section 5.

Sec. 12. [116F.46] [DISPLACED WORKERS.]

A worker who is displaced or loses a job in the beverage container manufacturing industry within two years of the effective date of sections 1 to 22 and as a direct result of sections 1 to 22, shall receive not more than one full year of compensation at full salary. This compensation shall be administered by the department of labor and industry and shall be paid in lieu of unemployment insurance benefits provided under chapter 268. A worker may also claim a credit against any individual income tax due the state for the taxable year for the cost of vocational or educational training or retraining and for any moving expenses due to relocation in order to obtain employment, if not paid by the employer. The credit shall be equal to 100 percent of the cost of the vocational or educational training or retraining and for any moving expenses due to relocation in order to obtain employment, but shall not exceed $5,000. If the amount of the credit provided exceeds the taxpayer's liability for the taxable year, the excess may be carried forward to future taxable years until the actual or maximum allowable credit has been taken.

Sec. 13. [116F.47] [PROCUREMENT OF RECYCLED COMMODITIES.]

(a) The department of administration shall establish rules to increase the purchases of recycled commodities by state government. These rules shall establish a 20 percent price preference for commodities containing recycled materials manufactured in Minnesota, in order to reflect the inherent land, energy, and natural resource savings not considered in the purchase price. In addition, a ten percent price preference shall be given to commodities containing recycled materials not manufactured in Minnesota. These rules shall include, but not be limited to, the following items: cellulose insulation, office paper, vehicle oil, tires, and compost.

(b) The state architect shall specify the use of cellulose insulation in all state buildings. First preference shall be given to cellulose insulation made with post-consumer waste and manufactured in Minnesota. Second preference shall be given to cellulose insulation which is manufactured outside of Minnesota.

(c) Department of administration rules shall be made consistent so that specifications and guidelines published for soliciting bids do not contain requirements for only "virgin materials."

(d) Department of administration rules shall be made consistent so that specifications for office papers do not require a minimum brightness factor greater than 55. State specifications on printing and bond papers shall not restrict papers with Tappi dirt or speck counts of 15 point three specks and 50 point one specks. Ruled and unruled scratch pad specifications shall not exclude purchasing of papers with Tappi dirt counts up to 50 point three specks and 100 point one specks.

(e) The department of administration shall establish performance standards on motor oil and purchase re-refined oil whenever possible.

(f) The department of administration shall establish specifications to provide that recapped tires can be used on state vehicles.

(g) The department of administration shall specify preference for compost as a substitute for black dirt, soil amendments, and plant nutrients whenever possible.

Sec. 14. [116F.48] [METROPOLITAN BILLING SYSTEM AND COMMISSION FOR SOLID WASTE COLLECTION.]

Subdivision 1. [ESTABLISHMENT OF DISTRICT AND COMMISSION; PURPOSE; AREA; GOVERNING BODY.] A metropolitan solid waste collection billing system is created to provide a billing system for solid waste haulers and their customers in the metropolitan area as defined in section 473.121. The area of the district is the metropolitan area. The metropolitan solid waste billing system commission is created as the governing body of the district, composed and exercising the powers as prescribed in subdivision 8.

Subd. 2. [COMMISSION MEMBERSHIP; TERMS.] The system established in subdivision 1 shall be operated by a commission which shall consist of two members from each county within the system, except that a county within the system which has a seven member county board as provided in section 375.01, shall have one additional member on the commission. Commissioners shall be members of the board of county commissioners of their respective counties, and shall be appointed by their respective boards of county commissioners.

The terms of the members of the first commission shall expire on December 31 next following their appointment. Thereafter the terms of the commissioners shall be one year commencing on January 1 of each year.

If a vacancy occurs on the commission, it shall be filled by the appropriate board of county commissioners.

A person appointed to the commission shall qualify as a commissioner by filing with the director of the commission a written certificate of appointment from the county auditor, together with a written acceptance of the appointment; provided that the members of the first commission shall file in the office of the county auditor of Hennepin county.

Subd. 3. [ORGANIZATIONAL MEETING.] The commission shall meet on the first Wednesday after the first Monday in January of each year in order to select the officers of the commission for the current year and to conduct other necessary organizational business.

Subd. 4. [OFFICERS.] The officers, who shall be commissioners, shall be a chairperson, a vice-chairperson, and a secretary, no two of whom shall be from the same county. The chairperson shall preside at meetings of the commission, and in his or her absence, the vice-chairperson shall preside. The secretary shall keep a complete record of meeting minutes.

Subd. 5. [CONTRACTS.] Contracts and other written instruments of the commission shall be signed by the chairperson or vice-chairperson and by the business administrator of the commission pursuant to authority from the commission.

Subd. 6. [BYLAWS.] The commission may adopt bylaws to regulate its own proceedings.

Subd. 7. [VOTING RIGHTS.] A county in the system shall have one vote. Each commissioner shall have one-half vote, but if only one commissioner from a county is present, he or she shall have one full vote. The majority of the voting power of the commission shall be a quorum, although a smaller number may adjourn from time to time. A motion other than adjournment shall be favored by a majority of the voting power of the commission in order to carry.

Subd. 8. [POWERS AND DUTIES OF COMMISSION.] The commission shall establish rules governing the establishment of a comprehensive billing system for solid waste collection in the Twin City metropolitan area. These rules shall provide:

(a) that private haulers can adjust their monthly billing to customers with a 60-day notice to the commission;

(b) that the commission may prepare requests for proposals to private enterprises to provide the necessary services to establish a centralized billing system;

(c) that the commission is responsible for bill collections, and that waste haulers are paid monthly for units for which collection was provided regardless of the status of the customer account;

(d) that residential and commercial collection rates are established on a per can or volume basis; and

(e) that the commission bills housing and commercial establishments in the metropolitan area monthly and that these customers shall be charged for the cost of hauling services, billing administration, closure and post-closure costs of landfills, mitigation and compensation, and money to be contributed to the metropolitan portion of the waste abatement and recycling fund.

Sec. 15. [116F.49] [CENTRALIZED METALS RECOVERY.]

Subdivision 1. [BONDING AUTHORITY.] The metropolitan council may issue industrial revenue bonds for the purpose of fulfilling council responsibilities as a Minnesota housing and redevelopment authority and as an authority for which industrial development projects can be financed. The council may issue bonds for the purpose provided in subdivision 4.

Subd. 2. [DELAYED ENFORCEMENT OF RULES.] The metropolitan council and Minnesota pollution control agency shall allow a delay in the enforcement of pretreatment rules until January 1, 1986, when the Twin City metal platers and circuit board manufacturers have been given a reasonable opportunity to design and implement a centralized metal recovery operation.

Subd. 3. [ALLOCATION.] The legislature allocates $300,000 to the metropolitan council from the waste abatement and recycling fund during 1983 to fund engineering and architectural design of the centralized metal recovery facility.

Subd. 4. [COOPERATIVE.] Twin Cities metal platers, circuit board manufacturers, and other users of the metropolitan waste control commission sewer system that discharge heavy metals, may establish a cooperative to insure and bond the centralized treatment facility and equipment operated at each business location that collects or processes metals and other materials to be treated, processed, and marketed at the centralized metals recovery facility.

Sec. 16. [116F.50] [METROPOLITAN AREA ORGANIZED COLLECTION SYSTEM.]

The metropolitan council, with the assistance of its waste management advisory committee, shall develop a plan to implement organized collection of residential and commercial solid wastes in the metropolitan area. The council shall submit the plan for approval to the legislative commission on waste management, no later than June 1, 1984. The plan shall go into effect no later than one year after approval by the legislative commission on waste management. The purpose of this plan is: (1) to reduce the costs of all solid waste collection by developing a more efficient and more coordinated system of collection and transportation of solid waste; (2) to encourage source separation programs to be developed in conjunction with organized collection; (3) to encourage competition from a large variety of private solid waste hauling firms; (4) to maintain the current diversity of hauling operations in the metropolitan area to prevent monopolistic conditions; and (5) to provide for easier implementation of resource recovery systems.

Sec. 17. [116F.51] [STUDIES AND REPORTS.]

Subdivision 1. [ANNUAL REPORT BY AGENCY.] By June 30 of each year, the agency shall file a report to the legislative commission on waste management specifying the total amount of money collected by the commissioner pursuant to sections 3 and 10 for the fiscal year, the total amount of the surplus in the waste abatement and recycling fund, the payments made pursuant to section 5, and recommendations for legislation or other actions.

Subd. 2. [LOSS OF EMPLOYMENT STUDY.] The department of economic security shall annually conduct a study for a period of four years after the effective date of sections 1 to 22 on loss of employment directly related to, or caused by, the provisions of sections 1 to 22. The study shall be forwarded by June 30 of each year to the legislative commission on waste management.

Subd. 3. [OTHER DEPARTMENTAL ANNUAL REPORTS.] By June 30 of each year, the department of energy, planning and development; the waste abatement board; the department of transportation; the department of revenue; and the department of labor and industry shall file a report with the legislative commission on waste management specifying their activities pursuant to sections 1 to 22, and recommending legislation or other actions.

Subd. 4. [LEGISLATIVE COMMISSION ON WASTE MANAGEMENT STUDY.] The legislative commission on waste management shall prepare a study to review and analyze the allocations made pursuant to section 5, and to recommend legislation or other actions. The study shall include, but is not limited to, an analysis and recommendations on:

(a) methods to meet the conditions specified in section 15, including developing local waste markets and uses for recovered waste, establishing litter control or waste collection and management programs of local units of government, and subsidizing regional collection, separation, and transfer systems until recycling becomes economically viable; and

(b) ensuring the money surplus pursuant to section 3 diminishes if the conditions specified in section 5 are met.

Sec. 18. [116F.52] [FLOW OF WASTE CONTROL.]

Waste districts and units of government using their power to direct the flow of waste to specific solid waste facilities shall:

(a) Spend 75 cents per capita in 1983 dollars for waste reduction and recycling educations for the public and for local school education programs;

(b) Direct the flow of recyclables to a recycling processing facility and require source separation by residents and waste generators, or there shall be no flow control restrictions placed on potentially recyclable wastes that are or might at some time in the future be collected through source separation programs. Recycling and waste reduction efforts shall be allowed to prevent or recover as much as 50 percent of the mixed municipal solid waste stream without flow control regulation; and

(c) If the flow of recyclables is controlled, contracts for collection of recyclables, materials processing, and marketing shall be awarded to enterprises or organizations providing the lowest bid or highest return to the district or unit of government while meeting public safety and environmental standards. Contractors shall charge the identical tip fee that is assessed for waste which is accepted by resource recovery facilities operated by the district or units of government.

Sec. 19. [116F.53] [RULES.]

The department of revenue and the agency shall adopt rules necessary to perform responsibilities under sections 1 to 18.

Sec. 20. Minnesota Statutes 1982, section 116F.06, is amended by adding a subdivision to read:

Subd. 2a. The agency shall develop rules to require a labeling system for each package sold for consumption in Minnesota after 1985. The labeling system shall provide the following:

(a) A green recycling emblem shall be placed on each package that is made from at least 25 percent recycled material or is recyclable.

(b) A yellow recycling emblem shall be placed on each package that is made from at least 25 percent recycled material but is not recyclable.

(c) A red recycling emblem, with a line drawn through it shall be placed on each package sold for consumption in Minnesota that is composed of materials, whether alone or in combination that result in a package that is not recyclable.

Sec. 21. Minnesota Statutes 1982, section 116F.06, is amended by adding a subdivision to read:

Subd. 2b. Industries that sell products in Minnesota that are not regulated under this section are encouraged to voluntarily adopt the labeling system provided in section 20.

Sec. 22. Minnesota Statutes 1982, section 290.06, is amended by adding a subdivision to read:

Subd. 9b. [SECONDARY MATERIALS PROCESSORS AND MANUFACTURERS.] A credit of ten percent of the costs of qualified facilities that utilize at least 50 percent post-consumer secondary materials in the production of new goods may be deducted from the tax due under this chapter for the first three years of operation. This credit is in lieu of any deductions or grants to which the taxpayer may otherwise be entitled. If the amount of this credit exceeds the taxpayer's liability under this chapter for the taxable year, the excess may be carried forward to succeeding years until the credit is used.

A "qualifying facility" is a plant, facility, land, building, machinery vehicles, tools, or equipment that is constructed, reconstructed, erected, installed, improved, put into operation, utilized, or acquired by a trader or business for the primary purpose of processing or manufacturing secondary materials into commercially marketable raw materials or products. The facility must have a useful life of three years and must be placed into operation within five years of the original application. The facility must be located within Minnesota.

"Post-consumer secondary material" is material that is utilized in the place of primary or raw material in manufacturing a new product. This material includes waste paper and secondary fibers, glass cullet, ferrous metals, plastics, tires, discarded textiles, and raw organic matter reclaimed by taxpayers from garbage, trash, refuse, or commercial or agricultural operations.

This material does not include waste or scrap that is created in a manufacturing or converting operation which is reused by the same manufacturer or waste or scrap purchased from another manufacturer who manufactures the same or closely related products to products manufactured by the taxpayer.

Sec. 23. [EFFECTIVE DATE.]

Sections 1 to 22 are effective July 1, 1984.

05/19/83 [REVISOR] MVH/KC 83-2578

Introduced by D. Nelson, Long

H.F. No. 1361

May 23rd, 1983
Ref. to Com. on Environment & Natural Resources

Companion S.F. No. ________
Ref. to S. Com. on ________

Reproduced by PHILLIPS LEGISLATIVE SERVICE, INC.

A bill for an act

relating to solid waste; imposing a tax on operators of solid waste disposal facilities; establishing funds for abatement, cleanup, closure, and postclosure care of solid waste disposal facilities; providing duties and authority to the pollution control agency; requiring adoption of rules for closure, postclosure care, and financial responsibility for landfill operators; providing penalties; appropriating money; proposing new law coded in Minnesota Statutes, chapter 116.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF MINNESOTA:

Section 1. [116.46] [SOLID WASTE LANDFILL TAX.]

Subdivision 1. [DEFINITIONS.] The definitions provided in this subdivision apply to sections 1 to 4.

(a) "Agency" means the pollution control agency.

(b) "Commissioner" means the commissioner of revenue.

(c) "Mixed municipal solid waste" means the waste defined in section 115A.03, subdivision 21.

(d) "Operator" means the permittee, owner, or other person in control of a facility under a lease, contract, or other arrangement.

(e) "Remedial action" means action taken to prevent, mitigate, or minimize pollution of water, land, or air which is caused by a solid waste disposal facility and which poses a substantial danger to the public health or welfare or the environment, including investigation and monitoring action.

(f) "Solid waste disposal facility" means real or personal property which is primarily used for the land disposal of mixed municipal solid waste.

Subd. 2. [AMOUNT OF TAX; APPLICATION.] The operator of a solid waste disposal facility shall pay a tax on solid waste accepted at the facility as follows:

(a) A solid waste disposal facility that weighs the waste which it accepts shall pay a tax of $3 per ton of solid waste accepted.

(b) A solid waste disposal facility that does not weigh the waste which it accepts but that measures the volume of the waste shall pay a tax of 90 cents per cubic yard of waste accepted.

(c) A solid waste disposal facility that does not measure the weight or volume of waste accepted shall pay a tax based on equivalent cubic yards accepted by the facility as determined by the agency.

The tax imposed under this subdivision may be reduced by the amount of tax which is attributable to waste accepted by the facility which is separated for recycling or reuse and is not land disposed.

Subd. 3. [TAX REDUCED UPON PROOF OF FINANCIAL RESPONSIBILITY.] The tax imposed on an operator of a facility that has submitted proof of financial responsibility which meets the requirements of agency rules under section 4 is reduced by one-third. The director of the agency shall certify the adequacy of proof of financial responsibility under this subdivision.

Subd. 4. [PAYMENT OF TAX.] On or before the 20th day of each month each operator shall pay the tax due under this section for the previous month, using a form provided by the commissioner.

Subd. 5. [EXCHANGE OF INFORMATION.] Notwithstanding the provisions of section 116.075, the pollution control agency may provide the commissioner of revenue with the information necessary for the enforcement of this section. Information disclosed in a return filed under this section is public information. Information exchanged between the commissioner and the agency is public unless the information is of the type determined to be for the confidential use of the agency under section 116.075 or is trade secret information classified under section 13.37. Information obtained in the course of an audit of the taxpayer by the department of revenue shall be private or nonpublic data to the extent that it is not directly divulged in a return of the tax.

Subd. 6. [PENALTIES; ENFORCEMENT.] The audit, penalty, and enforcement provisions applicable to taxes imposed under chapter 290 apply to the taxes imposed under this section and those provisions shall be administered by the commissioner.

Subd. 7. [RULES.] The commissioner may adopt temporary and permanent rules necessary to implement the provisions of this section.

Subd. 8. [ADMINISTRATIVE EXPENSES.] Any amount expended by the commissioner from a general fund appropriation to enforce and administer this section shall be reimbursed to the general fund and the amount necessary to make the reimbursement is appropriated from the landfill abatement fund to the commissioner of finance for transfer to the general fund.

Subd. 9. [DISPOSITION OF PROCEEDS.] The proceeds of the taxes imposed under this section including interest and penalties shall be deposited as follows:

(a) two-thirds of the proceeds shall be deposited in the landfill abatement fund established in section 2; and

(b) one-third of the proceeds shall be deposited in the landfill closure, postclosure, and remedial action fund established in section 3.

Sec. 2. [116.47] [LANDFILL ABATEMENT FUND.]

Subdivision 1. [ESTABLISHMENT; PURPOSES.] The landfill abatement fund is created as an account in the state treasury in order to reduce to the greatest extent feasible and prudent the need for and practice of land disposal of mixed municipal solid waste. The fund shall consist of revenue deposited in the fund under section 1, subdivision 9, clause (a) and interest earned on investment of money in the fund. Subject to appropriation by the legislature, the money in the fund may be spent only for the following purposes:

(a) solid waste management planning assistance under sections 115A.42 to 115A.46;

(b) solid waste management demonstration projects under sections 115A.49 to 115A.53;

(c) grants to eligible recipients for resource recovery projects and market development under subdivision 3;

(d) grants for research and development in the area of solid waste abatement and market development for reusable or recyclable solid waste materials;

(e) grants to complete and implement county and regional landfill abatement plans; and

(f) regulatory activities of the agency as described in subdivision 2, clause (b).

Subd. 2. [APPROPRIATIONS.] (a) Up to ten percent of the money in the fund may be appropriated to the agency for grants under subdivision 1, clause (d).

(b) Up to ten percent of the money in the fund may be appropriated to the agency for development, adoption, and enforcement of rules relating to solid waste management including rules required to implement sections 1 to 4.

(c) Of the amounts appropriated for purposes other than clauses (a) and (b), 60 percent of the amount appropriated is available to the pollution control agency for assistance to political subdivisions and other eligible recipients outside of the metropolitan area as defined in section 473.121, and 40 percent is available to the agency for assistance to political subdivisions and other eligible recipients in the metropolitan area. Not more than ten percent of each amount may be used by the agency and the council to administer the grants.

Subd. 3. [RESOURCE RECOVERY PROJECTS; MARKET DEVELOPMENT.] Grants may be made to eligible recipients for resource recovery projects and development of markets for reusable or recyclable solid waste materials. The grants may include the cost of planning, acquisition of land and equipment, capital improvements, and operation of a project. Grants under this subdivision for acquisition of land and equipment and for capital improvements may not exceed 50 percent of the cost of the project. Grants for operating costs are limited to not more than five years of operation beginning at not more than 50 percent of the costs in the first year and reduced in each succeeding year by at least one-fifth of the amount paid in the first year. Eligible recipients under this subdivision are limited to cities, counties, and solid waste management districts. Eligible recipients may apply for grants under this subdivision on behalf of other persons. The grant program under this subdivision shall be administered by the pollution control agency according to rules adopted under chapter 14, except in the metropolitan area where the program shall be administered by the metropolitan council under chapter 473 in a manner consistent with the rules of the agency.

Sec. 3. [116.48] [LANDFILL CLOSURE, POSTCLOSURE, AND REMEDIAL ACTION FUND.]

Subdivision 1. [ESTABLISHMENT.] The landfill closure, postclosure, and remedial action fund is created as an account in the state treasury. The fund consists of revenue deposited in the fund under section 1, subdivision 9, clause (b); amounts recovered under subdivision 5; and interest earned on investment of money in the fund. Subject to appropriation by the legislature, money in the fund may be spent by the agency as provided in subdivisions 2 to 4.

Subd. 2. [REMEDIAL ACTION.] The agency may take reasonable and necessary remedial action with respect to a solid waste disposal facility, including a closed facility. Except for remedial action under subdivision 3 or 4, the agency may take remedial action only if it determines that the operator or other person responsible for remedial action is unwilling or unable to take the action. Except as otherwise provided in subdivisions 3 and 4, the operator of a solid waste disposal facility may be required to pay the expenses of remedial action taken by the agency at the facility as provided for recovery of cleanup expenses under section 115.071, subdivision 3.

Subd. 3. [ASSISTANCE FOR CLOSURE, POSTCLOSURE, AND REMEDIAL ACTION.] For a facility that is not required to comply with the financial responsibility rules of the agency adopted under section 4, subdivision 2, and that is not subject to a reduced rate of tax under section 1, subdivision 3, the agency shall pay:

(a) Up to one-half of the reasonable and necessary expenses for closure and postclosure care authorized by the agency at a facility for which the operator has paid the full tax under section 1, subdivision 3. An operator is eligible for payment of ten percent of the expenses for every four years of payment of the full tax under section 1, subdivision 3; and

(b) One-half of the reasonable and necessary expenses of remedial action taken at the facility by or with the authorization of the agency unless the conditions that required remedial action were caused by failure of the operator to comply with the terms of an agency permit, order, rule, or stipulation.

No operator is eligible for payments under this subdivision for costs incurred before the rules adopted under section 4 are effective. This subdivision does not apply to a facility that qualifies for postclosure care under subdivision 4.

Subd. 4. [POSTCLOSURE CARE.] The agency shall pay the expenses of postclosure care and reasonable and necessary remedial action at a facility that has been closed in compliance with the closure rules of the agency and that has complied with the postclosure care rules of the agency for at least five years to demonstrate that there is no substantial likelihood that the facility will cause pollution of the water, land, or air outside of the facility site that poses a substantial danger to the public health or welfare or the environment. The operator of the facility is not liable under section 115.071 or any other law for the expenses of postclosure care or remedial action taken by the agency at that facility under this subdivision.

Subd. 5. [RECOVERY OF EXPENSES.] Any provision of this section which relieves the operator of a facility from liability for the payment of the agency's expenses for remedial action, closure, or postclosure care shall not be construed to affect the liability of any other person who may be liable for those expenses. When the agency incurs expenses for remedial action, closure, or postclosure care at a facility, the agency is subrogated to any right of action which the operator of the facility may have against any other person for the recovery of the expenses. The attorney general may bring an action to recover amounts spent by the agency under this section from persons who may be liable for them. Amounts recovered shall be deposited in the landfill closure, postclosure, and remedial action fund.

Subd. 6. [RULES.] The agency shall adopt rules to administer this section, including procedures for: (a) evaluating and taking appropriate remedial action; (b) providing assistance for closure and postclosure care under subdivision 3; and (c) paying expenses under subdivision 4.

Sec. 4. [116.49] [LANDFILL CLOSURE AND POSTCLOSURE; FINANCIAL RESPONSIBILITY.]

Subdivision 1. [CLOSURE AND POSTCLOSURE RULES.] The agency shall adopt rules establishing requirements for the closure of solid waste disposal facilities and for the postclosure care of closed facilities. The rules shall apply to all disposal facilities in operation at the time the rules are adopted. Compliance with the rules shall be a condition of obtaining or retaining a permit to operate the facility. The rules shall provide standards and procedures for closing disposal facilities and for the care, maintenance, and monitoring of the facilities after closure which will prevent, mitigate, or minimize the dangers to public health and the environment that are posed by closed disposal facilities.

Subd. 2. [FINANCIAL RESPONSIBILITY RULES.] The agency shall adopt rules requiring the operator of a solid waste disposal facility to submit to the agency proof of the operator's financial capability to provide reasonable and necessary remedial action during the operating life of the facility and to provide for the closure of the facility and postclosure care required under agency rules. Proof of financial responsibility shall be required of the operator of a facility receiving an original permit or a permit for expansion after adoption of the rules and to the operator of a facility with a remaining capacity of more than five years or 500,000 cubic yards that is in operation at the time the rules are adopted. Compliance with the rules shall be a condition of obtaining or retaining a permit to operate the facility.

Sec. 5. [APPROPRIATION AND COMPLEMENT.]

Subdivision 1. [LANDFILL ABATEMENT FUND.] The following amounts are appropriated from the landfill abatement fund to the pollution control agency for the biennium ending June 30, 1985:

(a) for solid waste management planning assistance under sections 115A.42 to 115A.46, $..........;

(b) for solid waste demonstration projects under sections 115A.49 to 115A.53, $..........;

(c) for grants for resource recovery projects and market development under section 2, subdivision 3, $..........;

(d) for grants for research and development under section 2, subdivision 1, clause (d), $..........;

(e) for grants for landfill abatement planning under section 2, subdivision 1, clause (e), $..........; and

(f) for solid waste management regulatory activities of the pollution control agency under section 2, subdivision 2, clause (b), $...........

Subd. 2. [LANDFILL CLOSURE, POSTCLOSURE, AND REMEDIAL ACTION FUND.] $.......... is appropriated from the landfill closure, postclosure, and remedial action fund to the pollution control agency for the biennium ending June 30, 1985, for remedial action under section 3, subdivision 2. Not more than $.......... of that amount may be spent for administrative expenses.

Subd. 3. [COMPLEMENT OF POLLUTION CONTROL AGENCY.] The complement of the pollution control agency is increased by ...

positions to implement sections 1 to 4.

Subd. 4. [TAX ADMINISTRATION.] $.......... is appropriated from the general fund to the commissioner of revenue for the purpose of administering section 1. This appropriation shall be reimbursed to the general fund under section 1, subdivision 8. The complement of the department of revenue is increased by .... positions.

Sec. 6. [EFFECTIVE DATE.]

Section 4 is effective the day following final enactment. The remaining sections of this act are effective July 1, 1984.

Abatement/Planning Issues

1. It has been suggested that solid waste management is not perceived as a problem by the general public and therefore abatement is not perceived as necessary. Do you think that lack of public awareness is a serious problem? What has been your past experience with this problem? Finally, what do you think the state and county should do to improve public awareness of solid waste management? (i.e: school programs and curriculum, media campaigns, literature distribution).

2. Do you think the state and county government systems should assume a leadership role in waste abatement? What actions should the government take? (i.e. change purchasing and design specifications, require recycling programs, procure products through life cycle costing.)

3. In many areas of the state, some materials cannot be reclaimed because of lack of established markets which are close enough to allow for economically viable recovery. What actions should the state take to improve the market situation? (provide grants/loans for facilities and research and development, provide investment property or sales tax credits)

4. Should counties and other entities applying for land disposal permits be required to thoroughly consider, and choose where feasible, non disposal alternatives? Does the EAW/EIS process accomplish this task? Should a waste abatement plan be required before a permit is issued?

Enforcement Issues

1. Is there a solid waste management problem in Minnesota? If so, what should the priority actions be to resolve the problem? Do you think current enforcement actions have been effective? Are they timely? How could they be improved? What are the alternative approaches to enforcement?

2. What type of standards should the agency enforce? Which ones are the most important? Are aesthetic concerns important in landfill operations?

3. Should transfer stations, tire storage areas, junk yards, demolition or compost sites be regulated? By whom?

4. What is the county role in solid waste management?

5. What should the county role be in enforcement? For private operations? For public?

6. Are open and abandoned dumps a problem? If so, what should be done? By whom?

7. Should non-hazardous industrial wastes (sludges, resins, etc.) be regulated? How? By whom?

Closure/Post-closure/Contingency Funding Issues

1. How many unpermitted disposal sites remain unclosed (open dumps, inactive sites)?

2. How has the local government attempted to achieve closure?

3. Have counties been requiring performance bonds at permitted landfills? If not why? If so, what have they accomplished? Should the Agency be responsible for bonding owners/operators? Are performance bonds adequate to ensure proper closure?

4. How should closure/post-closure/contingency actions at both permitted and unpermitted landfills be required? How should they be funded? Should post-closure be required at terminated dumps? How should this be funded?

5. Who should manage closure/post-closure/contingency funds? How can the red tape be kept to a minimum but ensure reports and payment are accurate? How should funds be collected and what amount?

6. Should a portion of the closure/post-closure or contingency funds be dedicated to inspection and enforcement by MPCA? By counties? Both or neither? Should permit fees be collected by MPCA to fund inspection enforcement and permit programs?

7. How should funding sources affect modified landfills? Should they receive more or less aid based on size?

8. Currently, the Agency's policy is to require most closure activities at permitted landfills (grading, final cover, seeding) to be completed while the facility is active. Should the general fund or other tax generated funds be used to pay for all such activities or only at those sites which are improperly closed and no efforts are made by the owner to correct the situation?

9. When, if ever, should the state be responsible for post-closure care? How should these funds be collected?

10. A contingency plan is intended to review the possible problems which might arise at a disposal site and present the necessary procedures, with cost estimates, to correct the situation. What type of actions (ground water flow diversion, collection, treatment, surface drainage modifications, increased monitoring, repair damaged vegetation, reseeding, etc.) should the fund pay for? Which things should not be funded?

11. What is necessary to get remedial actions, closure, and post-closure care done properly and in a timely manner? Should the Agency have the ability to levee fines and hire the work completed with costs charged to the disposal site owner?

12. How should publicly owned facilities fit into funding requirements?

13. Is an escrow account, with funds reverting to the state if not used by the contributor, likely to act as an incentive for the permitee to delay, until closure, activities that should be done during the operational life of the facility?

14. Should remedial actions at disposal sites go beyond isolating or containing the waste source to containing and treating contaminated ground water?

Liability Issues

1. Who should be liable for problems at disposal sites?

2. What types of financial mechanisms should be used - trust fund, insurance, letter of credit, bonds, etc.?

3. How should publicly owned facilities fit into this process?

4. How long should the appropriate party(ies) be held liable for problems at the site?

5. If the state assures responsibility for the site at some future time, how should this be accomplished?

6. Should any distinction be made in extent of liability for owners of existing sites (especially those with limited remaining lifespan) <u>vs</u>. sites permitted after any change in legislation?

Letter was sent to the the following list of people on August 18, 1983:

Mr. Richard Pecar
Resource Management Associates, Inc.
333 Sibley Street
St. Paul, Minnesota 55101

Mr. Nelson French
Project Environment
Boyd Place Suite North
2929 Fourth Avenue South
Minneapolis, Minnesota 55408

Mr. Curtis Johnson
Citizens League
Syndicate Building
84 South Sixth Street
Minneapolis, Minnesota 55402

Mr. John Madole
Washington County Solid Waste Planner
14900 61st Street North
Stillwater, Minnesota 55082

Ms. Barbara Kelley
Minnesota Waste Association
Suite 600, St. Paul Building
6 West Fifth Street
St. Paul, Minnesota 55102

Ms. Norma Cameron
Minnesota Department of Administration
671 North Robert Street
St. Paul, Minnesota 55101

Mr. Daniel Krivit
Minneapolis Department of Public Works
City Hall
350 South Fifth Steet, Room 203
Minneapolis, Minnesota 55415

Mr. David Locey
Minnesota Soft Drink Association
2353 Rice Street
Roseville, Minnesota 55113

Mr. Robert Pulford
Minnesota Waste Management Board
123 Thorson Building
7323 - 58th Avenue North
Crystal, Minnesota 55428

Mr. Paul Smith
Metropolitan Council
Room 300, Metro Square Building
7th and Robert Streets
St. Paul, Minnesota 55101

Ms. Sue Fries
Metropolitan Inter-County Association
114 Metro Square Building
7th and Robert Streets
St. Paul, Minnesota 55101

Ms. Jeanne Crampton
Minnesota League of Women Voters
555 Wabasha, Room 212
St. Paul, Minnesota 55102

Ms. Linda Bruemmer
Planning Division
Minnesota Department of Energy,
Planning and Development
Room 100, Capitol Square Building
St. Paul, Minnesota 55101

Mr. Gary Englund
Minnesota Department of Health
Environmental Health Division
Water Supply and General Engineering
717 Delaware Street Southwest, Post Office Box
Minneapolis, Minnesota 55440

Ms. Marilyn Lundberg, Executive Secretary
Southern Minnesota Rivers Basin Board
600 American Center Building
150 East Kellogg Boulevard
St. Paul, Minnesota 55101

Mr. Michael Howe, President
Association of Minnesota County Zoning Officer
c/o Pope County Environmental Planning Office
County Courthouse
Glenwood, Minnesota 56334

Mr. Steven Knight
Planning Department
Western Lake Superior Sanitary District
27th Avenue West and Waterfront
Duluth, Minnesota 55806

Mr. Robert Bystrom
Minnesota Environmental Education Board
Post Office Box 5
Centennial Building, 658 Cedar Street
St. Paul, Minnesota 55155

Mr. Bob Hutchison
Anoka County Comprehensive Health Department
County Courthouse
Anoka, Minnesota 55303

Mr. William Dilks
Ms. Virginia Harris
Carver County Courthouse
Chaska, Minnesota 55318

Mr. Ron Spong
Dakota County Community Health Services
1600 West Highway 55
Hastings, Minnesota 55033

Mr. Luther Nelson
Hennepin County Department of Public Works
Environmental Services Division
320 Washington South
Hopkins, Minnesota 55343

Mr. Douglas Wood and
Ms. Colleen Halpine
Ramsey County Community Health Service -
Division of Environmental Health
1910 West County Road B - Suite 209
Roseville, Minnesota 55113

Mr. Al Frechette
Scott County Environmental Health Officer
County Courthouse
Shakopee, Minnesota 55379

Mr. Mike Rhyner
Association of Minnesota Counties
555 Park Street
St. Paul, Minnesota 55103

Ms. Nancy Grimsby
Recycling Association of Minnesota
c/o Nancy Grimsby
5932 Wooddale Avenue
Minneapolis, Minnesota 55424

Mr. Paul Parker
National Association of Recycling Industries
330 Madison Avenue
New York, New York 10017

APPENDIX IV.

SOLID WASTE ACTION PLAN FOR THE MINNESOTA POLLUTION CONTROL AGENCY
NOVEMBER 22, 1983

OUTLINE

11-22-83

ISSUE STATEMENT

A. The primary means for solid waste disposal changed from dumps to landfills in the 1970's.

B. Landfills cause pollution and waste of resources and energy.

C. Reasonable and practical alternatives to land disposal are available.

D. State policy should be to minimize the use of landfills.

E. The MPCA should play a lead role in implementing policy.

I. Background:

History of solid waste management; Minnesota and nationally.

A. Early practices and controls.

B. Policy and legislative transitions of the 1970's.

C. Directions established by the Waste Management Act, recent technical discoveries and changes in public perceptions.

II. Discussion:

A. Environmental protection:

1. Ground water pollution has been documented at 30 percent of Minnesota's permitted mixed-municipal waste landfills.

2. Ground water is presumed to be degraded at the majority of the 111 active and 20 closed or inactive permitted landfills, although the extent of impacts and the threat to water users is unknown.

3. Only 25 (19 percent) of the 131 landfills have currently-acceptable ground water monitoring systems. Another 17 have marginal systems which may or may not be adequate. The rest are inadequate.

4. Environmental impacts from Minnesota's 200 active and 1300 closed unpermitted dumps are unknown.

5. Modern technologies to seal out moisture and to contain, collect, and treat landfill pollutants are very expensive, difficult to apply retroactively to existing landfills, and are not being employed at Minnesota landfills. In general, Minnesota landfills are run on extremely limited budgets, allowing only rudimentary measures to reduce ground water impacts.

6. Current state solid waste regulations contain few provisions protective of ground water, and the nondegradation policy in the state's general ground water protection regulation is unattainable by current landfills. As with any facility that impacts ground water, there is currently uncertainty on how to apply 6 MCAR §4.8022 (WPC-22) to these situations.

7. The enforcement process is time-consuming and most past enforcement actions have not been carried through to completion.

8. Only recently has the public developed a strong interest in protecting ground water. This has improved public receptiveness toward regulation and abatement of solid waste and has diminished the support for landfills and open dumps in many parts of the state.

9. Despite the shift in public attitude, 200 open dumps exist to this day, creating enforcement and waste abatement problems.

10. Management and regulation of industrial waste is inadequate. Industries find it difficult to locate suitable off-site disposal facilities, so they construct or continue operating sites on their property. Many historical sites are in poor geologic locations and in most cases are inadequately monitored. Disposal of most industrial wastes is mingled in the normal

waste stream entering landfills and thus does not receive separate regulatory review.

B. Resource conservation through waste abatement:

1. In Minnesota and the nation, the average person throws away greater quantities of waste each year.

2. Nationally, seven percent of the waste stream is recycled. Optimally, Minnesota could recycle 20 percent of the waste stream, compost 20 percent, and incinerate 37 percent of the waste stream. Currently, of Minnesota's total municipal waste stream, only five percent is recycled and one percent goes to active waste-to-energy incinerators.

3. Counties are required (by rule only) to prepare and implement solid waste plans, but just 23 of the 80 nonmetropolitan counties have adequate plans, and less than one-half of those have implemented the portions dealing with alternatives to land disposal.

4. Counties lack expertise and familiarity with alternatives to land disposal, and the state's budget problems have resulted in severe cutbacks in state technical assistance to counties.

5. Many counties have not placed priority on developing, financing, and implementing alternatives to land disposal.

6. Many counties have been unwilling to commit resources to solid waste management planning, or to consider alternatives to landfilling, and the state lacks incentives or enforcement authority to require planning or consideration of alternatives.

7. Counties that have implemented alternatives have tended to jump to the high-technology alternative, incineration with energy recovery, without adequate consideration of less costly low-technology methods.

8. There presently exists no state funding for feasibility studies and implementation of abatement activities.

9. The state does not have a comprehensive state solid waste management plan which establishes priorities for solid waste management and describes appropriate solid waste management technologies.

10. Demand for many recyclables has been lacking. Current demand for recycled materials results in low prices for many of these materials in relation to the costs of alternatives to land disposal. Many markets are characterized by fluctuating prices. Secondary materials markets are heavily concentrated in the Twin Cities. This low level of demand has discouraged separation of materials from the waste stream.

11. Low land disposal rates, not reflective of many environmental, social, and economic costs, place alternative methods of waste management at a severe competitve disadvantage. Existing landfills do not prevent or even greatly limit their leakage of pollutants. The improvements in monitoring and landfill operation required by MPCA thus far have extended only to a limited number of priority landfills.

12. Although the public attitude has recently shifted away from continued tolerance of landfills and open dumps, the public is generally uninformed about alternatives to land disposal.

13. Summary of case histories of abatement projects.

C. Coordinated solid waste management among political subdivisions:

1. The state, counties, and other political subdivisions share responsibilities for all aspects of solid waste management. There is no distinct or identified leader in solid waste management.

2. Very few county solid waste programs are effective in all areas of solid waste management: planning, licensing, inspections and enforcement, and financial assurance. Nineteen of the 80 nonmetropolitan counties had no ordinance as of April 1, 1983, and most of the rest had ordinances dating from the early 1970s. A random survey of nonmetropolitan county solid waste programs showed that the vast majority of the counties do not provide planning, enforcement, licensing, and financial assurance programs.

3. Approximately 50 percent of the 87 counties have either less than five years remaining capacity at their landfills or documented ground water pollution at the landfill in their county. Although these are the counties that may have the greatest need to act, most have done little to plan for alternatives to the existing landfill or to correct the existing problems.

4. Multi-county efforts to develop alternatives to land disposal have been established in the southeast and the northwest part of the state, but most counties have not looked to multi-county organizations for solid waste management. Individual counties do not have as many opportunities or options to develop alternatives to land disposal.

5. The state has not taken a leadership role in solid waste management and planning. At times, the MPCA has stepped up its emphasis on technical assistance and planning, but has not been consistent in this effort.

D. Orderly and deliberate development and financial security of waste facilities:

1. Only a few landfills have set aside any funds for the costs of closure and of post-closure maintenance, monitoring, and

remedial actions to correct environmental problems. These costs continue for many years after closure, long after incoming revenues from disposal have ceased.

2. The MPCA is beginning to impose much more stringent closure and post-closure requirements, which are also much more costly than in the past. In most cases, landfill owners can afford the improvements only by raising tipping fees and setting aside revenues over a period of many years. However, many landfills lack enough remaining capacity to operate for many more years. Also, competition from other landfills and open dumps, which have not yet been required to upgrade, discourages rate increases.

3. The cost of isolating or cleaning up contaminated ground water is potentially very high. If these types of remedial actions were needed at a landfill, existing financial resources could be exhausted, leaving government with the public's expectation that government should resolve the problem. The MPCA, under existing statutes, has the authority to require financial assurance as part of the permit condition. However, no specific legislative directive for MPCA to require financial assurance exists.

III. Conclusions:

A. The lack of a designated leader in solid waste management has impeded effective management dedicated to meeting the legislative objectives for the state.

B. The legislature should direct MPCA to complete a state solid waste management plan which provides a framework for coordinated and efficient solid waste management in Minnesota, and requires management options to be considered in the following order of priority: reduction in the amount of waste generated, separation and recovery of materials including organics, energy recovery, and land disposal of residuals.

C. Most existing municipal waste landfills pollute ground water. Impacts can be reduced by the current efforts to require tighter soil covers over the landfills, but these improvements will not totally prevent ground water pollution. Landfills currently operate with a substantial public subsidy of sorts: they do not incorporate the costs of preventing or remedying ground water pollution.

D. Because 30 percent of existing landfills have documented ground water pollution and the rest are presumed to have, the solid waste rules governing land disposal must be revised and upgraded. Existing facilities should be upgraded using new requirements and available technologies to reduce their environmental impacts. Existing landfills that cannot comply with the revised requirements should be closed and remedial action taken.

E. Methods of solid waste management emphasizing source reduction, recovery, conversion, and recycling of all solid wastes are essential to the long-range preservation of the health, safety, and well-being of the public, to the economic productivity and environmental quality of the state, and to the conservation of the state's remaining natural resources. Continued land disposal threatens ground water resources, wastes reclaimable resources, wastes energy, consumes valuable land, and increasingly raises public opposition, and, therefore, should be the solid waste management technique of last choice.

F. Landfills should be used only for residuals left after reasonable and practical waste abatement, recycling, and resource recovery have been fully implemented.

G. To reduce the dependence on land disposal, the slow progress in waste reduction, recycling, and resource recovery must be greatly accelerated.

H. The most significant factor inhibiting the use of alternative management practices to date has been the artifically low costs of land disposal. All solid waste management options must be regulated so that they more fully reflect all environmental, social, and economic costs.

I. By not planning for or setting aside funds for closure and post-closure, landfill owners create an economic problem for themselves and potentially for the public.

J. On-going facilities should be required to provide the financial assurances for closure, post-closure, and remedial actions. The MPCA should receive a specific directive to require financial assurance at solid waste disposal facilities.

K. The public expects government to remedy solid waste pollution problems. A state fund must be established to remedy those problems when the state has no recourse against responsible parties.

L. Although active state participation in long term financial responsibility at solid waste disposal sites appears to be an attractive incentive to encourage county support for proposed state programs, such participation presents serious problems to the goals of the state programs, i.e., masks the true costs of land disposal impacting the feasibility of alternative management, promotes continued land disposal practices, potentially subsidizes publicly owned facilities, presents unknown liabilities to the state.

M. To promote implementation of alternatives to landfills, the MPCA must expand its efforts to inform and educate the public.

N. To promote sound planning and adequate consideration of alternative management options, the state should provide aid for plan development and feasibility studies.

O. Financial assistance in the form of low interest implementation loans and grants for research and development may be needed to expedite development of demand for recovered secondary materials.

P. The use of existing technologies appears to be sufficiently documented so that additional money for demonstration grants does not seem to be the best use of state resources at this time. The Waste Management Board has distributed limited amounts of demonstration grants because of the apparent difficulty in meeting criteria for demonstration projects.

Q. To achieve the desired legislative and MPCA goals, compliance with rules, plans, standards, and policies is imperative. It is essential that MPCA devise a compliance and enforcement system that rewards compliance and effectively deters and penalizes noncompliance.

R. A plan of action is needed, to include changes in legislation, regulation, and programs, to strengthen the efforts to meet the legislature's mandated goals.

IV. Recommendations:

A. The MPCA should obtain legislative directive to require counties to plan for the order of priority for waste management as follows: waste reduction, waste separation and recovery of materials, energy recovery, and landfills.

B. The MPCA should obtain legislative directive to require counties to write a plan (and achieve MPCA approval) to manage solid waste through the year 2000.

C. The MPCA should not issue permits for new landfills, or expansions, if the alternatives have not been addressed according to the state plan.

D. The MPCA should obtain legislative authority to provide financial aid to regional and local governments in developing plans.

E. The MPCA should provide technical assistance to state agencies and regional and local governments.

F. The MPCA should work with the Department of Energy and Economic Development to expedite resource recovery and market development.

G. The MPCA should obtain legislative authority to require a system to provide financial assurances at waste disposal facilities for closure, post-closure, and remedial actions.

H. The MPCA should obtain legislative authority to establish a fund to implement corrective actions and recover costs when responsible parties are unable or unwilling.

I. The MPCA should implement a general public awareness effort.

J. The MPCA should design a system to inform educator and interested groups on solid waste management.

K. The MPCA should amend current solid waste disposal rules to improve ground water protection, monitoring, and design/operational requirements of the rule.

L. The MPCA should obtain legislative authority to implement a procedure to achieve local government compliance with a state plan.

M. The MPCA should establish a system to detemine priorities for compliance actions.

N. The MPCA should continue to issue compliance/upgraded permits with revised closure, monitoring, and financial assurance requirements.

O. The MPCA should strengthen internal enforcement procedures and utilize outside resources.

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N. The MPCA should continue to issue compliance/upgraded permits with revised closure, monitoring, and financial assurance requirements.

O. The MPCA should strengthen internal enforcement procedures and utilize outside resources.

STAFF RESOLUTION

THEREFORE, BE IT RESOLVED that the MPCA Board supports new state legislation to improve solid waste management in Minnesota as follows:

1. The MPCA should obtain legislative directive to require counties to plan for the order of priority for waste management as follows: waste reduction, waste separation and recovery of materials, energy recovery, and landfills.

2. The MPCA should obtain legislative directive to require counties to write a plan (and achieve MPCA approval) to manage solid waste through the year 2000.

3. The MPCA should obtain legislative authority to provide financial aid to regional and local governments in developing plans.

4. The MPCA should obtain legislative authority to require a system to provide financial assurances at waste disposal facilities for closure, post-closure, and remedial actions.

5. The MPCA should obtain legislative authority to establish a fund to implement corrective actions and recover costs when responsible parties are unable or unwilling.

6. The MPCA should obtain legislative authority to implement a procedure to achieve local government compliance with a state plan.

AND THEREFORE, BE IT FURTHER RESOLVED that the MPCA Board adopts the following policies and procedures to improve the MPCA's effectiveness in administering the solid waste program:

1. The MPCA should not issue permits for new landfills, or expansions, if the alternatives have not been addressed according to the state plan.

2. The MPCA should provide technical assistance to state agencies and regional and local governments.

3. The MPCA should work with the Department of Energy and Economic Development to expedite resource recovery and market development.

4. The MPCA should implement a general public awareness effort.

5. The MPCA should design a system to inform educator and interested groups on solid waste management.

6. The MPCA should amend current solid waste disposal rules to improve ground water protection, monitoring, and design/operational requirements of the rule.

7. The MPCA should establish a system to detemine priorities for compliance actions.

8. The MPCA should continue to issue compliance/upgraded permits with revised closure, monitoring, and financial assurance requirements.

9. The MPCA should strengthen internal enforcement procedures and utilize outside resources.

APPENDIX V.

PROPOSED LEGISLATIVE ACTION

January 19, 1984

TO: INTERESTED PARTIES

Enclosed is a copy of the January 24, 1984 Minnesota Pollution Control Agency (MPCA) Board item regarding the MPCA position on state solid waste legislation. This item is scheduled for presentation to the MPCA Board sometime after 1:00 p.m. in the MPCA's Board room.

The legislative position supports comprehensive solid waste management planning, promoting alternatives to land disposal, establishing a fund to correct environmental problems, and requiring facilities to have adequate financial assurances. The Board item includes a suggested staff resolution, which approves policies supportive of this legislation.

If you have any questions, please contact Roger D. Bjork at 612/296-7785.

Sincerely,

DLW 1/19/84

Dale L. Wikre
Director
Solid and Hazardous Waste Division

DLW:dd
Enclosure

bcc: Roger D. Bjork
 Gerald J. Stahnke

January 19, 1984

TO: INTERESTED PARTIES

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Sincerely,

Dale Wikre

Dale L. Wikre
Director
Solid and Hazardous Waste Division

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COLOR CODE:
Blue = DWQ
Yellow = DAQ
Green = DSHW
Pink = Other
Gold = Info

MINNESOTA POLLUTION CONTROL AGENCY

Agenda Item Control Sheet

WR

AGENDA # ____________

MEETING DATE: January 24, 1983

APPEARANCE REQUESTED - Yes: ____ No: X
SCHEDULED TIME: ____________

PREPARED BY: Roger D. Bjork

DATE PREPARED: January 11, 1984
DATE MAILED : ____________

SUBJECT: State Solid Waste Legislation

LOCATION: N/A (City) N/A (County)

TYPE OF ACTION:

Permit		Request for hearing		New	
Stipulation		Request for legal action		Modification	
Contract		Variance request		Extension	
Policy	X	Rulemaking		Revocation	
Information		Administrative order		Other	

RECOMMENDED ACTION:

Issuance		Approval	X	No action needed	
Denial		Authorization			

ISSUE STATEMENT: Past and current solid waste land disposal practices have caused ground water pollution and wasted valuable resources and energy. Reasonable and practical alternatives to land disposal are available. The staff recommends that the Board adopt a resolution urging the Legislature to pass legislation which requires comprehensive solid waste management planning, establishes a fund to promote alternatives to land disposal, limits establishment of new landfill capacity to only that needed after implementation of alternatives to the greatest possible extent, establishes a fund to ensure proper closure and post-closure care, and requires facilities to have adequate financial assurances.

ATTACHMENTS:

1. ____________
2. ____________
3. ____________
4. ____________
5. ____________

MINNESOTA POLLUTION CONTROL AGENCY
Division of Solid and Hazardous Waste Division
Program Development Section

State Solid Waste Legislation

January 24, 1984

ISSUE STATEMENT

Past and current solid waste land disposal practices have caused ground water pollution and wasted valuable resources and energy. Reasonable and practical alternatives to land disposal are available. The staff recommends that the Board adopt a resolution urging the Legislature to pass legislation which requires comprehensive solid waste management planning, establishes a fund to promote alternatives to land disposal, limits establishment of new landfill capacity to only that needed after implementation of alternatives to the greatest possible extent, establishes a fund to ensure proper closure and post-closure care, and requires facilities to have adequate financial assurances.

I. Background:

Historically, the most common method for disposal of refuse in Minnesota and the nation has been the open burning dump. In Minnesota, it is estimated that over 1,500 historical dumps were used for disposal purposes, the majority sited in undesirable locations, including floodplains, swamps, and gravel pits.

Few, if any, controls were imposed to regulate health hazards or nuisance conditions resulting from the operation of dumps. Typical problems were smoke, odors, rodents, flies, blowing paper, and ground and surface water pollution. At many dumps, cover material was applied infrequently, and sometimes not at all. Most dump sites accepted all types of waste including garbage (food wastes), and refuse (waste paper, used tin cans, glass bottles, plastics, tires rags, broken furniture, white goods, etc.). In addition, various amounts of hazardous wastes such as oils and solvents probably found their way into many of these disposal sites. In general, any regulatory control of the dumps was the responsibility of the townships, villages, and cities in which they were located.

By the 1950s, land use pressures resulted in a number of housing developers building uncomfortably close to many once isolated dump sites. This was especially true in the Twin Cities metropolitan area. As competitive land use increased, so did public intolerance of open dumping practices and one by one the dumps began to close. These same factors made it increasingly difficult to site new disposal sites.

In 1967, the Legislature created the MPCA investing them with broad powers to control air, water, and land pollution. The same Legislature created the Metropolitan Council and directed them, in part, to study and plan for solid waste management in the Twin Cities metropolitan area.

In January 1970, the MPCA promulgated solid waste rules SW-1 to SW-11. The highlights of these rules were SW-5, which required disposal facilities to have MPCA permits; SW-6, which set up minimum operational standards and permit requirements for sanitary landfills, but no specific ground water protection standards; SW-10, which required non-conforming dumps to close by July 1, 1972; and SW-11, which required counties to develop solid waste management plans. The technical aspects of Minnesota Rule SW-6 regarding sanitary landfills were borrowed heavily from consultant reports and publications of the U.S. Department of Health, Education and Welfare, and were highly oriented toward nuisance conditions associated with operation of dumps. As an example, a consultant's report entitled, "Study and Investigation of Solid Waste Control for the Agency," February 1969, stated "the disposal of solid waste can be accomplished using sanitary landfill techniques without causing pollution of air, water or land." Many of the existing landfills were developed by permitting the existing dumps sites.

In 1971, the Legislature enacted Chapter 400 establishing a much expanded role in solid waste management for counties outside the metropolitan area. The authority was almost a duplicate of that given to the seven metropolitan counties in 1969.

In 1972, the first EPA publications were circulated to the MPCA mentioning the need for a separation distance between refuse and ground water of five feet.

In 1973, the MPCA revised the solid waste rules, in part, to exclude hazardous waste disposal at sanitary landfills, provide for a five-foot minimum separation to the ground water table, and establish general closure requirements for dumps. With this exception, the current solid waste rules contain few provisions protective of ground water, rather they were written to resolve other nuisance conditions. By the mid 1970s, water monitoring results began to indicate the presence of leachate at permitted sanitary landfills. This was an early warning that sanitary landfills actually could cause pollution.

The true extent and significance of pollution from landfills was not realized until the advent of ground water sampling for organic compounds in conjunction with a number of newsworthy hazardous waste problems at dumps and landfills. As these sites began to make headlines, county siting problems for new or expanded sites were magnified because the public began to equate the word landfill with hazardous waste.

The realization of the potential impact of sanitary landfills caused the MPCA technical requirements at landfills to become more stringent since it had been discovered that, in general, upgraded monitoring requirements, hydrogeological investigations, new design criteria, and upgraded closure and post-closure care requirements were imperative for these sites. Since the MPCA could not upgrade and repermit all 111 of the active sites all at once, a priority scheme was devised to handle those sites deemed most in need of upgraded permits first.

These upgraded requirements increased the costs to the landfill. In most cases, landfill owners can afford the improvements only by raising tipping fees and setting aside revenues over a period of many years. Only a few landfill owners have set aside any funds for the cost of closure, post-closure maintenance and monitoring, and remedial actions to correct environmental problems.

Alternatives to continued reliance on landfills are primarily centered on reuse, recycling, and reduction of waste via energy recovery. None of these alternatives is new. Incineration without energy recovery was first established in Minneapolis in 1913 while reuse and recycling were formally begun in the late 1800s. Unfortunately, a number of barriers including: 1) the relatively low economic cost of existing dumps and landfills; 2) the lack of markets for recovered materials; 3) institutional barriers such as flow control; and 4) an unconvincing track record of past high technology energy recovery facilities, have caused Minnesota to rely heavily on the use of sanitary landfills.

As the public becomes more aware of the problems of existing landfills and the high cost of remedial action, alternatives to landfills will be considered further. These alternatives and technologies have now been improved and demonstrated. They remain only to be developed to the fullest potential. It should be realized, however, that few abatement alternatives will be self-sufficient unless compared to the true social and environmental cost of continued reliance on landfills. A review of the past and existing solid waste management practices, problems, and programs by MPCA staff has identified the need for changes in future solid waste management programs. Some of these changes will require legislative actions.

II. Discussion:

In Minnesota and the nation, the average person throws away greater quantities of waste each year. Currently, of Minnesota's total municipal waste stream, only five percent is recycled and one percent goes to active waste-to-energy incinerators. The remaining 94 percent is land disposed. Optimally, Minnesota could recycle 20 percent of the waste stream, compost 20 percent, and incinerate 37 percent of the waste stream.

Reducing waste generated, recycling reusable materials, and energy resource recovery are important in conserving Minnesota's and the nation's resources. Not only will these practices reduce the amount of virgin materials, such as wood, minerals, and petroleum products consumed; they will also help protect water and land resources. Additionally, recent research and actual monitoring data have shown many current landfills are polluting ground water. Therefore, land disposal of solid waste should be the alternative of last resort and then only for residuals after reasonable and practical waste reduction, recycling, and resource recovery have been fully implemented.

In order to achieve waste abatement and resource recovery to the maximum extent possible, comprehensive planning is a necessity. A solid waste management plan must minimize to the greatest possible extent the practice of land disposal. The management plan should describe specific functions to be performed and activities to be undertaken to achieve waste abatement. The management plan must remain a dynamic document. As specific functions described in the plan are implemented, the plan must be revised to reflect these changes and to indicate any new steps needed in an effort to meet the original objectives or achieve new objectives necessitated by changing conditions or technologies.

There are 87 counties and numerous other political subdivisions involved in solid waste management in Minnesota. Without central leadership in the management of solid waste, maximum waste reduction and resource recovery will not be accomplished. Shared responsibilities without leadership causes inconsistencies in management programs and limited progress in waste abatement and resource recovery. This has been shown by the few effective solid waste management programs developed and implemented in the State. Since solid waste management is a problem throughout the State, the State needs to take a leadership role.

Existing legislation mandates particular goals be met on a state-wide basis. Therefore, the Legislature should direct the MPCA to coordinate management programs throughout the State to meet these goals for protection of the environment, coordination of solid waste management, conservation of resources through waste abatement, and development of financial security for waste abatement.

The low cost of land disposal has been a major obstacle in establishing waste abatement programs. Land disposal costs have been low because they were not reflective of many environmental, social, and resource costs. Due to recently discovered environmental impacts showing the need for ground water monitoring systems, liners, low permeability covers, and closure and post-closure maintenance needs, the MPCA has begun to impose more stringent requirements than previously included in solid waste disposal permits. The improvements have been imposed through amended permits and have increased the cost of operation. In most cases, landfill owners can afford the improvement only by raising tipping fees and setting aside revenues over a period of time. Few owners have set aside money in the past because they did not recognize the costs involved, they operate on limited profit margins, or they believe they do not have enough time to collect sufficient funds.

Post-closure and remedial action costs continue for many years after incoming revenues from the disposal operations have ceased. Additionally, the remedial costs of isolating or cleaning up contaminated ground water are potentially very high. Therefore, landfill owners must be required to establish some mechanism of financial assurance to take necessary closure, maintenance, and corrective actions. Many landfills will be reaching capacity in the next few years, which limits the amount of revenue that a landfill owner might generate. The limited amount of money set aside by landfill owners for closure, post-closure, and remedial actions, along with the new more stringent requirements, may create situations where closure and post-closure will not be completed by current landfill owners for lack of funds. As these situations increase due to the depletion of financial resources, the public's expectations that government should resolve the problem will increase. If the State is to meet the public's expectations to resolve existing problems, a fund must be established to conduct closure and post-closure when the responsible party is not able to carry out these actions.

In addition to establishing a fund to make available the necessary monies st-closure when the responsible party is unwilling or unable should also be established to assist in developing lid waste management plans, promote and assist development of waste , recycling, and energy resource recovery alternatives, and provide public education.

Planning and education programs are often slow in turning current beliefs and practices around to new ideas. Thus, the MPCA needs a mechanism to control the development of land disposal facilities consistent with the availability of prudent and feasible alternatives to land disposal. The Legislature should require that new landfill capacity be permitted only upon a showing that the need for capacity has been reduced to the greatest possible extent by implementation of abatement alternatives.

III. <u>Conclusions</u>:

Landfills are known to contaminate ground water and waste resources, yet their operational costs have historically been low since they did not include the environmental, social, and resource costs. This low cost has placed waste reduction, recycling, and resource recovery projects at an economic disadvantage. Therefore, the true cost of landfilling must be recognized and paid. Alternatives to land disposal are often available. To enhance the implementation of these alternatives, counties should do comprehensive solid waste management plans. The State should provide financial and technical assistance for the development of these plans and the implementation of alternatives to land disposal. To ensure that adequate consideration is given to available alternatives, new landfill capacity should be permitted only upon a showing that the need for capacity has been reduced to the greatest possible extent by the implementation of abatement alternatives.

Few current landfill owners have adequate financial resources to ensure proper closure, post-closure care, and to take any necessary remedial actions in the future. Land disposal facilities should be required to have adequate financial assurances for these needs. The State should establish a fund to enable it to take closure and post-closure care when facility owners are unable to do so.

IV. Recommendation:

The staff recommends that the MPCA Board adopt the following resolution urging the Legislature to pass comprehensive solid waste management legislation.

SUGGESTED STAFF RESOLUTION

THEREFORE, BE IT RESOLVED, that the Minnesota Pollution Control Agency Board urges the Minnesota Legislature to enact legislation to improve solid waste management in Minnesota by reducing to the greatest possible extent the use of landfills and requiring the consideration and implementation of alternatives which result in the recovery of resources and energy from waste and the prevention of pollution to the air, land, and water of the State.

Specifically, the legislation should:

1. Require counties to develop comprehensive solid waste management plans, subject to MPCA approval, with the objective to achieve maximum waste reduction, separation and recovery of materials, and energy recovery.

2. Establish a special landfill abatement fund to be used to provide financial and technical assistance to counties for the preparation of plans and the implementation of abatement objectives.

3. Require that new landfill capacity be permitted only upon a showing that the need for the capacity has been reduced to the greatest possible extent by the implementation of abatement alternatives.

4. Direct the MPCA to adopt rules establishing requirements for financial responsibility and closure and post-closure care at land disposal facilities.

5. Establish a special fund to be used by the MPCA to pay closure and post-closure costs at a land disposal facility when the MPCA determines that the operator is unable or unwilling to do so.

6. Designate the Minnesota Pollution Control Agency as the lead agency for implementation of the recommended programs.

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luth, MN 55805

Frechette
ott County Environmental
alth Officer
unty Courthouse
akopee, MN 55379

Brian Bensen
Sherburne County Sanitarian
County Administration Bldg.
Elk River, MN 55330

Orlin Grack
Sibley County Engineer
Sibley County Courthouse
Gaylord, MN 55334

Michael C. Hanan
Stearns County Courthouse
Box 153
510-14 25th Avenue North
St. Cloud, MN 56302

Scott Golberg
Steele County Sanitarian
590 Dunnell Drive, Box 890
Owatonna, MN 55060

L.B. Schaub
Stevens County Engineer
County Courthouse
Morris, MN 56267

Byron Giese
Swift County Auditor
P.O. Box 288
Benson, MN 56215

Albert Steuck
Todd County Zoning Administrator
Courthouse Annex
Long Prairie, MN 56347

Lester M. Deyo
Traverse County Solid Waste Officer
County Courthouse
Wheaton, MN 56296

Charles McDonald
Wabasha County Auditor
County Courthouse
Wabasha, MN 55981

Greg J. Kempf
Wadena County Zoning Administrator
County Courthouse
Wadena, MN 56482

Bob McPartlin
Waseca County Engineer
County Courthouse
Waseca, MN 56093

Mike Ayers
Washington County Community Health
Service
2000 Industrial Blvd.
Stillwater, MN 55082

Marvin Wellnitz, Zoning Admin.
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St. James, MN 56081

Glen MacTaggart
Wilkin County Engineer
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Breckenridge, MN 56520

Gene L. Mossing, Sanitarian
Winona County Community Health
Services
County Courthouse
Winona, MN 55987

Chuck Davis
Wright County Sanitarian
County Courthouse
Buffalo, MN 55313

Jerry Holien
Yellow Medicine County Planner
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Clarkfield, MN 56223

Becker County Zoning Office
Floyd Svenby, Z.A.
Court House
Detroit Lakes, MN 56501

Big Stone County Zoning Office
Vincent Taffe, Z.A.
Court House
Ortonville, MN 56278

Blue Earth County Zoning Office
Rick Hanna, Z.A.
202 E. Jackson
Mankato, MN 56001

Brown County Zoning Office
Chuck Enter, Z.A.
Court House
New Ulm, MN 56073

Cass County Zoning Office
Carol J. Newstrand, Z.A.
Court House
Walker, MN 56484

Cottonwood County Zoning Office
Farley Grunig, Z.A.
Court House
Windom, MN 56101

Faribault County Zoning Office
Larry Lloyd, Z.A.
Court House
Blue Earth, MN 56013

Freeborn County Zoning Office
Truman Thrond, Z.A.
Court House
Albert Lea, MN 56007

Itasca County Zoning Office
mes H. Sullivan, Z.A.
Court House
Grand Rapids, MN 55744

Kandiyohi County Zoning Office
Chester Johnson, Z.A.
Court House
Willmar, MN 56201

Kittson County Zoning Office
William Krumholz, Z.A.
Kittson Co. Engineering Dept.
Hallock, MN 56728

Koochiching County Zoning Office
Ruth McLinn, Z.A.
Court House
International Falls, MN 56649

Lac Qui Parle County Zoning
Craig Zenter, Z.A.
Court House
Madison, MN 56256

Lake County Zoning Office
Lester Mattson, Z.A.
Court House
Two Harbors, MN 55616

LeSueur County Zoning Office
Arthur Poll, Z.A.
Box 124, Co. Hwy. Dept.
LeCenter, MN 56507

Lincoln County Zoning Office
Merle Hanson, Z.A.
Lake Benton, MN 56149

Mahnomen County Zoning Office
Jim C. Guy, Z.A.
Box 342, Court House
Mahnomen, MN 56557

Meeker County Zoning Office
ugene Fitterer, Z.A.
Court House
Litchfield, MN 55355

Murray County Zoning Office
Kathy Nepp, Z.A.
Court House
Slayton, MN 56172

Norman County Zoning Office
Howard Christianson, Z.A.
Court House
Ada, MN 56510

Olmsted County Zoning Offic
Ron Livingston, Z.A.
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Rochester, MN 55901

Pennington County Zoning Of
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Thief River Falls, MN 5670

Polk County Zoning Office
Henry Gredvig, Z.A.
Box 554, Court House
Crookston, MN 56716

Red Lake County Zoning Offi
George Dailey, Z.A.
Court House
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Renville County Zoning Offi
Jim Tersteeg, Z.A.
Court House
Olivia, MN 56277

Rice County Zoning Office
Bruce Peterson, Z.A.
P.O. Box 40
Faribault, MN 55021

k County Zoning Office
lliam McCormack, Z.A.
Highway Building
erne, MN 56156

eau County Zoning Office
. (Bud) Thompson, Z.A.
rt House
eau, MN 56751

Louis County Zoning Office
n W. Jubala, Planning Dir.
rt House
ginia, MN 55792

rburne County Zoning Office
vey L. Alfords, Z.A.
nty Administration Building
River, MN 55330

ley County Zoning Office
in Grack, Z.A.
rt House
lord, MN 55334

ele County Zoning Office
vin Pribyl, Zoning Officer
Dunnell Dr., Co. Adm. Annex
tonna, MN 55060

vens County Zoning Office
ald Madsen, Z.A.
347, Court House
ris, MN 56267

ft County Zoning Office
nell Fredrickson, Z.A.
5 McKinney
son, MN 56215

asha County Zoning Office
lliam Holmes, Z.A.
rt House
asha, MN 55981

eca County Zoning Office
k Scheidel, Z.A.
rt House
eca, MN 56093

Washington County Zoning Office
ll Schwab, Z.A.
300 E. Eugene St.
Stillwater, MN 55082

Wright County Zoning Office
Tom Salkowski, Z.A.
Court House
Buffalo, MN 55313

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Robert R. Olson, Z.A.
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Clarkfield, MN 56223

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Worthington, MN 56187

Mr. Larry Beiderman
Brown-Nicollet County Sanitarian
State Hospital Complex
St. Peter, Minnesota 56082

Ms. Linda Bruemmer
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MN Dept. of Energy, Planning & Devel.
Room 100, Capitol Square Building
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Mr. Robert Bystrom
Minnesota Environmental Education Board
Post Office Box 5
Centennial Building, 658 Cedar Street
St. Paul, Minnesota 55155

Ms. Norma Cameron
Minnesota Department of Administration
671 North Robert Street
St. Paul, Minnesota 55101

Ms. Jeanne Crampton
Minnesota League of Women Voters
555 Wabasha, Room 212
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717 Delaware Street SW, P.O. Box 9441
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Project Environment
Boyd Place Suite North
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Minneapolis, Minnesota 55408

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Metropolitan Inter-County Association
114 Metro Square Building
7th and Robert Streets
St. Paul, Minnesota 55101

s. Nancy Grimsby
ecycling Association of Minnesota
/o Nancy Grimsby
932 Wooddale Avenue
inneapolis, Minnesota 55424

s. Sue Hess
enter for Continuing Studies
hitney House
t. Cloud State University
t. Cloud, Minnesota 56301

r. Curtis Johnson
itizens League
yndicate Building
4 South Sixth Street
inneapolis, Minnesota 55402

s. Barbara Kelley
innesota Waste Association
uite 600, St. Paul Building
West Fifth Street
t. Paul, Minnesota 55102

r. Steven Knight
lanning Department
estern Lake Superior Sanitary District
7th Avenue West and Waterfront
uluth, Minnesota 55806

r. Daniel Krivit
inneapolis Department of Public Works
ity Hall
350 South Fifth Street, Room 203
inneapolis, Minnesota 55415

r. David Locey
innesota Soft Drink Association
2353 Rice Street
Roseville, Minnesota 55113

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Southern Minnesota Rivers Basin Board
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Douglas County Zoning
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Alexandria, Minnesota 56308.

Mr. Gordon Olson
Jackson County Courthouse
Jackson, Minnesota 56143

Mr. Paul Parker
National Asso. of Recycling Industries
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New York, New York 10017

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Resource Management Associates, Inc.
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St. Paul, Minnesota 55101

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Winona County Zoning
Winona, Minnesota 55972

Mr. Robert Pulford
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Crystal, Minnesota 55428

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Isanti County Zoning
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Cambridge, Minnesota 55008

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Associaton of Minnesota Counties
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St. Paul, Minnesota 55103

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Tri-County Sanitarian
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Fairmont, Minnesota 56031

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Metropolitan Council
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APPENDIX VI.

DERIVATION OF RALS FOR DRINKING WATER
MINNESOTA DEPARTMENT OF HEALTH

DERIVATION OF RALs

for

DRINKING WATER

Prepared by
by
Minnesota Department of Health
Section of Health Risk Assessment

January 1988

INTRODUCTION

There are hundreds of chemicals that, when released to the environment, are potential contaminants of ground water/drinking water. Only a handful of these chemicals has drinking water regulations. Furthermore, these limited regulations apply only to public water systems.[1] In the case of private water supplies there are no regulations. This presents considerable problems to State agencies responsible for protecting ground water/drinking water resources. These agencies are increasingly facing situations where they must apply control measures and/or provide drinking water advisories without benefit of either Federal or State regulations.

One program that is hampered by the lack of ground water/drinking water regulations is the Minnesota Pollution Control Agency's (MPCA) Ground Water and Solid Waste Division (GWSWD). GWSWD is responsible, under their Solid Waste Rules, for the regulation of landfills. The current rule does not contain ground water standards which could be used to guide their enforcement activities. However, GWSWD is in the process of revising these rules. As part of this revision, they plan to include ground water standards that are based on safe drinking water limits. The addition of ground water standards to the rules would enhance the regulatory effectiveness of this program. A hearing on the revised rules is tentatively scheduled for late Spring 1988.

In order to address the general needs of State agencies and the specific issue of the Solid Waste Rules an Interagency Toxics Committee was established. The committee, formed in April 1985, was comprised of staff from the Minnesota Pollution Control Agency's (MPCA) Division of Water Quality, Division of Solid and Hazardous Waste, and the Office of Planning and Review; and the Minnesota Department of Health's (MDH) Section of Health Risk Assessment and Section of Water Supply and Engineering.

In February 1986, under the direction of this committee, MDH's Section of Health Risk Assessment published, "Recommended Allowable Limits for Drinking Water", Release No. 1.[2] Release No. 1 established Recommended Allowable Limits (RALs) for 72 potential drinking water pollutants. The remainder of this report, which was first written in "draft" form in August, 1986, summarizes the process used to derive the Recommended Allowable Limits. The references cited are generally those that were available before February 1986. Some have since been revised in final form, but have not changed markedly.

SELECTION OF CHEMICALS FOR RAL DERIVATION

The MPCA listed approximately 150 chemicals that were potential candidates for RALs. This list was compiled from a number of U.S. Environmental Protection Agency (EPA) lists of health risk criteria and from ground water surveys involving landfills and other sources. The list included metals, inorganics, synthetic organic compounds, volatile organic compounds, and some pesticides.

Two alternative methods for deriving RALs were evaluated:

A. The first approach would entail the conduct of a complete risk assessment for each chemical. This would include hazard identification, dose-response evaluation, human exposure evaluation, and risk characterization. This alternative was rejected for the following reasons:

1. Expertise to conduct complete risk assessments is available in MDH's Section of Health Risk Assessment; however, considering the number of chemicals involved and the timeframe within which RAL's were needed, the project could not be completed in the allotted time with the available staff.

2. To prepare an accurate and thorough risk assessment requires access and evaluation of all toxicologic data pertinent to the chemical under review. These data are housed in a variety of formats, mostly, within several different EPA offices. Moreover, much of the data on the chemicals of interest is contained in unpublished EPA papers or in draft reports that carry the caveat "Do Not Quote or Cite". The logistics of accessing unpublished papers and obtaining approval to cite draft reports would further obstruct a comprehensive and fair

risk assessment.

3. Although few chemicals are regulated in drinking water, many of the chemicals needing RALs have, to varying degrees, been subjected to one or more risk assessments. A number of documents (primarily EPA) have been produced from these efforts. These reports contain lists of Reference Doses (RfDs) for non-carcinogens and/or risk estimates for carcinogens. This is the type of data needed to derive the RALs and to repeat this work for each chemical would be redundant and a poor use of available resources.

B. The second approach to the derivation of the RALs entails review and evaluation of the existing documents (discussed in A3 above) containing RfDs or carcinogen risk estimates. Review and evaluation would be done to determine if:

1. The risk assessment was conducted according to the most current and generally accepted methods. The methods of choice were outlined in a 1986 series of Federal guidelines, which were previously available in draft form.[3-8] The purpose of the guidelines is to promote quality and consistency of risk assessments. In general, they provide a framework to be followed in developing an analysis of risk. The guidelines also contain criteria to evaluate the quality of data in order to formulate judgments concerning the nature and magnitude of the hazard from suspect chemicals.

2. The risk assessment is current and peer reviewed. A current risk assessment, utilizing the latest valid data, would, hopefully, eliminate the need for frequent changes in the RALs. Peer review, particularly by scientists with expertise in drinking water and health issues, would lend a great deal of credibility to the use of risk assessment results. The most useful peer review would be by EPA's Office of Drinking Water.

3. The risk assessment is based on, or includes, an oral route of exposure. Risk assessments based on non-oral exposures to a chemical have often proved invalid for predicting the risk from oral exposure to the same chemical. Therefore, RALs to limit exposure to contaminated drinking water must be based on data obtained from studies employing oral routes of exposure.

Approach B was selected and endorsed by the Interagency Toxics Committee as the most efficient and reliable method of deriving the RALs. It was further decided that only those chemicals (from among the 150+ chemicals for which RALs were desired) that met the above criteria (B1-B3) would be considered for a RAL.

At the conclusion of the review and evaluation process, a total of 72 chemicals met the above criteria. The following sections discuss the risk assessment sources used for derivation of RALs for non-carcinogens and carcinogens.

NON-CARCINOGENS

Thirty of the 72 chemicals are considered non-carcinogens. The RALs for the non-carcinogens are based on state-of-the-art concepts in toxicology and risk assessment.[8-10] These procedures are widely accepted by risk assessment and public health professionals.

For non-carcinogens (i.e. agents with thresholds) a Reference Dose (RfD) is established and then adjusted to reflect a safe level of exposure for drinking water. The starting point for establishing a RfD is obtaining a "no observed adverse effect level" (NOAEL) from a valid animal study. To this value an uncertainty factor is applied that reflects the degree or amount of uncertainty when experimental data in animals are extrapolated to humans. The uncertainty factor also accounts for the non-homogeneity of a human population, i.e., differences in body size and chemical sensitivity. Since the RfD is intended to be protective for a lifetime of exposure, it is calculated for a 70 kilogram adult. The RfD is then adjusted to yield a Recommended Allowable Limit in drinking water. The adjustment is twofold. First, the RfD is expressed as a Drinking Water Equivalent Level (DWEL) to reflect the average, per day, amount of water consumed by an adult (2 liters/day). Second, a Relative Source Contribution (RSC) adjustment is made to account for the fact that the total RfD does not come from drinking water exposure alone. If the actual contribution from non-water sources (food, air, etc.) is known, then the final drinking water RAL is reduced by that factor. If these data are not available, a RSC value of 20 percent is assumed for synthetic organic chemicals and a RSC value of 10 percent is assumed for inorganic chemicals. These adjustments yield a final RAL.

The review and evaluation process produced two sources that met the criteria discussed in sections B1-B3. They are the Maximum Contaminant Levels Goals (MCLGs) and the Health Advisories (HA) for drinking water.[10,11] Both sources were generated by EPA's Office of Drinking Water and both follow the risk assessment procedures that were briefly outlined above.

MCLGs are being promulgated under EPA's Safe Drinking Water Act, which regulates public water systems. MCLGs are non-enforceable health goals which are to be set at levels which would result in no known or anticipated adverse health effects with an adequate margin of safety. The HAs prepared by the Health Advisory Program are also non-regulatory and provide information on health effects, analytical methodology and treatment technology that is useful in dealing with contamination of drinking water. They also describe concentrations of contaminants in drinking water at which adverse effects would not be anticipated to occur.

CARCINOGENS

To date, scientists have been unable to demonstrate experimentally a threshold of effect for "carcinogens".[10,12] This leads to the assumption that since no threshold dose can be demonstrated for carcinogens, any exposure might represent some finite level of risk. Based on this assumption, it would be necessary to set the RALs at zero in order to achieve zero risk. Setting a zero standard is impractical for a number of reasons including availablity of treatment technologies, treatment costs, analytical capabilities, etc..[12]

Consequently, any guidelines or standards that are developed are necessarily arbitrary, and can only be defended on the basis of what seems feasible, reasonable and has precedent. At present, there is a growing precedent for regulating to lifetime cancer risks of 10^{-4} to 10^{-6}.[12] In cases where there are no Federal regulations for environmental contaminants considered carcinogenic, MDH has adopted a position of applying a "tolerable risk level" of 10^{-5} (see reference 12 for a discussion of tolerable risk and its derivation). The RALs, for the 42 suspect human carcinogens contained in release No. 1, reflect a tolerable risk level of 10^{-5}.

As with the non-carcinogens, the RALs for carcinogens are based on the most current and generally accepted state-of-the-art concepts in toxicology and risk assessment.[4-6] The risk assessment process for carcinogens includes hazard identification, dose-response assessment, exposure assessment, and risk characterization.

The question of how likely an agent is to be a human carcinogen is answered during the hazard identification step of a risk assessment. This is done within a framework of a weight-of-evidence judgment. Judgments about the weight of evidence involve considerations of the quality and adequacy of the data and the kinds of responses induced by a suspect carcinogen. The EPA classification system for the characterization of the overall weight of evidence for carcinogenicity (animal, human, and other supportive data) includes: Group A - Carcinogenic to Humans; Group B - Probably Carcinogenic to Humans; Group C - Possibly Carcinogenic to Humans; Group D - Not Classifiable as to Human Carcinogenicity; and Group E - No evidence of Carcinogenicity for Humans.[10]

The MDH RALs for the chemicals that are in Groups A and B are based on carcinogenicity data. However, because the evidence on chemicals in Group C is equivocal, their RALs were derived in the same manner as non-carcinogens (outlined above), with one exception. In this case, because of the possibility of carcinogenicity, an additional safety factor of 10 is incorporated into the RAL. EPA's Office of Drinking Water used the same procedures to derive MCLGs for Group C chemicals.

From the review and evaluation process, a series of related sources were selected that met the criteria discussed in sections B1-B3. The sources are documents containing EPA's Carcinogen Assessment Group's (CAG) risk assessments done on known, probable, or possible human carcinogens. This office is responsible for the conduct of all EPA risk assessments on suspected carcinogens and, through February 1986, had evaluated 54 chemicals as suspect human carcinogens.

Once a chemical has been determined to be a suspect human carcinogen, through the process of hazard identification, the dose-response data are used to calculate its carcinogenic potency. This step in CAG risk assessments involves interspecies dose conversion and the use of a mathematical model to describe the dose-response relationship. Again, these procedures follow the Federal guidelines outlined in references 5 and 6. The result of the risk characterization step is a slope or a carcinogen potency value. The higher the potency value the higher the risk of cancer induction will be per unit of exposure.

The MDH RALs for carcinogens were derived using the CAG potency values, a tolerable risk level of 10^{-5}, and the weight of a "Standard Man" (70 kilograms). The resulting RAL represents an exposure limit with an attendant risk of 10^{-5}. That is, if 100,000 people were exposed at the concentration of the RAL, over a lifetime, one additional cancer would be expected in this population.

SUMMARY

The Recommended Allowable Limits represent MDH's best estimate of the maximum exposure levels that should be adhered to for long-term consumption of private water supplies. They are guidelines not regulations. They are intended to be applied to situations involving contaminated ground water/drinking water that are not covered by existing regulations. The RALs are based only on potential health effects. They do not consider treatment/clean-up technology, feasibility, or costs as is the case in drinking water regulations for public water systems. The RALs were derived according to the criteria outlined in sections B1-B3 and are, therefore, based on the most current and generally accepted methods of risk assessment.

REFERENCES

1. Code of Federal Regulations, 1987, Title 40, Part 141, "National Primary Drinking Water Regulations", revised July 1, 1987.

2. Minnesota Department of Health, Section of Health Risk Assessment, "Recommended Allowable Limits for Drinking Water", Release No. 1, February 1986.

3. U.S. EPA Environmental Criteria and Assessment Office, "Guidelines for the Health Risk Assessment of Chemical Mixtures", Cincinnati, OH, 1985.

4. Committee on the Institutional Means for Assessment of Risks to Public Health, Commission on Life Sciences, National Research Council, Risk Assessment in the Federal Government: Managing the Process, National Academy Press, Washington, D.C., 1983.

5. U.S. EPA Office of Health and Environmental Assessment, "Proposed Guidelines for Carcinogen Risk Assessment", Federal Register, 49:46294-46301, November 23, 1984.

6. U.S. Office of Science and Technology Policy, "Chemical Carcinogens; A Review of the Science and Its Associated Principles", Federal Register, 50:10371-10442, March 14, 1985.

7. U.S. EPA Office of Health and Environmental Assessment, "Proposed Guidelines For Mutagenicity", Federal Register, 49:46314-46331, November 23, 1984.

8. National Academy of Sciences, Drinking Water and Health Vols. I-V, National Research Council, Washington, D.C., 1977-1983.

9. U.S. EPA Office of Drinking Water, "National Primary Drinking Water Regulations; Volatile Synthetic Organic Chemicals; Proposed Rulemaking", Federal Register, 49:24330-24355, June 12, 1984.

10. U.S. EPA Office of Drinking Water, "National Primary Drinking Water Regulations; Volatile Synthetic Organic Chemicals; Final Rule and Proposed Rule", Federal Register, 50:46880-46933, November 13, 1985, and corrections, 50:4165-4166, February 3, 1986, and 51:4618-4619, February 6, 1986.

11. U.S. EPA Office of Drinking Water, "Health Advisories", October, 1985.

12. Minnesota Department of Health Section of Health Risk Assessment, "Tolerable Risk", September, 1985.

APPENDIX VII.

CODISPOSAL LIMITS

Appendix VII

Suggested Maximum Levels of Leachate

Arsenic (As)	0.1 mg/l
Barium (Ba)	10.0 mg/l
Boron (B)	7.5 mg/l
Cadmium (Cd)	0.1 mg/l
Chlorides (Cl)	1500 mg/l
Chromium (Cr^{+6})	0.5 mg/l
COD	10000 mg/l
Copper (Cu)	10.0 mg/l
Cyanides (CN-)	0.1 mg/l
Fluorides (F)	5.0 mg/l
Iron (Fe)	3 mg/l (or 250 mg/l if only parameter exceeding limits)
Lead (Pb)	0.5 mg/l
Manganese (Mn)	0.5 mg/l (or 25 mg/l if only parameter exceeding limits)
Mercury (Hg)	0.0002 mg/l
Nickel (Ni)	1.0 mg/l
Nitrates (No_3)	45.0 mg/l (or 10 mg/l as N)
Oil and Grease	0.1 mg/l
PCB	0.1 mg/l
Phenol (C_6H_5OH)	0.1 mg/l if chlorinated 2.0 mg/l if not chlorinated
Selenium (Se)	0.1 mg/l
Silver (Ag)	0.5 mg/l
Sulfates (SO_4)	500 mg/l
Total Dissolved Solids (TDS)	5000 mg/l
Zinc (Zn)	50 mg/l

APPENDIX VIII

LIST OF AUTHORIZED TRUSTEES

STATE OF MINNESOTA
DEPARTMENT OF COMMERCE
ST. PAUL 55101

OFFICE OF THE COMMISSIONER

500 METRO SQUARE BUILDING
ST. PAUL, MN 55101

October 23, 1987

Mr. Robert J. McCarron
Program Development Section
Solid and Hazardous Waste Division
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, Minnesota 55113-2785

Dear Mr. McCarron:

I am enclosing an updated list of financial institutions in Minnesota which have the authority to engage in trust operations.

Sincerely,

John P. Gillen
Chief Examiner

JPG:jmt

Enclosure

Minn. Stat. §48.67
MINNESOTA TRUST COMPANIES

City	Trust Company	Address	Zip
Austin	Minnesota Trust Company of Austin	107 W. Oakland Ave.	55912
Marshall (1)	First American Trust Company of MN	208 East College Drive	56258
Minneapolis	Advisory Bank & Trust Company	IDS Tower, 32nd Floor	55474
St. Paul (2)	First Trust Company, Inc.	332 Minnesota Street	55101

Minn. Stat. §48.37
MINNESOTA STATE CHARTERED BANKS WITH FULL TRUST POWERS

City	Bank	Address	Zip
Alexandria	First American Bank & Trust of	720 Broadway	56308
Bayport	First State Bank of Bayport	950 North Highway 95	55003
Duluth	North Shore Bank of Commerce	131 West Superior St.	55802
Glencoe	Security Bank & Trust Company	735 Franklin Avenue So.	55336
Hutchinson	Citizens Bank & Trust Co., Hutchinson,Mn	102 Main Street So.	55350
Marshall	First American Bank & Trust of	208 East College Drive	56258
Minneapolis	Union Bank and Trust Company	312 Central Avenue NE	55414
Minnetonka	Resource Bank & Trust	9800 Bren Road East	55343
Moorhead	American Bank and Trust Company of	730 Center Avenue	56560
New Ulm	State Bank & Trust Company of	100 North Minnesota St.	56073
Richfield (3)	Richfield Bank & Trust Co.	6625 Lyndale Ave. So	55423
Rochester	Marquette Bank Rochester	206 South Broadway	55901
Rochester	Rochester Bank and Trust Company of	331 16th Ave. N.W.	55901
St. Paul	Eastern Heights State Bank of St. Paul	2100 Wilson Avenue	55119
Wayzata	The Bank Wayzata	900 East Wayzata Blvd.	55391
Willmar	First American Bank & Trust of	302 S.W. Fifth Street	56201

Minn. Stat. §48.475
MINNESOTA STATE CHARTERED BANKS OR TRUST COMPANIES WITH TRUST SERVICE OFFICES

(1) Offices of First American Trust Company of Minnesota

Alexandria	First American Bank & Trust of	720 Broadway	56308
Breckenridge	First American Bank of	225 North Fifth Street	56520
Crookston	First American National Bank of	201 North Broadway	56716
Detroit Lakes	First American Bank of	115 East Holmes Street	56501
Granite Falls	Granite Falls Bank	702 Prentice Street	56241
Marshall	First American Bank & Trust of	208 East College Drive	56258
Redwood Falls	First American Bank of	101 East Fourth Street	56283
So. St. Paul	Drovers First American Bank of	633 South Concord Street	55075

(2) Offices of First Trust Company, Inc.

Minneapolis	First National Bank of	First Bank Place	55480
St. Paul	The First National Bank of	332 Minnesota Street	55101

(3) Office of Richfield Bank & Trust Company of

Roseville	Roseville State Bank	2100 N. Snelling Avenue	55113

September, 1987

Minn. Stat. §48.66

MINNESOTA NATIONAL BANKS WITH FULL TRUST POWERS

City	Bank	Address	Zip
Austin	The First National Bank of	301 No. Main Street	55912
Crookston	Crookston National Bank	116 West Robert Street	56716
Duluth	First Bank,(N.A.) -Duluth	130 West Superior St.	55802
Duluth	Norwest Bank Duluth, N.A.	230 West Superior St.	55802
Hastings	The First National Bank of	119 West 2nd. Street	55033
Milaca	The First National Bank of	P. O. Box 38	56353
Minneapolis	First National Bank of	First Bank Place	55440
Minneapolis	Marquette Bank Minneapolis, N.A.	7th & Marquette Ave	55480
Minneapolis	National City Bank of	75 S. Fifth Street	55480
Minneapolis	Norwest Bank Midland, N.A.	401 Second Avenue So.	55440
Minneapolis	Norwest Bank Minneapolis, N.A.	8th St. & Marquette Ave.	55479
Pipestone	The First National Bank of	101 2nd. Street N.W.	56164
Rochester	The First National Bank of	201 First Avenue S.W.	55903
St. Cloud	Norwest Bank St. Cloud, N.A.	400 South First Street	56302
St. Cloud	St. Cloud National Bank & Trust Co.	300 East St. Germain St.	56302
St. Cloud	The First American National Bank of	1100 St. Germain St.	56301
St. Cloud	Zapp National Bank of	717 St. Germain St.	56302
St. Paul	American National Bank and Trust Company	Fifth & Minnesota St.	55101
St. Paul	Norwest Bank St. Paul, N.A.	55 East Fifth Street	55101
St. Paul	The First National Bank of	332 Minnesota Street	55101
St. Paul	The Midway National Bank of	1578 University Avenue	55104
Stillwater	The First National Bank of	213 East Chestnut St.	55082
Virginia	Norwest Bank Mesabi, N.A.	401 Chestnut Street	55792
Winona	Merchants National Bank of	102 Plaza East	55987
Winona	Norwest Bank Winona, N.A.	177 Main St.	55987
Winona	Winona National and Savings Bank	204 Main Street	55987

Minn. Stat. §48.67

MINNESOTA LIMITED TRUST CORPORATIONS

Edina	First Fiduciary Corporation	Suite 633 2850 Metro Drive	55420
Hastings	Minnesota Fiduciary Services, Inc.	999 Westview Drive	55033
Minneapolis	Estate Management Corporation	3702 E. Lake Street	55406

September, 1987

Minn. Stat. §303.25 (48.67)

FOREIGN BANKING CORPORATION WITH FULL TRUST POWERS

NORTH DAKOTA

City	Bank	Address	Zip
Fargo	Dakota Bank and Trust Company of	51 Broadway	58108
Fargo	First Bank of North Dakota (N.A.)Fargo	505 - 2nd. Ave.N.	58102
Fargo	First Interstate Bank of Fargo,N.A.	Main at Broadway	58124
Fargo	Norwest Bank Fargo, N.A.-	406 Main Ave	58126
Grand Forks	First Bank of North Dakota(N.A.) Grand Forks	401 Demers Avenue	58201
Grand Forks	First National Bank in Grand Forks	322 Demers Avenue	58201

SOUTH DAKOTA

Brookings	First National Bank in Brookings	5th St. & 5th Avenue	57006
Sioux Falls	First Bank of South Dakota (N.A.)	141 N. Main Avenue	57117

Minn. Stat. §303.25

FOREIGN TRUST COMPANIES

NORTH DAKOTA

Fargo	First Trust Company of North Dakota	505 -2nd. Ave.N.	58102
Fargo	Norwest Capital Management & Trust Co.	15 Broadway	58126

WISCONSIN

La Crosse	La Crosse Trust Company	311 Main St.	54601

September 1987

APPENDIX IX.

CORRESPONDENCE ON TAX ISSUES

Minnesota Pollution Control Agency

June 27, 1984

Minnesota Department of Revenue
Office of the Commissioner
Centennial Office Building
658 Cedar Street
St. Paul, Minnesota 55145

To Whom This Matter Concerns:

Our office intends to revise the State's rules that pertain to waste disposal services. Recent discussions have raised a question with respect to the tax implications of some recommended measures. Please send us a formal ruling on the tax status of the funding arrangements that are recommended.

The new rules will require landfill operators to provide assurances that they can meet financial obligations for a number of years after their businesses have closed. Trust funds are recommended as one means to secure this end. The new rules will likely use a model that is now in effect for hazardous waste landfills. I have enclosed a copy of the model trust agreement we expect to use. Can you tell us whether such funds would be subject to business income taxation?

Thank you for your attention in this matter.

Sincerely,

Robert J. McCarron
Solid Waste Unit
Program Development Section
Solid and Hazardous Waste Division

IRS
correspondence

RJM:rw

Enclosure

Phone: 612/296-7353
1935 West County Road B2, Roseville, Minnesota 55113-2785
Regional Offices • Duluth/Brainerd/Detroit Lakes/Marshall/Rochester

Minnesota Pollution Control Agency

June 27, 1984

United States Internal Revenue Service
Office of the District Director
316 North Robert Street
St. Paul, Minnesota 55101

To Whom This Matter Concerns:

Our office intends to revise the State's rules that pertain to waste disposal services. Recent discussions have raised a question with respect to the tax implications of some recommended measures. Please send us a formal ruling on the tax status of the funding arrangements that are recommended.

The new rules will require landfill operators to provide assurances that they can meet financial obligations for a number of years after their businesses have closed. Trust funds are recommended as one means to secure this end. The new rules will likely use a model that is now in effect for hazardous waste landfills. I have enclosed a copy of the model trust agreement we expect to use. Can you tell us whether such funds would be subject to business income taxation?

Thank you for your attention in this matter.

Sincerely,

Robert J. McCarron
Solid Waste Unit
Program Development Section
Solid and Hazardous Waste Division

RJM:rw

Enclosure

Phone: 612/296-7353
1935 West County Road B2, Roseville, Minnesota 55113-2785

c. A special report from the owner's or operator's independent certified public accountant to the owner or operator stating that he or she has compared the data which the letter from the chief financial officer specifies as having been derived from the independently audited, year-end financial statements for the latest fiscal year with the amounts in such financial statements, and in connection with that procedure, no matters came to his or her attention which caused him or her to believe that the specified data should be adjusted.

6. An owner or operator of a new facility shall submit the items specified in 5. to the director at least 60 days before the date on which hazardous waste is first received for treatment, storage, or disposal.

7. After the initial submission of items specified in 5., the owner or operator shall send updated information to the director within 90 days after the close of each succeeding fiscal year. This information must consist of all three items specified in 5.

8. If the owner or operator no longer meets the requirements of 1., he or she shall obtain insurance for the entire amount of required liability coverage as specified in this rule. Evidence of insurance must be submitted to the director within 90 days after the end of the fiscal year for which the year-end financial data show that the owner or operator no longer meets the test requirements.

9. The director may disallow use of this test on the basis of qualifications in the opinion expressed by the independent certified public accountant in his or her report on examination of the owner's or operator's financial statements required by 5.b. An adverse opinion or a disclaimer of opinion will be cause for disallowance. The director shall evaluate other qualifications on an individual basis. The owner or operator shall provide evidence of insurance for the entire amount of required liability coverage as specified in this rule within 30 days after notification of disallowance.

6 MCAR § 4.9313 Incapacity of owners or operators, guarantors, or financial institutions.

A. Notification of bankruptcy. An owner or operator shall notify the director by certified mail of the commencement of a voluntary or involuntary proceeding under United States Code, title 11, Bankruptcy, naming the owner or operator as debtor, within ten days after commencement of the proceeding. A guarantor of a corporate guarantee as specified in 6 MCAR §§ 4.9306 F., 4.9308 F. and 4.9310 F. shall make the notification if he or she is named as debtor, as required under the terms of the corporate guarantee.

B. Incapacity of financial institutions. An owner or operator who fulfills the requirements of 6 MCAR §§ 4.9306, 4.9308, 4.9310, or 4.9312 by obtaining a trust fund, surety bond, letter of credit, or insurance policy will be deemed to be without the required financial assurance or liability coverage in the event of bankruptcy of the trustee or issuing institution, or a suspension or revocation of the authority of the trustee institution to act as trustee or of the institution issuing the surety bond, letter of credit, or insurance policy to issue these instruments. The owner or operator shall establish other financial assurance or liability coverage within 60 days after such an event.

6 MCAR § 4.9314 Wording of instruments.

A. Trust agreement for trust fund. The trust agreement and certificate of acknowledgement are as follows:

1. A trust agreement for a trust fund as specified in 6 MCAR § 4.9306 A., 4.9308 A., 4.9310 A., or 4.9410 A. must be worded as specified in Exhibit 6 MCAR § 4.9314 A. 1.-1, except that instructions in brackets must be replaced with the relevant information and the brackets deleted.

EXHIBIT 6 MCAR § 4.9314 A.1.-1

TRUST AGREEMENT

Trust Agreement, the "Agreement," entered into as of [date] by and between [name of the owner or operator], a [name of state] [insert "corporation," "partnership," "association," or "proprietorship"], the "Grantor," and [name of corporate trustee], [insert "incorporated in the state of ________________" or "a national bank"], the "Trustee."

Whereas, the Minnesota Pollution Control Agency (Agency), an agency of the state of Minnesota has established certain rules applicable to the Grantor, requiring that an owner or operator of a hazardous waste facility shall provide assurance that funds will be available when needed for closure and/or post-closure care of, and/or corrective action for the facility.

KEY: PROPOSED RULES SECTION — Underlining indicates additions to existing rule language. ~~Strike outs~~ indicate deletions from existing rule language. If a proposed rule is totally new, it is designated "all new material." ADOPTED RULES SECTION — Underlining indicates additions to proposed rule language. ~~Strike outs~~ indicate deletions from proposed rule language.

Whereas, the Grantor has elected to establish a trust to provide all or part of the financial assurance for the facilities identified herein,

Whereas, the Grantor, acting through its duly authorized officers, has selected the Trustee to be the trustee under this agreement, and the Trustee is willing to act as trustee,

Now, Therefore, the Grantor and the Trustee agree as follows:

Section 1. Definitions. As used in this Agreement:

a. The term "Grantor" means the owner or operator who enters into this Agreement and any successors or assigns of the Grantor.

b. The term "Trustee" means the Trustee who enters into this Agreement and any successor Trustee.

Section 2. Identification of Facilities and Cost Estimates. This agreement pertains to the facilities and cost estimates identified on attached Schedule A [on Schedule A, for each facility list the identification number, name, address, and the current corrective action, closure, and/or post-closure cost estimates, or portions thereof, for which financial assurance is demonstrated by this Agreement.]

Section 3. Establishment of Fund. The Grantor and the Trustee hereby establish a trust fund, the "Fund," for the benefit of the Agency. The Grantor and the Trustee intend that no third party have access to the Fund except as herein provided. The Fund is established initially as consisting of the property, which is acceptable to the Trustee, described in Schedule B attached hereto. This property and any other property subsequently transferred to the Trustee is referred to as the Fund, together with all earnings and profits thereon, less any payments or distributions made by the Trustee pursuant to this Agreement. The Fund shall be held by the Trustee, IN TRUST, as hereinafter provided. The Trustee shall not be responsible nor shall it undertake any responsibility for the amount or adequacy of, nor any duty to collect from the Grantor, any payments necessary to discharge any liabilities of the Grantor established by the Agency.

Section 4. Payment for Corrective Action, Closure, and Post-Closure Care. The Trustee shall make payments from the Fund as the Agency Director shall direct, in writing, to provide for the payment of the costs of corrective action, closure, and/or post-closure care of the facilities covered by this Agreement. The Trustee shall reimburse the Grantor or other persons as specified by the Agency Director from the Fund for corrective action, closure, and post-closure expenditures in amounts as the Agency Director shall direct in writing. In addition, the Trustee shall refund to the Grantor the amounts as the Agency Director specifies in writing. Upon refund, these funds shall no longer constitute part of the Fund as defined herein.

Section 5. Payments Comprising the Fund. Payments made to the Trustee for the Fund shall consist of cash or securities acceptable to the Trustee.

Section 6. Trustee Management. The Trustee shall invest and reinvest the principal and income of the Fund and keep the Fund invested as a single fund, without distinction between policies and income, in accordance with general investment policies and guidelines which the Grantor may communicate in writing to the Trustee from time to time, subject, however, to the provisions of this Section. In investing, reinvesting, exchanging, selling, and managing the Fund, the Trustee shall discharge his duties with respect to the trust fund solely in the interest of the beneficiary and with the care, skill, prudence, and diligence under the circumstances then prevailing which persons of prudence, acting in a like capacity and familiar with such matters, would use in the conduct of an enterprise of a like character and with like aims; except that:

a. securities or other obligations of the Grantor, or any other owner or operator of the facilities, or any of their affiliates as defined in the Investment Company Act of 1940, United States Code, title 15, section 80a-2.(a), shall not be acquired or held, unless they are securities or other obligations of the federal or state government;

b. the Trustee is authorized to invest the Fund in time or demand deposits of the Trustee, to the extent insured by an agency of the federal or state government; and

c. the Trustee is authorized to hold cash awaiting investment or distribution uninvested for a reasonable time and without liability for the payment of interest thereon.

Section 7. Commingling and Investment. The Trustee is expressly authorized in its discretion:

a. to transfer from time to time any or all of the assets of the Fund to any common, commingled, or collective trust fund created by the Trustee in which the Fund is eligible to participate, subject to all of the provisions thereof, to be commingled with the assets of other trusts participating therein; and

b. to purchase shares in any investment company registered under the Investment Company Act of 1940, United States Code, title 15, sections 80a-1 *et seq.* including one which may be created, managed, underwritten, or to which investment advice is rendered or the shares of which are sold by the Trustees. The Trustee may vote such shares in its discretion.

Section 8. Express Powers of Trustee. Without in any way limiting the powers and discretions conferred upon the Trustee by the other provisions of this Agreement or by law, the Trustee is expressly authorized and empowered:

a. To sell, exchange, convey, transfer, or otherwise dispose of any property held by it, by public or private sale. No person dealing with the Trustee may be bound to see to the application of the purchase money or to inquire into the validity or expediency of a sale or other disposition;

b. To make, execute, acknowledge, and deliver any and all documents of transfer and conveyance and any and all other instruments that may be necessary or appropriate to carry out the powers herein granted;

c. To register any securities held in the Fund in its own name or in the name of a nominee and to hold any security in bearer form or in book entry, or to combine certificates representing the securities with certificates of the same issue held by the Trustee in other fiduciary capacities, or to deposit or arrange for the deposit of the securities in a qualified central depository even though, when so deposited, the securities may be merged and held in bulk in the name of the nominee of the depository with other securities deposited therein by another person, or to deposit or arrange for the deposit of any securities issued by the United States Government, or any agency or instrumentality thereof, with a federal reserve bank, but the books and records of the Trustee shall at all times show that all these securities are part of the Fund;

d. To deposit any cash in the Fund in interest-bearing accounts maintained or savings certificates issued by the Trustee, in its separate corporate capacity, or in any other banking institution affiliated with the Trustee, to the extent insured by an agency of the federal or state government; and

e. To compromise or otherwise adjust all claims in favor of or against the Fund.

Section 9. Taxes and Expenses. All taxes of any kind that may be assessed or levied against or in respect of the Fund and all brokerage commissions incurred by the Fund shall be paid from the Fund. All other expenses incurred by the Trustee in connection with the administration of this Trust, including fees for legal services rendered to the Trustee, the compensation of the Trustee to the extent not paid directly by the Grantor, and all other proper charges and disbursements of the Trustee shall be paid from the Fund.

Section 10. Annual Valuation. The Trustee shall annually, at least 30 days prior to the anniversary date of establishment of the Fund, furnish to the Grantor and to the Agency Director a statement confirming the value of the Trust. Any securites in the Fund shall be valued at market value as of no more than 60 days prior to the anniversary date of establishment of the Fund. The failure of the Grantor to object in writing to the Trustee within 90 days after the statement has been furnished to the Grantor and the Agency Director shall constitute a conclusively binding assent by the Grantor, barring the Grantor from asserting any claim or liability against the Trustee with respect to matters disclosed in the statement.

Section 11. Advice of Counsel. The Trustee may from time to time consult with counsel, who may be counsel to the Grantor, with respect to any question arising as to the construction of this Agreement or any action to be taken hereunder. The Trustee shall be fully protected, to the extent permitted by law, in acting upon the advice of counsel.

Section 12. Trustee Compensation. The Trustee shall be entitled to reasonable compensation for its services as agreed upon in writing from time to time with the Grantor.

Section 13. Successor Trustee. The trustee may resign or the Grantor may replace the Trustee, but the resignation or replacement shall not be effective until the Grantor has appointed a successor trustee and this successor accepts the appointment. The successor trustee shall have the same powers and duties as those conferred upon the Trustee hereunder. Upon the successor trustee's acceptance of the appointment, the Trustee shall assign, transfer, and pay over to the successor trustee the funds and properties then constituting the Fund. If for any reason the Grantor cannot or does not act in the event of the resignation of the Trustee, the Trustee may apply to a court of competent jurisdiction for the appointment of a successor trustee or for instructions. The successor trustee shall specify the date on which it assumes administration of the trust in a writing sent to the Grantor, the Agency Director and the present Trustee by certified mail ten days before the change becomes effective. Any expenses incurred by the Trustee as a result of any of the acts contemplated by this Section shall be paid as provided in Section 9.

Section 14. Instructions to the Trustee. All orders, requests, and instructions by the Grantor to the Trustee shall be in writing, signed by the persons as are designated in the attached Exhibit A or other designees as the Grantor may designate by amendment to Exhibit A. The Trustee shall be fully protected in acting without inquiry in accordance with the Grantor's orders,

KEY: PROPOSED RULES SECTION — Underlining indicates additions to existing rule language. ~~Strike outs~~ indicate deletions from existing rule language. If a proposed rule is totally new, it is designated "all new material." ADOPTED RULES SECTION — Underlining indicates additions to proposed rule language. ~~Strike outs~~ indicate deletions from proposed rule language.

requests, and instructions. All orders, requests, and instructions by the Agency to the Trustee shall be in writing, signed by the Agency Director; and the Trustee shall act and shall be fully protected in acting in accordance with the orders, requests, and instructions. The Trustee shall have the right to assume, in the absence of written notice to the contrary, that no event constituting a change or a termination of the authority of any person to act on behalf of the Grantor or the Agency hereunder has occurred. The Trustee shall have no duty to act in the absence of orders, requests, and instructions from the Grantor and/or the Agency Director, except as provided for herein.

Section 15. Notice of Nonpayment. The Trustee shall notify the Grantor and the Agency Director by certified mail within ten days following the expiration of the 30-day period after the anniversary of the establishment of the Trust, if no payment is received from the Grantor during that period. After the pay-in period is completed, the Trustee shall not be required to send a notice of nonpayment.

Section 16. Amendment of Agreement. This Agreement may be amended by an instrument in writing executed by the Grantor, the Trustee, and the Agency Director, or by the Trustee and the Agency Director, if the Grantor ceases to exist.

Section 17. Irrevocability and Termination. Subject to the right of the parties to amend this Agreement as provided in Section 16, this Trust shall be irrevocable and shall continue until terminated at the written agreement of the Grantor, the Trustee, and the Agency Director, or by the Trustee and the Agency Director, if the Grantor ceases to exist. Upon termination of the Trust, all remaining trust property, less final trust administration expenses, shall be delivered to the Grantor.

Section 18. Immunity and Indemnification. The Trustee shall not incur personal liability of any nature in connection with any act or omission, made in good faith, in the administration of this Trust, or in carrying out any directions by the Grantor or the Agency Director issued in accordance with this Agreement. The Trustee shall be indemnified and saved harmless by the Grantor or from the Trust Fund, or both, from and against any personal liability to which the Trustee may be subjected by reason of any act or conduct in its official capacity, including all expenses reasonably incurred in its defense in the event the Grantor fails to provide a defense.

Section 19. Choice of Law. This Agreement shall be administered, construed, and enforced according to the laws of the state of Minnesota.

Section 20. Interpretation. As used in this Agreement, words in the singular include the plural and words in the plural include the singular. The descriptive headings for each Section of this Agreement shall not affect the interpretation or the legal efficacy of this Agreement.

In Witness Whereof the parties have caused this Agreement to be executed by their respective officers duly authorized and their corporate seals to be hereunto affixed and attested as of the date first above written. The parties below certify that the wording of this Agreement is identical to the wording specified in Exhibit 6 MCAR § 4.9314 A.1.-1, as such rules were constituted on the date first above written.

[SIGNATURE OF GRANTOR]
[TITLE]

Attest:
[TITLE]
[SEAL]

[SIGNATURE OF TRUSTEE]

Attest:
[TITLE]
[SEAL]

2. Exhibit 6 MCAR § 4.9314 A.2.-2 is an example of the certification of acknowlegment, which must accompany the trust agreement for a trust fund as specified in 6 MCAR § 4.9306 A., 4.9308 A., 4.9310 A., 4.9407 A., or 4.9409 A.

EXHIBIT 6 MCAR § 4.9314 A.2.-2

CERTIFICATION OF ACKNOWLEDGMENT

State of ______________________________

County of ______________________________

On this [date], before me personally came [owner or operator] to me known, who, being by me duly sworn, did depose and say that she/he resides at [address], that she/he is [title] of [corporation], the corporation described in and which executed the above instrument; that she/he knows the seal of said corporation; that the seal affixed to the instrument is the corporate seal;

STATE OF MINNESOTA

DEPARTMENT OF REVENUE

P. O. Box 64446
St. Paul, Minnesota 55164

Telephone: (612) 296-3401

July 20, 1984

RECEIVED
JUL 23 1984
MINN. POLLUTION
CONTROL AGENCY

Mr. Robert J. McCarron
Solid Waste Unit
Program Development Section
Solid and Hazardous Waste Division
Minnesota Pollution Control Agency
1935 West County Road B-2
Roseville, Minnesota 55113-2785

Dear Mr. McCarron:

I have received your letter of June 27, 1984 in which you ask if the trust fund which was created under your rules which were published in the State Register on October 24, 1983 would be subject to a business income tax.

My answer is that these funds would be subject to a business income tax. They would be treated as part of the unitary business of the corporation since it is funds which have been placed aside by the corporation to pay its legal obligations in the area of corrective action, closure and/or post-closure care of the facilities. As provided in Section 4 of the agreement, the trustee shall make payments from the fund as are directed by the agency director. Any excess amounts are to be refunded to the grantor. Under Section 13 the grantor can replace the trustee when there is a vacancy in the office of trustee. Under Section 14 the trustee is subject to orders, requests and instructions by the grantor. Under Section 17 the trust is established and continues until it is terminated by written agreement of the grantor, trustee and agency director.

The grantor has a large amount of control over the fund and the trustee. Because of this, the funds really are to be treated as part of the grantor and subject to taxation along with the grantor.

I hope this answers your question.

Sincerely,

Arthur C. Roemer

ARTHUR C. ROEMER
Commissioner of Revenue

ACR/DHB/ml

STATE OF MINNESOTA

DEPARTMENT OF REVENUE

P. O. Box 64446
St. Paul, Minnesota 55164

Telephone: (612) 296-343

May 9, 1985

RECEIVED
MAY 1 0 1985
MINN. POLLUTION
CONTROL AGENCY

Mr. Robert J. McCarron
Program Development Section
Solid and Hazardous Waste Agency
Minnesota Pollution Control Agency
1935 West County Road B-2
Roseville, Minnesota 55113-2785

Dear Mr. McCarron:

I have received your letter of April 12, 1985 in which you ask that I confirm that Minnesota will be adopting the provisions of Internal Revenue Code Section 468 as enacted in Section 91(b) of the Deficit Reduction Act of 1984, Public Law 98-369.

In House File 538, which is the Department of Revenue Income Tax Update Bill, the Department of Revenue is proposing to conform Minnesota's income tax treatment with the federal treatment. Specifically, I reference you to Section 12 of that bill which amends Minnesota Statutes, Section 290.07, subd. 7 by adding a new paragraph which says, "The provisions of Sections 461 to 468A of the Internal Revenue Code of 1954, as amended through December 31, 1984, shall determine the taxable year for which a deduction or credit may be taken." This provision of Section 12 is effective at the same time that the federal changes made in Public Law 98-369 are effective in 1984.

House File 538 has been passed by the House and is awaiting final floor action before the Senate. There has been no controversy about this provision.

In summary, this should confirm that once House File 538 is enacted into law by the Governor, Minnesota's tax treatment on the sinking funds set up for reclamation and closing costs would be identical with federal law.

Sincerely,

Dale H. Busacker

Dale H. Busacker
Division Attorney
Income Tax Division

DHB/ml

AN EQUAL OPPORTUNITY EMPLOYER

Internal Revenue Service

District
Director

Department of the Treasury

316 N. Robert St., St. Paul, Minn. 55101

Person to Contact:
M. Karel
Telephone Number:
(612) 725-7965
Refer Reply to:
E:QR:Room 430:MK:bm
Date:
JUL 16 1984

Robert J. McCarron
State of Minnesota
Solid & Hazardous Waste Division
1935 West County Road B2
Roseville, MN 55113

IN RE:
Ruling Request

Your Inquiry Dated:
June 27, 1984

Dear Mr. McCarron:

Thank you for your inquiry referred to above.

It is receiving our attention and we will send you a reply as soon as possible.

If you have any questions, please contact the person whose name and telephone number are shown above.

Thank you for your cooperation.

Sincerely yours,

Earl H. Hagg

Earl H. Hagg
Chief, Quality Review Staff

RECEIVED
JUL 17 1984
MINN. POLLUTION
CONTROL AGENCY

Internal Revenue Service

Department of the Treasury

District
Director

316 N. Robert St., St. Paul, Minn. 55101

Robert J. McCarron
State of Minnesota
Solid & Hazardous Waste Division
1935 West County Road B2
Roseville, MN 55113

Person to Contact:
M. Karel
Telephone Number:
(612) 725-7965
Refer Reply to:
E:R:Room 430:MGK:kp
Date:
AUG 03 1984

RECEIVED
AUG 06 1984
MINN. POLLUTION
CONTROL AGENCY

Dear Mr. McCarron:

This is in reply to your letter of June 27, 1984, in which a formal ruling is requested concerning whether or not funds held in trust to provide assurances that landfill operators can meet financial obligations for a number of years after their businesses have closed, would be currently deductible by the operators.

Your letter requests a reply on a proposed transaction based on a particular set of facts. Our response to such inquiries are subject to certain limitations as set out in Sections 4 and 7 of Revenue Procedure 84-1, enclosed. Based upon those limitations, we will not be able to furnish you a determination letter. However, our National Office exercises jurisdiction over rulings with respect to prospective transactions of specific taxpayer's issues which could affect a number of taxpayers and those questions which are not covered by clearly established principles of tax law, regulations, published rulings and court decisions. In order to request a National Office ruling, please follow the procedures discussed in Section 9. Additionally, your attention is directed to Section 5.05 which may restrict a National Office "ruling" response without your request being accompanied with one of the land fill operators request.

While a determination letter may not be issued on this matter, we are happy to provide the following general information.

In Fred P. Fiore, 79,360 PH Memo TC, Performance Bonds deposited with the state and local authorities to assure proper restoration of land involved in strip mining operations, weren't currently deductible in the year of payment since they were clearly not an expense. The bonds were in essence security deposits which the state and local authorities were required to return upon the petitioner's restoration of the land. The court ruled that the bonds therein, were similar to a security deposit in the sense that the recipient has no control over it and merely holds the sums deposited for the one who paid them. The bonds were not an expenditure at all but rather an asset of the petitioner. It would be an expense to him only if he defaulted as a result of his lack of performance.

Robert J. McCarron

In Revenue Ruling 58-190, A cemetery company or corporation was not required to include in gross income for Federal Income Tax Purposes that portion of the contract sale price of burial lots or mausoleum crypts which, by requirement of state law is obligated to be irrevocably set aside in trust solely for the perpetual care and maintenance of the cemetery, burial lot or mausoleum crypts to the extent that such portion is so set aside. The cemetery cases are different than the above performance bonds care in that in those cases it is impossible for the principal or income, of the irrevocable Trust Fund to inure to the benefit of the taxpayer.

While there is proposed legislation (H.R.1414) to allow landfill operators to take annual deductions for partial and post closure set aside expenses, this legislation is in the preliminary stages and therefore, it is not discussed within.

This is not a ruling or determination letter and should not be considered a predetermination in the event of a subsequent examination. We trust however, you will find the information helpful.

Sincerely,

Earl H Hagg

Earl H. Hagg
Chief, Quality Review Staff

Minnesota Pollution Control Agency

July 18, 1984

Mr. Mike Karel
Internal Revenue Service
316 North Robert Street
St. Paul, Minnesota 55101

Dear Mr. ~~Karel~~ Mike:

I have enclosed a copy of the magazine article you requested in our phone conversation on July 9, 1984. I hope it will save you some time in your research.

We also discussed the role of State laws and regulations in this process. The last legislative session passed the Metropolitan Landfill Abatement Act. Section 49 of this bill amends Minnesota Statutes 1982, section 116.07. This section directs the Minnesota Pollution Control Agency (MPCA) to adopt rules that will require landfill operators to perform closure and post-closure care activities. The MPCA is also directed to adopt rules that will secure financial assurance for these activities.

Our unit is developing these rules. We fully expect these rules to make some allowance for the use of trust funds that follow the model I sent to your office in my first letter.

Good luck in your research and please call again if you have more questions. I look forward to reading your results.

Sincerely,

Robert J. McCarron
Solid Waste Unit
Program Development Section
Solid and Hazardous Waste Division

RJM:dd
Enclosure

Phone: 612/296-7353
1935 West County Road B2, Roseville, Minnesota 55113-2785
Regional Offices • Duluth/Brainerd/Detroit Lakes/Marshall/Rochester
Equal Opportunity Employer

Minnesota Pollution Control Agency

April 12, 1985

Mr. Dale Brusacker
Income Tax Division
Department of Revenue
Centennial Office Building
658 Cedar Street
St. Paul, Minnesota 55145

Dear Mr. Brusacker:

I want to follow-up on the matters we discussed in our phone conversation of March 28, 1985. My early work on landfill financial assurance rules led me to consider the tax effects of the financial mechanisms customarily used in such rules. I believe you drafted Commissioner Roemer's reply to my first inquiry. The reply is dated July 20, 1984.

The Congress changed applicable federal tax provisions at nearly the same time that you were writing the reply. I believe the relevant law is referred to as the Tax Reform Act of 1984, section 232. There is a brief message appended to this section which may be related to the citation - it reads, "Act Sec. 91, adding Code Sec. 468."

You said in our phone discussion that Minnesota tax treatment will be the same as federal tax treatment. Please send me a written statement to that effect. I will need to incorporate some statement of tax impacts into the statement of need and reasonableness which accompanies the rule.

Thank you for your consideration in this matter.

Sincerely,

Robert J. McCarron
Program Development Section
Solid and Hazardous Waste Division

RJM:dd

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TIME VALUE OF MONEY—ACCOUNTING CHANGES

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Economic Performance Rule

¶ 230

Deduction for future expenses permitted no sooner than time of economic performance.—Under the so-called "all-events test" stated in Reg. § 1.461-1(a)(2), an accrual basis taxpayer is generally entitled to deduct the face amount of an accrued expense in the taxable year in which (1) all of the events have occurred that determine the fact of liability and (2) the amount of the liability can be determined with reasonable accuracy. This test has been interpreted by courts to permit the current deduction of expenses that are related to activities to be performed or amounts to be paid in future years. The current deduction of future expenses, however, results in an overstated deduction to the extent that the time value of money is not taken into account. For example, a partnership that claims a current deduction for the undiscounted amount of an expense that it is obligated to pay in a future tax year has overstated the deduction by the amount that exceeds the present value of the future expense.

The Act modifies the "all-events test" in a way that prevents such overstatement of advance deductions (and avoids the complexities that could have resulted if a discounted valuation system had been enacted). Generally effective on the day after the date of enactment, all of the events that establish liability for an amount, for the purpose of determining whether such amount has been incurred with respect to any item, are treated as not occurring any earlier than the time that economic performance occurs with respect to that item.

Specific statutory principles apply for purposes of determining when the time of economic performance occurs for the types of items described below.

Property and services provided to taxpayer. In the case of a liability of a taxpayer that requires a payment for property or services, economic performance is deemed to occur as the property or services are provided to the taxpayer. If the liability arises out of the taxpayer's use of property, economic performance occurs as the taxpayer uses the property.

> *Example (1):* A partnership on the accrual basis contractually obligates itself in October of 1984 to pay Techno Inc. $10,000 for research and development to be performed in 1985. No amount is deductible before performance is rendered in 1985.

Property and services provided by taxpayer. If the liability of the taxpayer requires him to provide services or property, then economic performance occurs as the taxpayer provides the services or property.

Workers' compensation and tort liabilities. In the case of liabilities of a taxpayer to another person that arise under workers' compensation laws or out of any tort, economic performance occurs as payments to that person are made.

Exception for certain recurring items. The Act treats certain recurring items as incurred in advance of economic performance, provided that the all-events test is otherwise satisfied. The exception is intended to prevent the disruption of normal business and accounting practices so as to avoid the imposition of unnecessary burdens on taxpayers. Under the exception, an item is treated as incurred during a taxable year if (1) the all-events test, without regard to economic performance, is satisfied during such taxable year, (2) the economic performance test is met within the shorter of 8½ months or a reasonable time after the close of such taxable year, (3) the item is recurring in nature and the taxpayer consistently treats similar items as incurred in the taxable year in which the all-events test is met, and (4) either the item is not material or accrual of the item in the year that the all-events test is met results in a better matching against the income to which it relates than accrual of the item in the taxable year of economic performance. In determining whether an item is material or whether a more proper matching against income results from deduction of an expense prior to economic performance for purposes of (4), above, the treatment of the expense on financial statements is to be taken into account. The recurring expense exception does not apply to workers' compensation liabilities or tort liabilities requiring payment by the taxpayer to another person.

> *Example (2):* Income from the sale of goods is recognized in year 1, but the goods are not shipped until year 2. The shipping costs are more properly matched to income in year 1, rather than in year 2.
>
> *Example (3):* A calendar-year taxpayer enters into a one-year maintenance contract on July 1, 1985. If the expense is prorated between 1985 and 1986 for financial statement purposes, it should also be prorated for tax purposes. However, if the full amount is deducted in 1985 on the financial statements because it is not material under generally accepted accounting principles, it may (or may not) be considered material for purposes of the recurring-items exception.

Other liabilities. The Secretary is authorized to prescribe regulations governing the time of economic performance of any other liability of the taxpayer.

Reserves for estimated expenses. The economic performance rule does not apply to any deductions for additions to reserves for estimated expenses that are specifically allowed by the Code, as, for example, reserves for bad debts (Code Sec. 166), vacation pay (Code Sec. 463), and discount coupons (Code Sec. 466).

Special elections permit deduction in advance of economic performance. Where a taxpayer elects either to adopt a uniform method for deducting qualified reclamation and closing costs associated with certain mining and solid waste disposal properties (¶ 232) or to deduct contributions to a qualified Nuclear Decommissioning Reserve Fund (¶ 234), the economic performance rule does not apply to these two types of costs.

Election for earlier application. In determining whether an amount has been incurred, a taxpayer may elect to have the economic performance rule

Mine and Waste Disposal Reclamation and Closing Costs

¶ 232

Election.—Effective generally for costs incurred after the date after enactment, the Act provides taxpayers with an election to adopt a uniform method for deducting qualified reclamation and closing costs associated with certain mining and solid waste disposal properties in advance of economic performance. In general, qualified reclamation and closing costs include expenses incurred under the Surface Mining Control and Reclamation Act of 1977, the Solid Waste Disposal Act, or any other similar Federal, State, or, in the case of waste disposal sites, local law. Taxpayers are permitted to revoke an election made with respect to any property; however, a revocation is irreversible.

The election to claim advance reclamation and closing cost deductions may not be made unless the taxpayer establishes a separate reserve account (sinking fund account) for reclamation costs and a separate reserve account for closing costs. The accounts are required for each reserve property for which the election is made. The reserves are used to determine additional deductions for excess amounts paid and amounts that must be added back to income each year.

Amount of deduction. In the case of qualified reclamation costs, the deduction for any taxable year is equal to the current reclamation costs allocable to a property disturbed during such taxable year. Current reclamation costs are the qualified costs that would be paid if the reclamation activities were performed currently. The deduction for qualified closing costs for any taxable year is equal to the current closing costs allocable to the production from a property during such taxable year. Current closing costs are the qualifying costs that would be paid if the closing activities were performed currently. Closing costs are determined on the unit-of-production method for mine sites and on the unit-of-capacity method for solid waste disposal sites.

Reserve account adjustments and recapture. The opening balance of any reserve account during its first taxable year is zero. Each taxable year, the account is to be increased by the deduction claimed for current reclamation and closing costs for that year and by the interest that would be earned on the opening balance if compounded semiannually at 70% of the Code Sec. 1274 short-term rate for tax years ending in 1984 and 1985, 85% in tax years ending in 1986, and 100% thereafter. Any amounts actually paid during a taxable year for qualified reclamation or closing costs are charged to the account as of the last day of the taxable year. An additional deduction is allowed in any taxable year in the amount of the excess (if any) of the qualified reclamation and closing costs paid during the year over the closing balance of the reserve account at the end of the year (determined without reducing the account by the qualified reclamation and closing costs actually paid).

In the case of an account established for reclamation costs, a taxpayer is required to include in gross income for any taxable year the excess of the closing balance of the account over the current reclamation costs of the taxpayer for all portions of the reserve property disturbed during any taxable year. In the case of a closing costs account, the excess of the ending balance over the current closing costs of the taxpayer—determined as if all production with respect to the reserve property for any taxable year to which the election applies had occurred in the taxable year—is included in the taxpayer's gross income. In determining the recapture amount, all adjustments described in the preceding paragraph are made first.

If an election is revoked or the closing or disposition of a mine or waste disposal site is completed, the outstanding balance of the account must also be included in gross income. If an election is not in effect for at least one taxable year in which the reserved property is disturbed (or production occurs), items with respect to such property will be allocated to the account in accordance with regulations to be prescribed by the IRS.

Effective date exception for existing accounting practice and fixed price ore supply contracts. If on March 1, 1984, a taxpayer was regularly computing deductions for mining reclamation activities under a current cost method of accounting, liability for reclamation activities (a) for land disturbed before the effective date of the Act or (b) relating to a fixed price supply contract described below is treated as having been incurred when the land is disturbed.

The amendments made by the Act relating to the reclamation and closing expense deduction do not apply to any minerals extracted from a property and sold pursuant to a fixed supply contract entered into before March 1, 1984. This exception, however, does not apply to any extension of a contract beyond the period that the contract was in effect on March 1, 1984, or to any renegotiation of, or other change in, the terms and conditions of a contract in effect on March 1, 1984.

Act Sec. 91, adding Code Sec. 468.

Deferred Statutory and Tort Liability Loss

¶ 233

Ten-year net operating loss carryback for deferred statutory or tort liability loss.—Under the Act, a deferred statutory or tort liability loss may be carried back as a net operating loss to each of the ten taxable years preceding the year of the loss. The extended ten-year carryback period applies to deferred statutory and tort liability losses incurred in taxable years beginning after 1983. However, the losses cannot be carried back to a taxable year beginning before 1984, except to the extent provided under other rules.

A deferred statutory or tort liability loss is defined as the lesser of (1) the net operating loss for the year reduced by any portion of the loss attributable to foreign expropriation and product liability losses or (2) the amount incurred for deductible liabilities arising under Federal or State law or out of any tort (other than a product liability loss for which a ten-year carryback period is provided by Code Sec. 172(b)) that is taken into account in computing the net operating loss for the year. With respect to (2) above, in the case of a statutory liability arising out of a federal or state law, the act or failure to act that gave rise to the liability must have occurred at least three years before the beginning of the taxable year. In the case of a tort liability, the liability must have arisen out of a series of actions or failures to act over an extended period of time, a substantial portion of which occurred at least three years before the beginning of the taxable year. The ten-year carryback period does not apply to a deferred statutory or tort liability unless the tax-

Deferred Payments Under Rental Agreements

[¶ 2926XS.09]—Continued

• *CCH Explanation*

Portion of lease term:	Cumulative percentage of total rent deemed paid:
1st ⅕	10
2nd ⅕	25
3rd ⅕	45
4th ⅕	70
Last ⅕	100

(ii) Operating Rules.—For purposes of this schedule—

(I) the rent allocable to each taxable year within any portion of a lease term described in such schedule shall be a level pro rata amount properly allocable to such taxable year, and

(II) any agreement relating to property which is to be placed in service in 2 or more stages shall be treated as 2 or more separate agreements.

(C) Paragraph Not to Apply.—This paragraph shall not apply to any agreement if the sum of the present values of all payments under the agreement is greater than the sum of the present value of all the payments deemed to be paid or received under the schedule under subparagraph (B). For purposes of computing any present value under this subparagraph, the annual discount rate shall be equal to 12 percent, compounded semiannually."

—CCH.

Caution: Code Sec. 468, below, as added by P. L. 98-369, generally applies to costs incurred after July 18, 1984.

[¶ 2926Y] SPECIAL RULES FOR MINING AND SOLID WASTE RECLAMATION AND CLOSING COSTS

'54 Code

Sec. 468 [1954 Code]. (a) ESTABLISHMENT OF RESERVES FOR RECLAMATION AND CLOSING COSTS.—

(1) ALLOWANCE OF DEDUCTION.—If a taxpayer elects the application of this subsection with respect to any mining or solid waste disposal property, the amount of any deduction for qualified reclamation or closing costs for any taxable year to which such election applies shall be equal to the current reclamation or closing costs allocable to—

(A) in the case of qualified reclamation costs, the portion of the reserve property which was distur[illegible]d during such taxable year, and

(B) in the case of qualified c[illegible]ing costs, the production from the reserve property during such taxa[illegible] year.

(2) OPENING BALANCE AND ADJUST[illegible]TS TO RESERVE.—

(A) OPENING BALANCE.—The [illegible]ing balance of any reserve for its first taxable year shall be zero.

(B) INCREASE FOR INTEREST.—

(i) IN GENERAL.—A rese[illegible] hall be increased each taxable year by an amount equal to the am[illegible] of interest which would be earned during such taxable year o[illegible] opening balance of such reserve for such taxable year if such [illegible] rest were computed—

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MINN. POLLUTION CONTROL AGENCY

'54 Code

Caution: Code Sec. 468, below, as added by P. L. 98-369, generally applies to costs incurred after July 18, 1984.

(I) at the Federal short-term rate or rates (determined under section 1274) in effect, and

(II) by compounding semiannually.

(ii) PHASE-IN OF INTEREST RATE.—In the case of taxable years ending before 1987, the rate determined under clause (i)(I) shall be equal to the following percentage of such rate (determined without regard to this clause):

In the case of taxable years ending in:	The percentage is:
1984 or 1985	70
1986	85

(C) RESERVE TO BE CHARGED FOR AMOUNTS PAID.—Any amount paid by the taxpayer during any taxable year for qualified reclamation or closing costs allocable to portions of the reserve property for which the election under paragraph (1) was in effect shall be charged to the appropriate reserve as of the close of the taxable year.

(3) ALLOWANCE OF DEDUCTION FOR EXCESS AMOUNTS PAID.—There shall be allowed as a deduction for any taxable year the excess of—

(A) the amounts described in paragraph (2)(C) paid during such taxable year, over

(B) the closing balance of the reserve for such taxable year (determined without regard to paragraph (2)(C)).

(4) LIMITATION ON BALANCE AS OF THE CLOSE OF ANY TAXABLE YEAR.—

(A) RECLAMATION RESERVES.—In the case of any reserve for qualified reclamation costs, there shall be included in gross income for any taxable year an amount equal to the excess of—

(i) the closing balance of the reserve for such taxable year, over

(ii) the current reclamation costs of the taxpayer for all portions of the reserve property disturbed during any taxable year to which the election under paragraph (1) applies.

(B) CLOSING COSTS RESERVES.—In the case of any reserve for qualified closing costs, there shall be included in gross income for any taxable year an amount equal to the excess of—

(i) the closing balance of the reserve for such taxable year, over

(ii) the current closing cost of the taxpayer with respect to the reserve property, determined as if all production with respect to the reserve property for any taxable year to which the election under paragraph (1) applies had occurred in such taxable year.

(C) ORDER OF APPLICATION.—This paragraph shall be applied after all adjustments to the reserve have been made for the taxable year.

(5) INCOME INCLUSIONS ON COMPLETION OR DISPOSITION.—Proper inclusion in income shall be made upon—

(A) the revocation of [illegible] election under paragraph (1), or

(B) completion of t[illegible] closing, or disposition of any portion, of a reserve property.

(b) ALLOCATION FOR PROPERT[illegible]HERE ELECTION NOT IN EFFECT FOR ALL TAXABLE YEARS.—If the election unde[illegible]bsection (a)(1) is not in effect for 1 or more taxable years in which the reser[illegible]roperty is disturbed (or production occurs), items with respect to the reser[illegible]operty shall be allocated to the reserve in such manner as the Secretary n[illegible]rescribe by regulations.

Caution: Code Sec. 468, below, as added by P. L. 98-369, generally applies to costs incurred after July 18, 1984.

[¶ 2926Y]—Continued

(c) REVOCATION OF ELECTION; SEPARATE RESERVES.—

(1) REVOCATION OF ELECTION.—

(A) IN GENERAL.—The taxpayer may revoke an election under subsection (a)(1) with respect to any property. Such revocation, once made, shall be irrevocable.

(B) TIME AND MANNER OF REVOCATION.—Any revocation under subparagraph (A) shall be made at such time and in such manner as the Secretary may prescribe.

(2) SEPARATE RESERVES REQUIRED.—If a taxpayer makes an election under subsection (a)(1), the taxpayer shall establish with respect to the property for which the election was made—

(A) a separate reserve for qualified reclamation costs, and

(B) a separate reserve for qualified closing costs.

(d) DEFINITIONS AND SPECIAL RULES RELATING TO RECLAMATION AND CLOSING COSTS.—For purposes of this section—

(1) CURRENT RECLAMATION AND CLOSING COSTS.—

(A) CURRENT RECLAMATION COSTS.—The term "current reclamation costs" means the amount which the taxpayer would be required to pay for qualified reclamation costs if the reclamation activities were performed currently.

(B) CURRENT CLOSING COSTS.—

(i) IN GENERAL.—The term "current closing costs" means the amount which the taxpayer would be required to pay for qualified closing costs if the closing activities were performed currently.

(ii) COSTS COMPUTED ON UNIT-OF-PRODUCTION OR CAPACITY METHOD.—Estimated closing costs shall—

(I) in the case of the closing of any mine site, be computed on the unit-of-production method of accounting, and

(II) in the case of the closing of any solid waste disposal site, be computed on the unit-of-capacity method.

(2) QUALIFIED RECLAMATION OR CLOSING COSTS.—The term "qualified reclamation or closing costs" means any of the following expenses:

(A) MINING RECLAMATION AND CLOSING COSTS.—Any expenses incurred for any land reclamation or closing activity which is conducted in accordance with a reclamation plan (including an amendment or modification thereof)—

(i) which—

(I) is submitted purs nt to the provisions of section 511 or 528 of the Surface Mir Control and Reclamation Act of 1977 (as in effect on Janua , 1984), and

(II) is part of a sur e mining and reclamation permit granted under the provisi of title V of such Act (as so in effect), or

(ii) which is submitted pu ant to any other Federal or State law which imposes surface mi reclamation and permit requirements substantially similar to requirements imposed by title V of such Act (as so in effect).

(B) SOLID WASTE DISPOSAL AND C G COSTS.—

Caution: Code Sec. 468 low, as added by P. L. 98-369, generally applies to costs ir red after July 18, 1984.

(i) IN GENERAL.—Ar xpenses incurred for any land reclamation or closing activity in co ection with any solid waste disposal site which is conducted in ac dance with any permit issued pursuant to—

(I) any provisi n of the Solid Waste Disposal Act (as in effect on January 1, 1984) requiring such activity, or

(II) any other Federal, State, or local law which imposes requirements substantially similar to the requirements imposed by the Solid Waste Disposal Act (as so in effect).

(ii) EXCEPTION FOR CERTAIN HAZARDOUS WASTE SITES.—Clause (i) shall not apply to that portion of any property which is disturbed after the property is listed in the national contingency plan established under section 105 of the Comprehensive Environmental, Compensation, and Liability Act of 1980.

(3) PROPERTY.—The term "property" has the meaning given such term by section 614.

(4) RESERVE PROPERTY.—The term "reserve property" means any property with respect to which a reserve is established under subsection (a)(1).

'54 Code

.01 Added by P. L. 98-369. For details, see Code Volumes.

.25 Committee Reports on P. L. 98-369 are at ¶ 2901.04.

[¶ 2926YS] Mine and Waste Disposal Reclamation and Closing Costs

• • *CCH Explanation*

.01 Election.—Effective generally for costs incurred after July 18, 1984, taxpayers can elect to adopt a uniform method for deducting qualified reclamation and closing costs associated with certain mining and solid waste disposal properties in advance of economic performance. In general, qualified reclamation and closing costs include expenses incurred under the Surface Mining Control and Reclamation Act of 1977, the Solid Waste Disposal Act, or any other similar Federal, State, or, in the case of waste disposal sites, local law. Taxpayers are permitted to revoke an election made with respect to any property; however, a revocation is irreversible.

The election to claim advance reclamation and closing cost deductions may not be made unless the taxpayer establishes a separate reserve account (sinking fund account) for reclamation costs and a separate reserve account for closing costs. The accounts are required for each reserve property for which the election is made. The reserves are used to determine additional deductions for excess amounts paid and amounts that must be added back to income each year.

.02 Amount of deduction.—In the case of qualified reclamation costs, the deduction for any taxable year is equal to the current reclamation costs allocable to a property disturbed during such taxable year. Current reclamation costs are the qualified costs that would be paid if the reclamation activities were performed currently. The deduction for qualified closing costs for any taxable year is equal to the current closing costs allocable to the production from a property during such taxable year. Current closing costs are the qualifying

Mine and Waste Disposal Reclamation and Closing Costs

[¶ 2926YS.02]—Continued

• • *CCH Explanation*

costs that would be paid if the closing activities were performed currently. Closing costs are determined according to the unit-of-production method for mine sites and on the unit-of-capacity method for solid waste disposal sites.

.05 **Reserve account adjustments and recapture.**—The opening balance of any reserve account during its first taxable year is zero. Each taxable year, the account is to be increased by the deduction claimed for current reclamation and closing costs for that year and by the interest that would be earned on the opening balance if compounded semiannually at 70% of the Code Sec. 1274 short-term rate for tax years ending in 1984 and 1985, 85% in tax years ending in 1986, and 100% thereafter. Any amounts actually paid during a taxable year for qualified reclamation or closing costs are charged to the account as of the last day of the taxable year. An additional deduction is allowed in any taxable year in the amount of the excess (if any) of the qualified reclamation and closing costs paid during the year over the closing balance of the reserve account at the end of the year (determined without reducing the account by the qualified reclamation and closing costs actually paid). See ¶ 6037S.20 for applicable federal rates.

In the case of an account established for reclamation costs, a taxpayer is required to include in gross income for any taxable year the excess of the closing balance of the account over the current reclamation costs of the taxpayer for all portions of the reserve property disturbed during any taxable year. In the case of a closing costs account, the excess of the ending balance over the current closing costs of the taxpayer—determined as if all production with respect to the reserve property for any taxable year to which the election applies had occurred in the taxable year—is included in the taxpayer's gross income. In determining the recapture amount, all adjustments described in the preceding paragraph are made first.

If an election is revoked or the closing or disposition of a mine or waste disposal site is completed, the outstanding balance of the account must also be included in gross income. If an election is not in effect for at least one taxable year in which the reserved property is disturbed (or production occurs), items with respect to such property will be allocated to the account in accordance with regulations to be prescribed by the IRS.

.09 **Effective date exception for existing accounting practice and fixed price ore supply contracts.**—If on March 1, 1984, a taxpayer was regularly computing deductions for mining reclamation activities under a current cost method of accounting, liability for reclamation activities (a) for land disturbed before July 18, 1984, or (b) relating to a fixed price supply contract described below is treated as having been incurred when the land was disturbed.

The amendments made by the Act relating to the reclamation and closing expense deduction do not apply to any minerals extracted

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Mine and Waste Disposal Reclamation and Closing Costs

• • *CCH Explanation*

from a property and sold pursuant to a fixed supply contract entered into before March 1, 1984. This exception, however, does not apply to any extension of a contract beyond the period that the contract was in effect on March 1, 1984, or to any renegotiation of, or other change in, the terms and conditions of a contract in effect on March 1, 1984.

For the text of the Tax Reform Act of 1984 (P. L. 98-369), Act Sec. 91(g)-(i), see ¶ 2907.2097.—CCH.

Caution: Code Sec. 468A, below, as added by P. L. 98-369, generally applies to costs incurred after July 18, 1984.

[¶ 2926Z]

SPECIAL RULES FOR NUCLEAR DECOMMISSIONING COSTS

'54 Code

Sec. 468A [1954 Code]. (a) IN GENERAL.—If the taxpayer elects the application of this subsection, there shall be allowed as a deduction for any taxable year the amount of payments made by the taxpayer to a Nuclear Decommissioning Reserve Fund (hereinafter referred to as the "Fund") during such taxable year.

(b) LIMITATION ON AMOUNTS PAID INTO FUND.—The amount which a taxpayer may pay into the fund for any taxable year shall not exceed the lesser of—

(1) the amount of nuclear decommissioning costs allocable to the fund which is included in the taxpayer's cost of service for ratemaking purposes for such taxable year, or

(2) the ruling amount applicable to such taxable year.

(c) INCOME AND DEDUCTIONS OF THE TAXPAYER.—

(1) INCLUSION OF AMOUNTS DISTRIBUTED.—There shall be includible in the gross income of the taxpayer for any taxable year—

(A) any amount distributed from the Fund during such taxable year, other than any amount distributed to pay costs described in subsection (e)(2)(B), and

(B) except to the extent provided in regulations, amounts properly includible in gross income in the case of any deemed distribution under subsection (e)(6), any termination under subsection (e)(7), or the disposition of any interest in the nuclear powerplant.

(2) DEDUCTION WHEN ECONOMIC PERFORMANCE OCCURS.—In addition to any deduction under subsection (a), there shall be allowable as a deduction for any taxable year the amount of the nuclear decommissioning costs with respect to which eco[...]mic performance (within the meaning of section 461(h)(2)) occurs dur[...] such taxable year.

(d) RULING AMOUNT.—[...]r purposes of this subsection—

(1) REQUEST REQU[...].—No deduction shall be allowed for any payment to the fund unless the [...]ayer requests, and receives, from the Secretary a schedule of ruling am[...]s.

(2) RULING AMOUN[...] The term "ruling amount" means, with respect to any taxable year, the amo[...] which the Secretary determines under paragraph (1) to be necessary to—

(A) fund th[...]rtion of the nuclear decommissioning costs of the taxpayer with re[...] to the nuclear powerplant which bears the same ratio to the tota[...]clear decommissioning costs with respect to such

Caution: Code Sec. 467, below, as added by P. L. 98-369, generally applies to costs incurred after July 18, 1984.

[¶ 2926Z]—Continued

nuclear powerplant as the period for which the Fund is in effect bears to the estimated useful life of such nuclear powerplant, and

(B) prevent any excessive funding of such costs or the funding of such costs at a rate more rapid than level funding, taking into account such discount rates as the Secretary deems appropriate.

(3) Review of amount.—The Secretary shall at least once during the useful life of the nuclear powerplant (or, more frequently, upon the request of the taxpayer) review, and revise if necessary, the schedule of ruling amounts determined under paragraph (1).

(c) Nuclear Decommissioning Trust Fund.—

(1) In general.—Each taxpayer who elects the application of this subsection shall establish a Nuclear Decommissioning Trust Fund with respect to each nuclear powerplant to which such election applies.

(2) Taxation of fund.—There is imposed on the gross income of the Fund for any taxable year a tax at a rate equal to the maximum rate in effect under section 11(b), except that—

(A) there shall not be included in the gross income of the Fund any payment to the Fund with respect to which a deduction is allowable under subsection (a), and

(B) there shall be allowed as a deduction any amount paid by the Fund described in paragraph (4)(B) (other than to the taxpayer).

(3) Contributions to fund.—The Fund shall not accept any payments (or other amounts) other than payments with respect to which a deduction is allowable under subsection (a).

(4) Use of fund.—The Fund shall be used exclusively for—

(A) satisfying, in whole or in part, any liability of any person contributing to the Fund for the decommissioning of a nuclear powerplant (or unit thereof), and

(B) to pay administrative costs (including taxes) and other incidental expenses of the Fund (including legal, accounting, actuarial, and trustee expenses) in connection with the operation of the Fund.

(5) Prohibitions against self-dealing.—Under regulations prescribed by the Secretary, for purposes of section 4951 (and so much of this title as relates to such section), the Fund shall be treated in the same manner as a trust described in section 501(c)(21).

(6) Disqualification of fund.—In any case in which the Fund violates any provision of this subsection or section 4951, the Secretary may disqualify such Fund from the appl[illegible]ation of this subsection. In any case to which this subparagraph applies, th[illegible]Fund shall be treated as having distributed all of its funds on the date such [illegible] termination takes effect.

(7) Termination u[illegible] completion.—Upon substantial completion of the nuclear decommissioning [illegible] the nuclear powerplant with respect to which a Fund relates, the taxpaye[illegible]all terminate such Fund.

(f) Nuclear Powerpl[illegible]—The term "nuclear powerplant" includes any unit thereof.

.01 Added by P. L. 98-369. For [illegible]ls, see the Code Volumes.

.25 Committee Reports on P. L. 98-369 are at ¶ 2901.04.

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APPENDIX X.

CORRESPONDENCE ON SELF-INSURANCE ISSUES

Correspon-
dence with
W.M.I.

September 9, 1985

Ms. Sheri K. Swibel
Chemical Waste Management, Inc.
3003 Butterfield Road
Oak Brook, Illinois 60521

Dear Ms. Swibel:

I briefly spoke with Jim O'Connor after our meeting last August 15. He suggested I contact you and that we begin discussions on the Minnesota Pollution Control Agency's (MPCA) proposed financial assurance rules. We are both particularly interested in your opinions on a financial assurance option known as either "self-assurance" or "self-insurance."

Mr. O'Connor and other representatives of Waste Management, Inc. have suggested that I write a self-assurance/insurance option into the rules. I have presented their suggestion as a proposed change to the draft that was mailed in January of this year. I hope by this means to receive as many opinions as possible from people with an interest in this area.

You probably realized during our meeting last month that I am more than a bit skeptical about the kinds of self-assurance/insurance arrangements that are usually proposed. I'll describe my concerns in some detail and ask for your opinions.

1. <u>Technical interpretation of statistical analyses.</u>

The self-assurance/insurance arrangements developed under the Resource Conservation and Recovery Act (RCRA) for hazardous waste facilities were chosen on the basis of statistical analyses. The U.S. Environmental Protection Agency (EPA) wanted to find a financial test or tests that would tell them the likelihood the tested firm would become bankrupt. A variety of tests were suggested. The EPA made its choice by comparing the suggested tests with historical data and "testing the tests" for the accuracy with which they predicted instances of business failure. The final choices were those tests which passed 96% of the viable firms and excluded all but 0.1% of bankrupt firms.

Two samples were used in this analysis. One sample consisted of all business firms in the United States operating from 1945 to the present. The other sample consisted of firms operating in industrial sectors ". . . that generate and dispose of large quantities of hazardous waste on-site . . ." Rates of failure in these two samples were used to check the predictive ability of the suggested financial tests.

Again, the analyses performed were statistical tests based on historical data. These analyses provide the main justification for inclusion of the self-asurance/insurance option. The question I raise is whether waste management firms, of any size, are properly represented by the firms studied in the analytical samples; particularly with respect to the major area of concern, risk.

Waste management firms, especially those that operate landfills, are probably riskier operations than the average United States business firm. Generalizing results derived from the first sample to the waste management sector is thus likely to understate the risks involved.

The micro-economic conditions of firms in the second sample vary quite significantly from similar conditions in the waste management sector, particularly with respect to regulatory and market structures. This means, again, that generalizations from the sample to the regulated sector have only questionable validity.

The financial assurance rules recently adopted by the state of Illinois on an emergency basis present a method to ease the riskiness of such regulations. These rules limit use of the self-assurance/insurance option to those firms that earn at least half of their gross revenue from activities other than waste disposal. By implication, these rules hold that diversification lowers risk. However, I don't believe these rules go far enough in their understanding of diversification. As they are now defined, the Illinois rules allow the self-assurance/insurance option to firms that are integrated vertically within a single market. Given that market forces comprise a large part of total business risk, diversification achieved through vertical integration is unlikely to ease overall risk as much as the rule writers may have intended.

2. <u>The impact of rules on overall risk.</u>

The main purpose of the proposed rules is to secure from the risk (to the greatest feasible extent) financial resources sufficient to meet specified expenses. The risk at issue is bankruptcy. Inclusion of self-assurance/insurance options may actually increase, rather than decrease these risks.

Arrangements under the proposed option normally include a "corporate guarantee" made by a parent corporation on behalf of its subsidiary. Consider the implications of widespread use of the proposed option. A qualifying parent corporation may guarantee the actions of subsidiaries spread across the country. At the margin, as the guarantees approach full "subscription" across the country, the overall risk increases at a greater than additive rate. This results because the costs of mishaps are spread throughout the corporate network. Absolute values of net worth and fixed financial ratio tests will likely not reflect the impact on a parent corporation of underwriting this network of risk.

3. Timeliness.

The financial reports used to demonstrate compliance under the proposed option are always at least a year out of date. Under normal arrangements, a certified public accountant (CPA) reviews last period's financial statements. The CPA then writes an opinion for the agency that either certifies that the reviewed firm complies with the agency's rules or that the firm cannot meet the financial assurance tests. The time needed to compile and review financial statements represents a period during which important financial reverses could occur, but not be detected. Reporting lags could well exceed a year in some cases.

The other financial mechanisms allowed under the proposed rules have no such reporting lags. Financial data are current and require no special expertise for interpretation.

4. Opportunity costs.

Generally, suggestions to include a self-assurance/insurance option in the MPCA's financial assurance rules argue that keeping such an option out of the rules imposes an opportunity cost on the landfill operator. The argument presumes that self-assurance/insurance is the least-cost option. However, the argument misses a central point. That is, whether the cost savings justify implicit risk increases.

Whatever the financial arrangement, the business firm must collect revenues sufficient to cover the specified costs. This means that any cost advantages one mechanism enjoys over another can only consist of savings in administrative costs. The question again becomes one of of deciding whether cost savings can justify increases in risk.

Another argument sometimes presented by proposers of the self-assurance/insurance option is that the waste management firm should not be denied use of financial assets. Depriving the firm of this use (as under trust fund arrangements, for example) is presented as an unnecessary constraint on business operations. This argument also misses a central point. The financial assurance rules are written not for the benefit of the waste management firm but for the benefit of its clients. There is no intent to cause harm to any business through implementation of these rules. But the central concern is protection of environmental resources, not enhancing the economic viability of business firms.

Moreover, the impact of excluding the self-assurance/insurance option on a business firm's competitive position will probably be moot. As noted before, the only cost impacts will be felt through differential administrative costs. These costs will not be an appreciable fraction of total financial assurance costs. This means that the difference between using a trust fund and using self-assurance/insurance will not be great if it is measured on a firm's income statement results. There should also be no impact on balance sheets since: a) trust funds should not appear on corporate balance sheets [e.g., employee pension funds] and b) any assets gathered to comply under self-assurance/insurance options would have to be completely offset by specific liabilities [i.e., no equity increase].

To sum up: I see a convincing technical argument against the proposed option and no real advantage, for the agency or the business firm, favoring the proposed option. I present these arguments as a starting point for discussion. Please consider them and let me know your reactions. I look forward to hearing from you soon.

Sincerely,

Original Signed By

Robert J. McCarron
Program Development Section
Solid and Hazardous Waste Division

RJM:km

Bob McCarron

Minnesota Pollution Control Agency

November 22, 1985

Mr. Forrest D. Nowlin
Larkin, Hoffman, Daly & Lindgren, Ltd.
1500 Northwestern Financial Center
7900 Xerxes Avenue South
Bloomington, Minnesota 55431

Dear Mr. Nowlin:

Thanks for the considered responses you provided in your October 30 letter to Gordon Meyer, the head of our Program Development Section. Your suggestions provide us with an opportunity to discuss openly financial assurance issues that have so far received little consideration.

Your first point is that trust agreements are an unreasonable and ineffective means to secure financial assurance for contingency action costs. Your choice of words tells me that there is some threshold criterion which defines the difference between reason and unreason, between efficacy and inefficacy. I need to know where this threshold lies.

I suspect the threshold criteria are financial. However, the range of financial conditions under which landfills operate indicates that margins are totally insensitive to costs. I have hoped for evidence from firms such as your client that will help me set acceptable limits on the regulations. Perhaps you can request a statement from your clients on both the price sensitivity of their services and the minimum scale at which a landfill can earn acceptable profits.

Your discussion implies that insurance mechanisms are sufficient to meet the need in this case. Indeed, you seem to suggest that only insurance can do the job. I'm sure you know of the current problems that insurers face in many markets. We cannot rely on any solutions from that sector in the near term.

However, your suggestion highlights a conventional misunderstanding about the way insurance operates. You correctly understand that insurers quantify, buy and sell risk. Risk is measurable and tradeable. But with landfills we confront an entirely different problem - uncertainty - which can't be measured. The pervasive uncertainty surrounding landfill problems is a large reason insurers won't write coverage for landfill firms. I suggest to you, and ask for your opinion in return, that only trust funds can remedy the problem when uncertainty prevails over risk.

Your second suggestion is that I write a "self-assurance" option into the rules. I understand the suggestion but I don't understand the reasons behind it. Again, I'll present my reasons for writing the draft as I did and ask you for your response to the arguments raised.

1. Technical interpretation of statistical analyses.

The self-assurance/insurance arrangements developed under the Resource Conservation and Recovery Act (RCRA) for hazardous waste facilities were chosen on the basis of statistical analyses. The U.S. Environmental Protection Agency (EPA) wanted to find a financial test or tests that would tell them the likelihood of failure by the firm being tested. A variety of tests were suggested. The EPA made its choice by comparing the suggested tests with historical data and "testing the tests" for the accuracy with which they predicted instances of business failure. The final choices were those tests which passed 95% of the viable firms and excluded all but 0.1% of bankrupt firms.

Two samples were used in this analysis. One sample consisted of all business firms in the United States operating from 1945 to the present. The other sample consisted of firms operating in industrial sectors ". . . that generate and dispose of large quantities of hazardous waste on-site . . . ." Rates of failure in these two samples were used to check the predictive ability of the suggested financial tests.

Again, the analyses performed were statistical tests based on historical data. These analyses provide the main justification for inclusion of the self-assurance/insurance option. The question I raise is whether waste management firms, of any size, are properly represented by the firms studied in the analytical samples; particularly with respect to the major area of concern, risk.

Waste management firms, especially those that operate landfills, are probably riskier operations than the average United States business firm. Generalizing results derived from the first sample to the waste management sector is thus likely to understate the risks involved.

The micro-economic conditions of firms in the second sample vary quite significantly from similar conditions in the waste management sector, particularly with respect to market structures. This means, again, that generalizations from the sample to the regulated sector have only questionable validity.

The financial assurance rules recently adopted by the state of Illinois on an emergency basis present a method to ease the riskiness of such regulations. These rules limit use of the self-assurance/insurance option to those firms that earn at least half of their gross revenue from activities other than waste disposal. By implication, these rules accept the notion that diversification lowers risk. However, I don't believe these rules go far enough in their understanding of diversification. As they are now defined, the Illinois rules allow the self-assurance/insurance option to firms that are integrated vertically within a single market. Given that market forces comprise a large part of a total business risk, integrated diversification is unlikely to ease overall risk as much as the rule writers may have intended.

2. The impact of rules on overall risk.

The main purpose of the proposed rules is to secure from risk (to the greatest feasible extent) financial resources sufficient to meet specified expenses. The risk at issue is bankruptcy. Inclusion of self-assurance/insurance options may actually increase, rather than decrease these risks.

Arrangements under the proposed option normally include a "corporate guarantee" made by a parent corporation on behalf of its subsidiary. Consider the implications of widespread use of the proposed option. A qualifying parent corporation may guarantee the actions of subsidiaries spread across the country. At the margin, as the guarantees approach full "subscription" across the country, the overall risk increases at a greater than additive rate. This results because the costs of mishaps are spread throughout the corporate network. Absolute values of net worth and fixed financial ratio tests will likely not reflect the impact on a parent corporation of underwriting this network of risk.

3. Timeliness.

The financial reports used to demonstrate compliance under the proposed option are always at least a year out of date. Under normal arrangements, a certified public accountant (CPA) reviews last period's financial statements. The CPA then writes an opinion for the agency that either certifies that the reviewed firm complies with the agency's rules or that the firm cannot meet the financial assurance tests. The time needed to compile and review financial statements represents a period during which important financial reverses could occur, but not be detected. Reporting lags could well exceed a year in some cases.

The other financial mechanisms allowed under the proposed rules have no such reporting lags. Financial data are current and require no special expertise for interpretation.

4. Opportunity costs.

Generally, suggestions to include a self-assurance/insurance option in the Minnesota Pollution Control Agency's financial assurance rules argue that keeping such an option out of the rules imposes an opportunity cost on the landfill operator. The argument presumes that self-assurance/insurance is the least-cost option. However, the argument misses a central point. That is, whether the cost savings justify implicit risk increases.

Whatever the financial arrangements, the business firm must collect revenues sufficient to cover the specified costs. This means that any cost advantages one mechanism enjoys over another can only consist of savings in administrative costs. The question again becomes one of deciding whether cost savings can justify increases in risk.

Another argument sometimes presented by proposers of the self-assurance/insurance option is that the waste management firm should not be denied use of financial assets. Depriving the firm of this use (as under trust fund arrangements, for example) is presented as an unnecessary constraint on business operations. This argument also misses a central point. The financial assurance rules are written not for the benefit of the waste management firm but for the benefit of its clients. There is no intent to cause harm to any business through implementation of these rules. But the central concern is protection of environmental resources, not enhancing the economic viability of business firms.

Moreover, the impact of excluding the self-assurance/insurance option on a business firm's competitive position will probably be moot. As noted before, the only cost impacts will be felt through differential administrative costs. These costs will not be an appreciable fraction of total financial assurance costs. This means that the difference between using a trust fund and using self-assurance/insurance will not be great if it is measured by income statement results. There should also be no impact on the balance sheets since: a) trust funds should not appear on corporate balance sheets [e.g., employee pension funds] and b) any assets gathered to comply under self-assurance/insurance options would have to be completely offset by specific liabilities [i.e., no equity increase].

To sum up: I see a convincing technical argument against the proposed option and no real advantage, for the agency <u>or</u> the business firm, favoring the proposed option.

Finally, I suggested the change in determination of trust fund pay-in periods and amounts as an accommodation to landfill operators. People who know tax matters have told me that unless the pay-in period is equal to the site's operating life, some part of the trust fund payments will be taxable. But this operating life has to relate to a period of actual operations, not a potential that may not be realized. This is why I suggested we tie the trust fund schedule to the certificate of need. Beyond the tax savings realized, this method will allow planning time for both landfill operators and local governments. When the time comes for renewal of the certificate of need, then trust arrangements can be adjusted to account for the extended future of the site.

Please consider this letter as a starting point for further discussions. We welcome written replies or personal meetings. I look forward to hearing from you soon.

Sincerely,

Robert J. McCarron
Program Development Section
Solid and Hazardous Waste Division

RJM:km

Enclosures

Minnesota Pollution Control Agency

August 25, 1986

Mr. Ron Moening
9813 Flying Cloud Drive
Eden Prairie, Minnesota 55344

Dear ~~Mr. Moening~~ Ron:

I have enclosed copies of the letters we talked about before our August 21 meeting at the Minnesota Pollution Control Agency (MPCA) offices. I will spend some time here refreshing your memory. The questions raised in these letters must be raised again in a support document I am preparing for the landfill financial assurance rules. The document is called Statement of Need and Reasonableness (SONAR). State law requires that a SONAR accompany all proposed administrative rules.

I wrote the enclosed letters in hopes that I could find a way to justify putting in the rules the "self-insurance option" which both BFI and Waste Management, Inc., have argued for. However, I have not yet gotten any response to the letters. It may well be that I have been writing to the wrong people. I would appreciate it if you could forward these letters to someone in your organization who can give me a response.

If I do not get any answers, I will have no reason to include a self-insurance provision in the rules. The enclosed letters and this one will likely appear as support documents for the SONAR. The justification for the exclusion will likely rest on a sort of negative proof - that your firm operates sites (profitably, it is assumed) in states which have financial assurance rules that do not allow self-insurance.

I am facing an October 31 deadline for the SONAR. Please let me know if you locate someone who can respond for your organization. Thanks for your help in this matter.

Sincerely,

Bob McCarron

Robert J. McCarron
Program Development Section
Solid and Hazardous Waste Division

RJM/cds

Enclosure

Phone:

1935 West County Road B2, Roseville, Minnesota 55113-2785
Regional Offices • Duluth/Brainerd/Detroit Lakes/Marshall/Rochester
Equal Opportunity Employer

Minnesota Pollution Control Agency

August 25, 1986

Mr. Jim Morgan
6515 Grand Teton
Madison, Wisconsin 53719

Dear ~~Mr. Morgan~~ Jim:

I have enclosed copies of the letters we talked about before our August 21 meeting at the Minnesota Pollution Control Agency (MPCA) offices. I will spend some time here refreshing your memory. The questions raised in these letters must be raised again in a support document I am preparing for the landfill financial assurance rules. The document is called Statement of Need and Reasonableness (SONAR). State law requires that a SONAR accompany all proposed administrative rules.

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Sincerely,

Bob McCarron

Robert J. McCarron
Program Development Section
Solid and Hazardous Waste Division

RJM/cds

Enclosure

Phone:
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November 3, 1986 Madison West

Mr. Robert J. McCarron
Program Development Section
Solid and Hazardous Waste Division
Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155

Dear Bob:

Enclosed herewith is the financial assurance information that you and I have been talking about for well over a year. It is timely because the new rules are a current topic of debate. The paper that Debera Falcone and Sherry Swibel have put together indeed strikes at the very heart of the problem you and I have been discussing. A need exists for a financial assurance program that does not unduly tie the hands of the very people who must ultimately work to handle waste in the State of Minnesota as well as the rest of the United States. It's my old argument--this generation can't pay for all the past sins.

I would add two comments to the argument which I believe make the paper more relevant to the State of Minnesota.

1. The State of Minnesota is one of the few states that does not have state of the art sites in place and operational. Most states, such as Wisconsin, have had lined leachate collection sites for a number of years. With that in mind, it becomes apparent that the ratio of failure will decrease at an increasing rate as state of the art sites come on line. Contrast this to Minnesota where one state of the art site exists today. Hopefully, many more will exist in the not too

distant future. But, I can see where that would skew some of your thinking as to the ability of a company to comply with the financial assurance rules. But in the case here of Waste Management of Minnesota, you can see that you are dealing with a multi-state company whose reserves and financial strength must be taken into account.

2. One of the arguments which has been bandied back and forth is the timeliness of the corporate information, i.e. is it old or new at the time you receive it. This one I found rather interesting because we both know that the timeliness of the information which you, the State of Minnesota, receives on solid waste sites is always subject to the same criticism. If nothing more, a year and three months for corporate reporting is somewhat in advance of the information you would have collected at the agency. The least you can say under the scenario argued by Debera is that the two come closer to corresponding on an apples-to-apples basis than the argument which you made that the information is outdated.

I know we're going to be talking about this at great length in the months to come. I appreciate your comments and hope you will take this information into account. As I plow through the remainder of the proposed rules prior to November 12, I think this particular paper is very helpful.

I add my name to the list of people who remain ready to help in the event you require further information. I am sending this by Federal Express so as to not delay your review time.

Sincerely,

James W. Morgan

JWM:jms
Enclosure

cc: S. Swibel
D. Falcone

Waste Management, Inc.
3003 Butterfield Road • Oak Brook, Illinois 60521

October 31, 1986

Mr. Robert J. McCarron
Program Development Section
Solid and Hazardous Waste Division
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, MN 55113-2785

Dear Mr. McCarron:

In your letter of September 9, 1985, you raised several concerns regarding self-insurance options for financial assurance. I would like to address these concerns.

1. <u>Technical interpretation of statistical analyses</u>. The concern you raised on this topic is that the statistical samples used by the USEPA to test the self-insurance option may not have properly reflected waste management firms. You also contend that waste management firms are probably riskier than the average U.S. business firm.

   Waste management firms were included in the statistical samples to the extent possible. Only firms of a certain size are eligible to use self-insurance, which severely limits the number of waste management firms which would be eligible for self-insurance or which could therefore be included in the samples. There are few waste management firms meeting the financial test requirements now, and at the time the samples were selected there were fewer still - two to be precise. Since the number of waste management firms which are eligible for self-insurance is so limited, it would probably not be feasible or possible to have a statistically valid sample of exclusively waste management firms.

   The fact that a limited number of waste management firms were included in the samples does not necessarily negate the validity of the results of the samples when applied to waste management firms. Waste management firms are not inherently riskier than all other businesses. There are other industries that have similar regulatory constraints or risks, such as the pharmaceutical industry. There are industries in which firms have very little diversification and are highly dependent on one

312/654-8800 • Telex: 253091 • TWX 910 651-0829

product or raw material, such as the oil industry. Any industry is subject to risks that might be peculiar to only certain industries. For example, all firms which manufacture or market consumer goods run the risk of product liability suits. A product liability suit on a single product can result in the bankruptcy of a firm, as demonstrated recently with the Dalkon Shield manufactured by A. H. Robbins. I would therefore question your contentions that waste management firms are inherently riskier than other firms and that the USEPA study has "only questionable validity" for the waste management industry.

You discussed the possibility of limiting the use of self-insurance to firms which are diversified, as a means of reducing risk. There are other industries where lack of diversification is prevalent and also many firms within various industries which are not diversified. There is no rationale for essentially singling out the waste management industry for this reason. These various firms and industries would have been included in the USEPA samples used to test the validity of the self-insurance option. And, although there may be certain risks associated with non-diversified firms, there are also risks related to diversified firms. For example, the management of a diversified firm would likely not have the same level of technical and industry expertise and competence as the management of a non-diversified firm. A diversified firm might also not have the same commitment to one small segment of its business in comparison to a non-diversified firm's commitment to the future and improvement of their particular industry. Therefore the conclusion that non-diversified firms should not be eligible for the self-insurance option would be unjustified.

2. <u>The impact of rules on overall risk</u>. You contend that the use of the corporate guarantee allows a parent corporation to use self-insurance for a number of sites, which increases the risk that the financial resources are not sufficient to meet the specified expenses.

   The self-insurance option is structured so that as the number of facilities covered (i.e. the amount of expenses for which financial resources must be provided) increases, the minimum amount of net worth which the corporation must have in order to qualify to use self-insurance increases correspondingly. It does <u>not</u> involve an "absolute value of net worth" as a ceiling, but rather only as a floor.

As the number of facilities increases, the likelihood that a contingent event will occur at at least one facility increases. However, the likelihood that events will occur at both of two facilities is significantly less than the likelihood that an event will occur at only one facility. Similarly, the likelihood of events occurring at three of three facilities is much lower than the likelihood of events occurring at two of two facilities, and so on. As the number of facilities increases, the amount of net worth increases to be able to cover that number of sites. Yet at the same time, the likelihood that events will occur at all sites decreases. Therefore, as the number of sites covered by self-insurance increases, the risk that adequate financial resources are available decreases rather than increases.

3. Timeliness. You state that the financial reports used to demonstrate compliance under self-insurance are "always at least a year out of date" and that "Reporting lags could well exceed a year."

Most regulations which allow use of self-insurance require that the financial assurance documents must be revised within 90 days of the end of the latest fiscal year. This means that the financial data is at most one year and three months old. And for the majority of the year between updates, the data are less than one year old.

A vast number of financial decisions are based on fiscal year end financial data. The reporting lag does not prevent banks and lending institutions from making decisions on loans, investors from making buy and sell decisions, or vendors from making credit decisions. In addition, if your concern is the possibility of financial reverses during the year, quarterly financial data is available. For publicly held companies, quarterly financial data is a matter of public record, filed with the Securities and Exchange Commission. Regardless of this, quarterly financial data can be requested or required by regulatory bodies allowing the self-insurance option.

4. Opportunity costs. With regard to opportunity costs (i.e. depriving a firm of the use of funds in the case of a trust fund), you suggest that this is irrelevant as the purpose of financial assurance regulations is to protect the environment rather than waste management firms.

We do not dispute the purpose of financial assurance regulations nor are we trying to dilute or circumvent that purpose. Our point is, however, that self-insurance is a valid way of providing financial assurance for the protection of the environment. Therefore, by denying the use of the self-insurance option you are unnecessarily and unfairly depriving us of the use of our capital.

In addition, allowing us the use of these funds is also to the advantage of both our customers and the environment. These funds enable us to devote additional resources to research and development, towards finding innovative and safer methods of disposing of wastes. In addition, to the extent that these funds improve our financial strength, we are able to borrow and obtain capital at lower costs and thus serve our customers at lower rates. Allowing us to use the funds would allow the funds to be put to productive use until needed, rather than sitting idle in a trust fund.

In contrast to your conclusions, we believe that self-insurance is a technically valid mechanism for providing financial assurance. We also believe that self-insurance provides significant advantages to not only waste management firms, but also to our customers and to the environment. We would be glad to further discuss any of these issues or address any additional concerns you may have regarding self-insurance. Please feel free to contact Sheri Swibel or me at your convenience at (312) 572-8800.

Sincerely

Debera A. Falcone

Debera A. Falcone

DAF/cd

cc: J. Morgan
S. Swibel

Minnesota Pollution Control Agency

June 15, 1987

Dear Interested Person:

Re: Proposed Self-Insurance Provisions in Draft Landfill Financial Assurance Rules.

Many who have reviewed the Minnesota Pollution Control Agency's (MPCA) proposed amendments to the solid waste rules have suggested that the financial assurance portions should contain self-insurance provisions. Such provisions were not written into the initial drafts because existing self-insurance models have no technical validity in their application to firms in the solid waste management sector.

The MPCA staff has developed a self-insurance rule that I believe will satisfy both landfill permittees and the MPCA. I have enclosed a conceptual description of the proposed self-insurance rules. Please review it and let me know at your earliest convenience whether or not you agree with the concept. If you disagree, it will be most helpful if you present your objections in detail. I am also interested in any suggestions you have for improving the proposals.

We intend to include this concept in the rules we propose to the MPCA Board later this summer. We are now drafting the rule language and compiling evidence in support of this rule. Please let me know if you want to see the draft self-insurance rule when it is ready.

We are moving ahead with the rest of the proposed rule amendments, so I will appreciate your response by July 1, 1987. Please give your comments to Bob McCarron (612/296-7324) or Art Dunn (612/296-7294).

Sincerely,

Richard A. Svanda

Richard A. Svanda
Director
Solid and Hazardous Waste Division

RAS/RJM:bmj

Enclosure

PROPOSED SELF INSURANCE RULE FOR MIXED MUNICIPAL LANDFILLS

Some landfill permittees have suggested that the financial responsibility sections of the proposed solid waste rules should allow permittees with demonstrated financial strength to self-insure. The hazardous waste facility rules contain provisions of this sort. Self-insurance allows permittees with large reserves or with powerful corporate parents to write the Minnesota Pollution Control Agency (MPCA) an I.O.U. They promise to pay for all long-term care costs at their sites. The MPCA accepts this promise as sufficient proof that the sites will be cared for. Permittees who do not qualify for this option have to use mediated financial instruments (trust funds, letters of credit, and surety bonds).

The MPCA staff has resisted requests to include self-insurance in the proposed solid waste rules for a number of reasons. These include: 1) the statistical analyses used to validate the usual financial tests have no meaning in the solid waste sector, 2) networking provisions usually allowed in self-insurance arrangements could increase, rather than minimize risks, 3) the solid waste sector differs fundamentally from the economic sectors which use the self-insurance provisions of the hazardous waste facility rules, and 4) mediated instruments will make timely action easier, if a permittee should refuse to take action or become bankrupt.

Those who want self-insurance maintain that their concerns focus on cost and control. They want to minimize the cost of compliance and maximize their control of funds reserved for long-term care. The MPCA's primary concern is risk - the risk that a landfill permittee will mismanage financial reserves and be unable to pay for long-term care. This is why the initial drafts of the proposed rules require that independent financial intermediaries provide guarantees for the permittees' long-term care liabilities.

The MPCA staff has developed a plan that can accomplish both permittees' and the State's goals. The proposal is to adapt customary self-insurance provisions for use with marketable bonds. This proposal is a two-stage process. First, allow self-insurance as determined by a series of customary tests. After the permittee has passed the specified financial tests, the permittee sends marketable bonds to the State as collateral for the closure, postclosure care, and corrective action obligations undertaken.

Consider this example.

Step 1. Financial test - the permittee must demonstrate that:

a. more than 50 percent of gross revenues are derived from sources other than waste disposal;
b. the permittee has a tangible net worth greater than $10 million;
c. tangible net worth is at least six times greater than estimated costs;
d. net working capital is at least six times greater than estimated costs;
e. 90 percent of the firm's assets are located in the United States;
f. total assets are at least six times greater than estimated costs;
g. at least two of the following three conditions hold: total liabilities are not more than double net worth; cash flow is at least one-tenth of total liabilities; current assets are at least one and a half times greater than current liabilities; and
h. annual CPA reports find that all financial data are accurate and fairly representative of the firm's financial position.

Step 2. Provision of collateral.

The permittee sends the State unsubordinated debentures (bonds) whose market value is equal to estimated costs. The evaluation of market value becomes a part of the CPA's annual report. The term of the bonds is tied to the permittee's long-term plans. That is, the bonds used as collateral for closure costs expire two years after scheduled closure. The bonds used as collateral for postclosure care and corrective action expire twenty-two years after scheduled closure.

The bonds must be marketable. Permittees will also have to establish standby trust funds which will receive the proceeds if any bonds must be sold.

Step 3. State maintenance.

The State holds the bonds as collateral to be used only if the permittee should fail to meet its permit obligations. Annual reviews should lead to adjustments in cost estimates and the amount of the bonds. Permittees may also choose to rely on other financial media to cover cost changes.

Step 4. Release from financial assurance responsibilities.

Permittees must be released from requirements to maintain financial assurance once their responsibilites have been met. The State must return the bonds to the permittees when they are released from their financial assurance responsibilities.

This proposal accommodates the objections of the reviewers who suggest the need for self-insurance. The arrangement need not make great demands on current cash; just the cost for CPA reports, bond issues, and a nominal charge for setting up a standby trust. The firm will still have to close and maintain the site and pay for any corrective action costs.

The MPCA receives marketable bonds which can be sold for cash if the need arises. The market value of bonds can change, so some risk remains. Annual reviews and adjustments should minimize this risk.

Discussion about self-insurance usually makes distinction between private sector and public sector permittees. The usual financial tests were obviously designed for private sector firms. They cannot be applied in the public sector because public sector financial accounting does not recognize the test values, e.g., net worth, working capital, etc. However, there are other effective measures of public sector performance and expectations.

Bond ratings can serve as an overall measure of financial strength (net worth). The hazardous waste facility rules allow Standard and Poor's ratings of BBB or higher and Moody's ratings of Baa or higher. This alternative measure was designed to accommodate public utilities. It can also serve for local governments. Current financial position data could substitute for liquidity measures. For example, past, current, and predicted future budget data provide the same sort of information available in private sector balance sheets. The needed test value (used to determine whether or not the permittee is allowed to self-insure) must relate to short-term liquidity. The proposed test values require a demonstration of: the municipality's surplus of levy limits over actual levies, the municipality's surplus of debt limits over actual debt, and projections that these values will not become negative in the short term. Appropriate local officials will be required to certify the accuracy of the demonstrations. Once again, annual updates can be used to make sure that cost estimates and market valuations are kept current and adequate.

Waste Management, Inc.
3003 Butterfield Road • Oak Brook, Illinois 60521

October 26, 1987

Mr. Robert J. McCarron
Program Development Section
Solid and Hazardous Waste Division
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, MN 55113-2785

Dear Mr. McCarron:

I have reviewed the proposed Self-Insurance Provisions and would like to point out that the provisions do not describe what would normally be thought of as self insurance by the very definition. Self insurance by definition means to rely on yourself rather than paying insurance. The State's proposal would rely on marketable security or a third party instrument, not on the financial resources of the permittee.

Definitions aside, another objection to "self insurance" in the proposed form would be the cost. To issue marketable securities would be more costly and more administratively burdensome than the other alternatives (letters of credit, bonds).

Even if the cost of providing collateral under the "self-insurance" provision were reasonable (it is not), the financial test proposed would exclude commercial operators through the 50% gross revenue test. It would seem logical that a company whose primary revenue was from landfill operations would have more expertise in the field and would be less risky than someone whose primary revenue was derived elsewhere.

Another of the provisions that should be changed is the net working capital provision which would have to be six times the cost estimate. This is especially stringent when one thinks of the probabilities that all cost included in closure, post-closure, or corrective action could be incurred at one time. The test really only looks at the current assets of a company when the bulk of a company's assets may be long term or fixed. Why not adopt a provision similar to the Federal Regulation relying on a test based on an alternative of net worth or working capital which reflects the long-term viability of the company?

Privately owned facilities are not allowed to use their bond rating in lieu of specific ratios under the provision. This is inconsistent with Federal regulations and is even inconsistent with your proposed "self-insurance" provision. In your provision you will only accept marketable securities with their value and marketability being determined by the financial community. If you feel that the financial community can be trusted in the above situation, why not allow the bond rating for privately owned facilities to be used in lieu of specific ratios? The bond ratings are updated regularly by the rating agencies and are probably the most current indicator of a company's financial position.

This so called "self-insurance" provision severely limits the options a company has. Self insurance should allow a financially secure company to rely on their financial strength to fund their responsibilities. This proposal would needlessly cost a company, and ultimately this cost will be passed on to the users and to the environment.

Sincerely,

Thomas J. Alexander

TJA/sk

cc: M. Rooney
S. Swibel

Minnesota Pollution Control Agency

November 10, 1987

Mr. Thomas J. Alexander
Waste Management, Inc.
3003 Butterfield Road
Oak Brook, Illinois 50521

Dear Mr. Alexander:

Thank you for your October 26 response to our June 15 mailing on a new proposal for the financial assurance rules that will affect Minnesota's municipal landfills. I appreciate the time you and others in your firm have devoted to this subject.

I intend to amend the proposed rules based on one of your suggestions. You believe that the self-insurance rule should allow a permittee to exercise this option by either directly demonstrating financial strength as specified in the rule or, in the alternative, providing evidence of investment grade bond ratings. The June 15 proposal did not mention this option. That was an oversight that will be corrected in the final proposed rule.

I cannot respond to your other objections to the June 15 proposal. Those objections relate to costs and to interpretations of federal and state regulations. I contacted members of our local financial community and asked them about the costs of the proposal. Their data and information clearly show that the June 15 proposal will prove less costly than available alternatives. I will need verifiable data that support your contrary assertion before I can act on it.

Other objections involve interpretations of federal and local laws. I have reviewed again the federal and state rules that I believe are relevant. I can find no regulations that support your objections. However, I may well have missed the regulations on which you base your objections. If you can give me the appropriate references, I will be glad to review those regulations also.

Mr. Thomas J. Alexander
Page Two

Please let me know if you have more specific information that supports your objections. Such information could provide the basis for amending the proposed rules.

Sincerely,

Robert J. McCarron
Program Development Section
Ground Water and Solid Waste Division

RJM:jcj

cc: Mr. Jim Morgan, DeWitt, Sundby, Huggett, Schumacher and Morgan
Ms. Terry Hoffman, St. Paul
Mr. Dwight Wagenius, Special Assistant Attorney General

Waste Management, Inc.
3003 Butterfield Road, Oak Brook ...

RECEIVED

DEC 17 87

MPCA, Ground Water
& Solid Waste Div.

December 2, 1987

Mr. Robert J. McCarron
Program Development Section
Solid and Hazardous Waste Division
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, MN 55113-2785

Dear Mr. McCarron:

Thank you for your letter of November 10, 1987. In my previous letter I was attempting to point out that the Minnesota proposed financial test is more stringent than the Federal test which is outlined in Section 264.143. The Federal Regulation does not require more than 50% of gross revenue of a permittee be derived from sources other than waste disposal. The rule also allows a permittee to use either financial test outlined in Section 264.143 (which is attached) to prove that it is financially responsible.

Again, I appreciate your response to my previous letter and hope you will consider using the financial tests outlined in the Federal Regulations.

Sincerely,

Thomas J. Alexander

TJA/sk
Att.

312/572-8800 · Telex: 25[illegible] · TWX: [illegible]

significantly greater than the face amount of the policy, he may withhold reimbursements of such amounts as he deems prudent until he determines, in accordance with § 264.143(i), that the owner or operator is no longer required to maintain financial assurance for final closure of the facility. If the Regional Administrator does not instruct the insurer to make such reimbursements, he will provide the owner or operator with a detailed written statement of reasons.

(6) The owner or operator must maintain the policy in full force and effect until the Regional Administrator consents to termination of the policy by the owner or operator as specified in paragraph (e)(10) of this section. Failure to pay the premium, without substitution of alternate financial assurance as specified in this section, will constitute a significant violation of these regulations, warranting such remedy as the Regional Administrator deems necessary. Such violation will be deemed to begin upon receipt by the Regional Adminstrator of a notice of future cancellation, termination, or failure to renew due to nonpayment of the premium, rather than upon the date of expiration.

(7) Each policy must contain a provision allowing assignment of the policy to a successor owner or operator. Such assignment may be conditional upon consent of the insurer, provided such consent is not unreasonably refused.

(8) The policy must provide that the insurer may not cancel, terminate, or fail to renew the policy except for failure to pay the premium. The automatic renewal of the policy must, at a minimum, provide the insured with the option of renewal at the face amount of the expiring policy. If there is a failure to pay the premium, the insurer may elect to cancel, terminate, or fail to renew the policy by sending notice by certified mail to the owner or operator and the Regional Administrator. Cancellation, termination, or failure to renew may not occur, however, during the 120 days beginning with the date of receipt of the notice by both the Regional Administrator and the owner or operator, as evidenced by the return receipts. Cancellation, termination, or failure to renew may not occur and the policy will remain in full force and effect in the event that on or before the date of expiration:

(i) The Regional Administrator deems the facility abandoned; or

(ii) The permit is terminated or revoked or a new permit is denied; or

(iii) Closure is ordered by the Regional Administrator or a U.S. district court or other court of competent jurisdiction; or

(iv) The owner or operator is named as debtor in a voluntary or involuntary proceeding under Title 11 (Bankruptcy), U.S. Code; or

(v) The premium due is paid.

(9) Whenever the current closure cost estimate increases to an amount greater than the face amount of the policy, the owner or operator, within 60 days after the increase, must either cause the face amount to be increased to an amount at least equal to the current closure cost estimate and submit evidence of such increase to the Regional Administrator, or obtain other financial assurance as specified in this section to cover the increase. Whenever the current closure cost estimate decreases, the face amount may be reduced to the amount of the current closure cost estimate following written approval by the Regional Administrator.

(10) The Regional Administrator will give written consent to the owner or operator that he may terminate the insurance policy when:

(i) An owner or operator substitutes alternate financial assurance as specified in this section; or

(ii) The Regional Administrator releases the owner or operator from the requirements of this section in accordance with § 264.143(i).

(f) *Financial test and corporate guarantee for closure.* (1) An owner or operator may satisfy the requirements of this section by demonstrating that he passes a financial test as specified in this paragraph. To pass this test the owner or operator must meet the criteria of either paragraph (f)(1)(i) or (ii) of this section:

(i) The owner or operator must have:

(A) Two of the following three ratios: a ratio of total liabilities to net worth less than 2.0; a ratio of the sum of net income plus depreciation, depletion, and amortization to total liabilities greater than 0.1; and a ratio of current assets to current liabilities greater than 1.5; and

(B) Net working capital and tangible net worth each at least six times the sum of the current closure and post-closure cost estimates and the current plugging and abandonment cost estimates; and

(C) Tangible net worth of at least $10 million; and

(D) Assets located in the United States amounting to at least 90 percent of total assets or at least six times the sum of the current closure and post-closure cost estimates and the current plugging and abandonment cost estimates.

(ii) The owner or operator must have:

(A) A current rating for his most recent bond issuance of AAA, AA, A, or BBB as issued by Standard and Poor's or Aaa, Aa, A, or Baa as issued by Moody's; and

(B) Tangible net worth at least six times the sum of the current closure and post-closure cost estimates and the current plugging and abandonment cost estimates; and

(C) Tangible net worth of at least $10 million; and

(D) Assets located in the United States amounting to at least 90 percent of total assets or at least six times the sum of the current closure and post-closure cost estimates and the current plugging and abandonment cost estimates.

(2) The phrase "current closure and post-closure cost estimates" as used in paragraph (f)(1) of this section refers to the cost estimates required to be shown in paragraphs 1-4 of the letter from the owner's or operator's chief financial officer (§ 264.151(f)). The phrase "current plugging and abandonment cost estimates" as used in paragraph (f)(1) of this section refers to the cost estimates required to be shown in paragraphs 1-4 of the letter from the owner's or operator's chief financial officer (§ 144.70(f) of this title).

(3) To demonstrate that he meets this test, the owner or operator must submit the following items to the Regional Administrator:

(i) A letter signed by the owner's or operator's chief financial officer and worded as specified in § 264.151(f); and

(ii) A copy of the independent certified public accountant's report on examination of the owner's or operator's financial statements for the latest completed fiscal year; and

(iii) A special report from the owner's or operator's independent certified public accountant to the owner or operator stating that:

(A) He has compared the data which the letter from the chief financial officer specifies as having been derived from the independently audited, year-end financial statements for the latest fiscal year with the amounts in such financial statements; and

(B) In connection with that procedure, no matters came to his attention which caused him to believe that the specified data should be adjusted.

(4) An owner or operator of a new facility must submit the items specified in paragraph (f)(3) of this section to the Regional Administrator at least 60 days before the date on which hazardous waste is first received for treatment, storage, or disposal.

(5) After the initial submission of items specified in paragraph (f)(3) of this section, the owner or operator must send updated information to the Regional Administrator within 90 days after the close of each succeeding fiscal year. This information must consist of all three items specified in paragraph (f)(3) of this section.

(6) If the owner or operator no longer meets the requirements of paragraph (f)(1) of this section, he must send notice to the Regional Administrator of intent to establish alternate financial assurance as specified in this section. The notice must be sent by certified mail within 90 days after the end of the fiscal year for which the year-end financial data show that the owner or operator no longer meets the requirements. The owner or operator must provide the alternate financial assurance within 120 days after the end of such fiscal year.

(7) The Regional Administrator may, based on a reasonable belief that the owner or operator may no longer meet the requirements of paragraph (f)(1) of this section, require reports of

financial condition at any time from the owner or operator in addition to those specified in paragraph (f)(3) of this section. If the Regional Administrator finds, on the basis of such reports or other information, that the owner or operator no longer meets the requirements of paragraph (f)(1) of this section, the owner or operator must provide alternate financial assurance as specified in this section within 30 days after notification of such a finding.

(8) The Regional Administrator may disallow use of this test on the basis of qualifications in the opinion expressed by the independent certified public accountant in his report on examination of the owner's or operator's financial statements (see paragraph (f)(3)(ii) of this section). An adverse opinion or a disclaimer of opinion will be cause for disallowance. The Regional Administrator will evaluate other qualifications on an individual basis. The owner or operator must provide alternate financial assurance as specified in this section within 30 days after notification of the disallowance.

(9) The owner or operator is no longer required to submit the items specified in paragraph (f)(3) of this section when:

(i) An owner or operator substitutes alternate financial assurance as specified in this section; or

(ii) The Regional Administrator releases the owner or operator from the requirements of this section in accordance with § 264.143(i).

(10) An owner or operator may meet the requirements of this section by obtaining a written guarantee, hereafter referred to as "corporate guarantee." The guarantor must be the parent corporation of the owner or operator. The guarantor must meet the requirements for owners or operators in paragraphs (f)(1) through (8) of this section and must comply with the terms of the corporate guarantee. The wording of the corporate guarantee must be identical to the wording specified in § 264.151(h). The corporate guarantee must accompany the items sent to the Regional Administrator as specified in paragraph (f)(3) of this section. The terms of the corporate guarantee must provide that:

(i) If the owner or operator fails to perform final closure of a facility covered by the corporate guarantee in accordance with the closure plan and other permit requirements whenever required to do so, the guarantor will do so or establish a trust fund as specified in § 264.143(a) in the name of the owner or operator.

(ii) The corporate guarantee will remain in force unless the guarantor sends notice of cancellation by certified mail to the owner or operator and to the Regional Administrator. Cancellation may not occur, however, during the 120 days beginning on the date of receipt of the notice of cancellation by both the owner or operator and the Regional Administrator, as evidenced by the return receipts.

(iii) If the owner or operator fails to provide alternate financial assurance as specified in this section and obtain the written approval of such alternate assurance from the Regional Administrator within 90 days after receipt by both the owner or operator and the Regional Administrator of a notice of cancellation of the corporate guarantee from the guarantor, the guarantor will provide such alternative financial assurance in the name of the owner or operator.

(g) *Use of multiple financial mechanisms.* An owner or operator may satisfy the requirements of this section by establishing more than one financial mechanism per facility. These mechanisms are limited to trust funds, surety bonds guaranteeing payment into a trust fund, letters of credit, and insurance. The mechanisms must be as specified in paragraphs (a), (b), (d), and (e), respectively, of this section, except that it is the combination of mechanisms, rather than the single mechanism, which must provide financial assurance for an amount at least equal to the current closure cost estimate. If an owner or operator uses a trust fund in combination with a surety bond or a letter of credit, he may use the trust fund as the standby trust fund for the other mechanisms. A single standby trust fund may be established for two or more mechanisms. The Regional Administrator may use any or all of the mechanisms to provide for closure of the facility.

APPENDIX XI.

UNPUBLISHED TOLERABLE RISK REPORT
MINNESOTA DEPARTMENT OF HEALTH

TOLERABLE RISK

Section of Health Risk Assessment
Minnesota Department of Health
September 1985

RECEIVED
SEP 26 1985
MPCA, SOLID & HAZ.
WASTE DIVISION

TOLERABLE RISK

Issue

From the standpoint of public health, possible biological effects from exposure to contaminated groundwater include: acute, subacute, or chronic toxicity; mutagenicity; teratogenicity; and carcinogenicity. It is the consensus of scientists that these end points can be considered to be either threshold or nonthreshold phenomena (NAS, 1977). Biologically, threshold represents a no-effect level explained by an organism's resistance or sum total of defense mechanisms in the face of toxicologic challenge. In contrast, chemical carcinogens are considered to be nonthreshold agents, since a single genotoxic molecule can be assumed to interact with the cell's DNA and, thereby, result in a malignant growth. While not all carcinogens are genotoxic, epigenetic carcinogens are treated conservatively using the nonthreshold hypothesis since sufficient data are not yet available to resolve this issue.

Threshold agents have long had available conventional toxicologic methods for the estimation of safe exposure levels for humans (i.e., levels below which no serious effect is expected). The most commonly used and accepted method involves the application of safety factors to the "no observed effect level" in animal studies. To achieve the same level of protection for nonthreshold agents; i.e., carcinogens, criteria or standards would have to be set at a zero exposure level.

A number of factors prohibit this approach. In some instances potential carcinogens are found in the environment at naturally occurring background levels and their removal is an impossibility eg., naturally occurring ionizing radiation. Most potential carcinogens enter the environment as a result of the activities of a technology based society. For the most part, these activities are of considerable benefit to society e.g., electric power production, chlorination of public water supplies, etc.. To require a zero exposure level associated with these activities could result in an unacceptable loss of benefits, increased economic cost, or even increased health risks (for example an increase in communicable disease as result of non-chlorination of public water supplies).

Since nonthreshold agents cannot always be prevented from entering the environment or completely removed once they have found their way into the environment, it becomes a matter of managing the risks associated with exposure to these agents in a way that is tolerable to society. This then is the central issue of this report; what level of risk is tolerable for a potential life-time exposure to nonthreshold agents?

The concept of tolerable risk is often called acceptable risk. The term "risk acceptability" conveys the impression that society purposely accepts risks as the reasonable price for some beneficial technology or activity. For some special cases, this may approach reality. Hang-gliding, race-car driving, mountain climbing, etc. are all voluntary high-risk activities in which the benefits are intrinsically entwined with the risks. These activities are exhilarating because they are dangerous. But most risks of concern are the involuntary, undesired and often unforseen by-products of otherwise beneficial activities or technologies. Since most risks are imposed on a less than fully informed risk-bearer, the reponse is more properly thought of as tolerance rather than acceptance (Kates, 1983; Kasperson, 1983).

The remainder of this report examines the issue of a tolerable level of risk for exposure to nonthreshold agents. The current MDH procedures regarding tolerable risk levels are explained. The methods used to examine this issue are outlined. The various decision analysis methods used in risk management are discussed and a recommendation is made for a tolerable risk level.

Current MDH/MPCA Procedures

In 1977 the Minnesota Department of Health formalized environmental health risk assessment activites with the creation of the Section of Health Risk Assessment (HRA) in the Division of Environmental Health. In 1980-81 HRA conducted a critical review of the risk assessment/risk management literature (Gray, 1981). Included in this review was an examination of the tolerable risk issue. This report concluded that the "benefit-risk analysis" method proposed by Starr (1969, 1972) was the best alternative for the selection of a lifetime tolerable risk. Using this method HRA derived a lifetime tolerable risk level of 10^{-5}. Since this time, whenever risk assessments have been conducted on various nonthreshold agents and there are no existing state or federal standards for these agents, the Department has made recommendations for action based on this level of risk. A lifetime risk of 10^{-5} means that during the 70 year period assumed to comprise a lifetime, one extra adverse effect (usually a cancer) will occur for each 100,000 persons exposed.

The Minnesota Pollution Control Agency has, as a matter of policy, relied on the MDH for the conduct of risk assessments and decisions regarding tolerable risk.

Methods Used to Examine the Issue of Tolerable Risk

Since this report is basically a reexamination of the issue of tolerable risk, HRA's efforts were directed toward determining what changes in philosophy, theory, methods, and actions, regarding this issue, have occurred since 1980. To accomplish this task, HRA surveyed the pertinent literature from 1980 to the present; and also, contacted a number of scientists and regulators, outside the state of Minnesota, to solicit their input.

These discussions are summarized in the following section. The literature review, which includes Gray's 1981 report and the present survey, is presented in the section on "Alternatives for the Selection of a Tolerable Risk Level". A bibliography is provided at the end of this report.

Summary of Outside Contacts

Between twenty to thirty contacts were made with state and federal scientists and regulators with experience in risk assessment and risk management. Information was obtained from seven states (California, Florida, Michigan, New Jersey, New Mexico, New York, and Wisconsin) that have been active in setting maximum contaminant levels (MCLs) for substances in drinking water. In these states, MCLs for nonthreshold agents are based on lifetime excess cancer risk levels ranging from 10^{-5} to 10^{-6}. From the information available it appears that none of these states have developed their risk management guidelines or regulations based on quantitative methods, i.e., benefit-risk, cost-effectiveness analysis, balanced risk, etc.. In several states (Wisconson, New Jersey, and Florida) the legislature simply mandated a lifetime tolerable risk level. None of the states contacted were able to provide documented rationale for their choice of a lifetime tolerable risk level.

Numerous contacts were also made with various Environmental Protection Agency Programs including: Drinking Water Section, Office of Safe Drinking Water, Region V; Health Effects Branch, Office of Drinking Water, Region V; Environmental Criteria Assessment Office, Office of Research and Development, Cincinnati; Criteria Standards Division, Office of Drinking Water, Washingtion D.C.; EPA Science Advisory Board, Washington D.C.; and the Carcinogen Assessment Group, Office of Research and Development, Washington D.C..

EPA is at the forefront in the development of risk assessment methods and also in performing risk assessments on potentially hazardous substances found in the environment. However, for pollutants that they do not regulate or are in the process of regulating EPA will not give guidance on tolerable risk. EPA officials repeatedly indicated that decisions on tolerable risk are the responsiblity of the individual states. Their reasoning is that the factors that impact tolerable risk vary from area to area, i.e. state to state. These factors might include public perception and awareness of the seriousness of environmental contamination problems, public willingness to underwrite the costs of clean-up and control, impacts of regulatory decisons on local and state job markets, political climate, etc..

Alternatives for the Selection of a Tolerable Risk Level

Risk assessment or estimation is the measurement of consquence likelihood. Once such estimates have been generated, the meaning of the projected outcome must be evaluated. The evaluation of risk is variable and relative; however, a practical division between methods can be made by focusing the types of comparisons related solely to the risk in question, to other risks, to costs of avoidance and to benefits. What follows is a summary of methods which have been used to establish tolerable risk. These methods can provide a logical basis for the development of environmental exposure guidelines for nonthreshold hazards.

1. Aversive Methods

Aversive methods are directed toward the total avoidance of risk. Aversive risk judgements can be made by individuals or socities. Much regulatory activity is directed toward maximum aversion. Zero tolereance standards and standards at or below the dose-consequence threshold are examples of aversive risk evaluation. Wolf (1979) describes the Delaney Clause (Food Additives Admendment, 1958, Food and Drug Administration) as follows:

> ...Congress essentially said, there can never be any benefit in a food additive that is great enough to outweigh the risk of cancer, particularly if 100 million to 150 million consumers might be subject to this kind of risk over a period of time.

The effort by the Occupational Safety and Health Administration to establish a generic cancer standard is another example of an aversive approach (Kates, 1978). They suggest that for workplace exposures, the Delaney Clause approach (i.e., no exposure to carcinogens) is most efficacious. In discussing zero risk goal Starr et al. (1970) concludes the following:

> One criticism stems from the fact that in several cases, a zero risk goal has been established. This denies the concept of a trade-off between risk and benefit, and ignores the difficulty or impossibility of reaching zero risk.

Such standards often seem to be based on little logic; carcinogens are banned from food in the United States but not in water. If aversive methods involve any comparisons at all it seems to be with a higher power imperative, or postulate (Kates, 1978).

2. Balanced Risk

Balanced risk evaluation methods seek to compare and equalize the consequences of some proposed action or environmental exposure with those of commonly tolerated risks. To peform this comparison consequences need to normalized. Usually frequencies of mortality, morbidity, or damage are compared to encourage a desired action or reveal some inconsistency. An example of this approach is a study to develop earthquake codes for the City of Long Beach (Wiggins, 1972). Earthquake risks were compared with risks encountered everyday in the use of automobiles, at work, in public activities, and at home. The magnitude of these various risks differed and earthquake code standards were offered that lead to mortality of 10^{-5}, 10^{-6}, or 10^{-7} per person per year, the final selection depending on the risk aversiveness of the community.

One can gauge typical societal response to such comparisons by looking at actions commonly taken to avoid common risks as described by Otway (1970):

> Fatal accidents providing hazards on the order of 10^{-3} per person/year are uncommon. When a risk approaches this level, immediate action is taken to reduce the hazard. This level of risk appears unacceptable to everyone.
>
> At an accident level of 10^{-4} per person/year, people spend money, especially public money, to control the cause. Money is spent for traffic signs and control, and police and fire departments are maintained with public funds. Safety slogans popularized in the U.S. for accidents in the category show an element of fear, e.g., 'the life you save may be your own.'
>
> Mortality risks at the level of 10^{-5} per person/year are still considered by society. Mothers warn their children about most of these hazards (playing with fire, drowning, firearms, poisons), and some people accept a degree of inconvenience, such as not traveling by air, to avoid them. Safety slogans for these risks have a precautionary ring, 'Never swim alone,' 'Never point a gun at another person,' 'Keep medicines out of children's reach.'
>
> Accidents with a probability of about 10^{-6} per person/year are not of great concern to the average person. He may be aware of them, but he feels that they never happen to him. Phrases associalted with these occurrences have an element of resignation, 'Lightning never strikes the same place twice,' 'An act of God.'

The risks discussed above are a mixture of voluntary and involuntary risks. Starr's work (1969, 1972, 1984) indicates that the public considers involuntary risk 1,000 times less acceptable than voluntary risk. Others argue with the degree of this difference but not its existence (Lave, 1972; Rowe, 1975; Otway et al., 1975).

A fundamental concept to the notion of a balancing of risks, or any non-aversive method of evaluation, is the existence of some non-zero level of risk which is tolerable. Starr (1969, 1972, 1984) has pioneered the search for tolerable consequences embedded in broad, societal behavior. The work of Starr will be discussed in more detail in the section on benefit risk analysis.

3. <u>Cost Effectiveness of Risk Reduction</u>

This method involves a comparison of risk and the cost of actions necessary to prevent exposure to that risk. Such studies are sometimes referred to as cost-effectiveness studies. Such an analysis has been done by Sinclair (1972) who evaluated the effectiveness of preventive costs in industrial safety. Based on the level of risk and the cost of prevention, he calculated the implied life evaluation implicit in the preventive activity.

Comparative Risks, Safety Outlays and Implicit Life Valuations in Three United Kingdoms Industries.

	Annual Risk per 1,000 workers of:				
Sector	Injury	Serious Injury	Death	Average Outlay (£/worker)	Valuation £
Agriculture	25.7	4.44	0.197	3 (1966-68)	15,000
Steel Handling	72.7 62.54	9.92	0.216	50 (1969)	230,000
Pharmaceutical	25.0 36.80	2.42	0.020	210 (1968)	10,500,000

The calculated life evaluation can be seen to vary widely for the various industries. This variability suggests either a difference in the perceived value of a human life between the three industries, or a difference in the awareness of hazard. In any case, such calculations can be used to evaluate and compare proposed risk reduction actions. This method can be taken one step further to cost-benefit analysis if one establishes the value of a human life for comparison with the cost of death prevention.

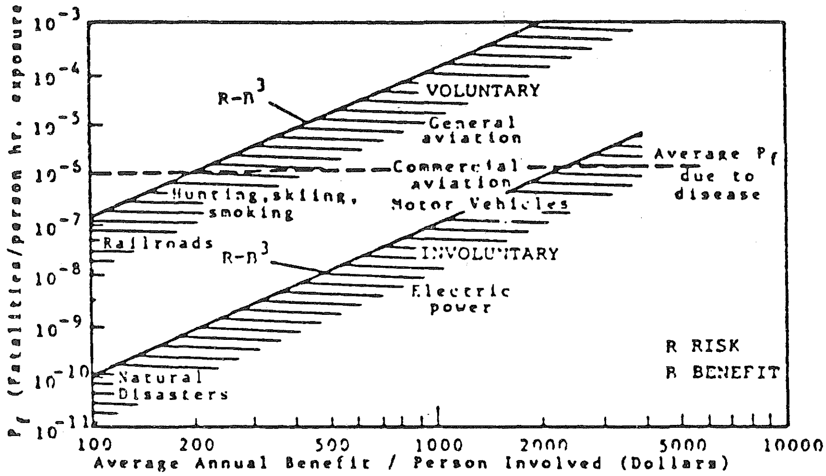
4. Benefit-Risk Analysis

Benefit-risk analysis is the comparison of risk level to benefit arising from the activity. The major distinction between this method and cost-benefit or cost effectiveness methods is the absence of any attempt to express risk in the same units as benefit for easy comparison. Rather, the relationship between benefit and risk which has been established by society is examined in an effort to predict tolerable risk for a situation of given benefit.

Estimates of mortality risk for a number of activities compared to the resulting benefits have been developed by Starr (1969, 1972, 1984). Historically, trade-off relationships between benefit and risk have been empirically determined. For example, automobile and airplane safety have continuously been weighed against the economic costs and operating performance. The trade-off process is a dynamic one with many parts of our society out-of-phase due to the separate "time constants" involved. Starr assumed that for historical situations a socially tolerable and optimum trade-off had been achieved and that the relationship between the two could be used for predictive purposes.

Starr found that risk increased approximately as the cube of benefit for both voluntary and involuntary risk.

VOLUNTARY AND INVOLUNTARY EXPOSURE

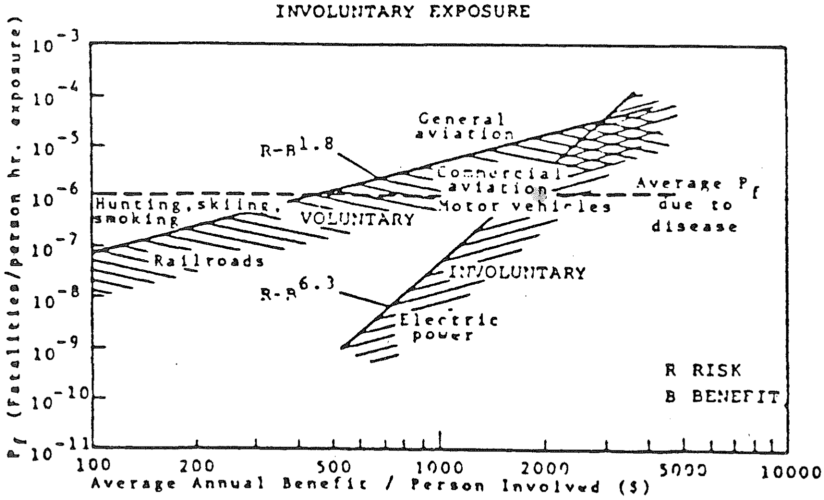


(Starr 1969)

(NOTE: An hourly risk ratio of 10^{-10} corresponds to an annual risk ratio of 8.8×10^{-7}).

Other authors have questioned the quantitative parameters of Starr's risk-benefit relationship.

B. REGRESSION LINES FOR VOLUNTARY AND INVOLUNTARY EXPOSURE



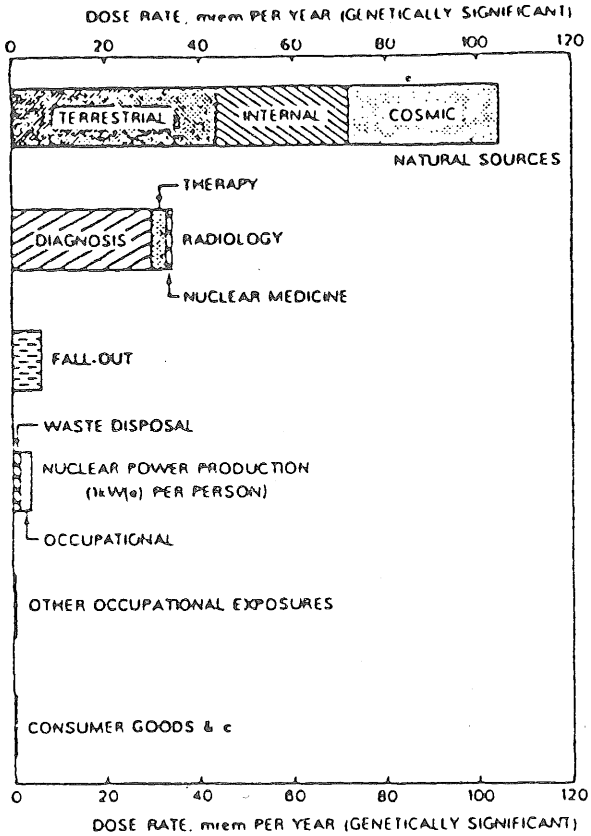
(Otway and Cohen, 1975)

Notice that the low risk region in the above curve gives similar risk-benefit ratios to Starr's; however, in the high risk region the variation in slopes significantly alter the benefit-risk relationship. Otway and others have suggested different quantitative relationships; however, Starr's basic concepts which relate benefit to risk have received general acceptance. These can be summarized by Starr (1972, pp. 38) as follows:

> 1. Rate of death from disease is an upper guide in determining the acceptability of risk - somewhat less than 1 (chance per person) in 100 years.
>
> 2 Natural disasters ('acts of God') tend to set a base guide for risk - somewhat more than 1 in a million years - similar to the intrinsic 'noise' level of physical systems. Man-made risks at this level can be considered almost negligible, and can certainly be neglected if they are several magnitudes less.
>
> 3. As would be expected, societal acceptance of risk increases with the benefits to be derived from an activity. The relationship appears to be nonlinear, with this study suggesting that the acceptable level of risk is an exponential function of the benefits (real and imaginary).
>
> 4. The public appears willing to accept voluntary risks roughly 1,000 times greater than involuntary exposure risks...

5. <u>Risk Elevation</u>

Somers (1979) suggests that looking at risk elevation is an additional way to estimate tolerable risk. If exposure is below the background level, the risk must be tolerable. For example, the dose of radiation routinely received from nuclear power production (does not consider accidents) can be compared with natural background exposure from other sources.



(NOTE: Annual genetically-significant dose rate as averaged through whole population).

Weinburg (1981) has also suggested this approach terming it a "de minimis" principle. He writes:

> ...a 'de minimis' principle: Below a certain level of exposure or insult, we shall simply accept whatever residual risk is incurred; we only assure ourselves that the risk is 'small'...Where the insult is a manmade addition to an existing background, as is the case for radiation, an exposure 'small' compared to the natural background seems to me to be a sensible standard...We make the implicit assumption that background radiation poses an acceptable risk, whatever that risk may be (and which we do not try to quantify).

For insults for which there is no background (e.g., many organic chemicals), Weinburg suggests a comparison of risk from exposure to that insult with risk from exposure to radiation at levels high enough so that each can be unequivocally determined. One would then invoke the following principle of consistency to determing an allowable level of exposure for the new insult.

> The allowable exposure to the chemical in question should cause no more damage than that caused by the "de minimis" level previously set for radiation. The damage caused by the "de minimis" level for radiation and for the chemical in question is determined by the linear hypothesis.

The problem with all of this is that background exposure, especially to radiation (see table on page 18, Commonplace Risks of Daily Life), is not acceptable not because the resulting risk is considered by society to be negligible, but rather because there is no alternative to its acceptance. There is no logic in adjusting our tolerance of hazard to levels which have nothing to do with our perception of or aversion to risk. Practical problems such as the wide variability of background concentrations would also arise. The above figure also demonstrates how the risks of two man-made exposures can be compared. The exposures from nuclear power production and radiology can be compared and the argument made that since the latter is higher and is tolerable, the former must therefore also be tolerable. Unfortunately, the argument ignores possible differences in benefit resulting from the two exposures.

Discussion

It is apparent from the above summary that the selection of a method to establish tolerable risk is a difficult decision. All of the methods have aspects to them that argue for and against their use. Risk-benefit analysis is intuitively appealing because it provides a quantitative methodology; however, benefits must be quantified or it must be assumed they are equal or are zero for the various alternatives. Risk elevation is also intuitively appealing, but logically flawed. The balancing of environmental risks with those commonly encountered is less objective than other methods but can be useful if one is careful not to lose sight of the magnitude of the benefits associated with the risks being compared.

Of the five methods reviewed the benefit-risk approach is, in HRA's opinion, is the most defendable. Its implications and how it was used to derive a tolerable risk level are discussed in the remainder of this section.

Starr and others have compared benefit and risk in the aggregate. Unfortunately benefits and risks are not distributed evenly over all members of society (Kates, 1978). Benefits may be concentrated and risk diffuse such as in the use of pesticides by farmers. Conversely, risks may be concentrated and benefits diffuse such as for occupational hazards. The distribution in time may also be uneven with immediate benefits and delayed risks as with the latent effects of chemicals. These inequalities make the application of benefit-risk relationships difficult to apply to individuals or special subgroups of the general population. Yet for the purpose of evaluating risk assessments, it is necessary to have an estimate of negligible risk which applies in the aggregate and which can be adjusted to accommodate the risk aversiveness of special subgroups.

It is entirely possible that special subgroups or individuals, such as those occupationally exposed, will derive considerable benefit from tolerance of a higher risk level. Clearly, tolerable risk for special population groups needs to be calculated on a case-by-case basis.

Not withstanding the above caveat, environmental risks can be balanced against commonly tolerated risks of equal or lower benefit for the purpose of establishing exposure guidelines. Starr (1969, 1972, 1984) classifies as "negligible" those risks which are lower than the probability of death by natural disaster, a probability of about 10^{-6} per year. This comparison should hold for risks of any benefit level since natural disasters have no concomitant benefits. It therefore follows that environmental exposures resulting in annual mortality risk ratios of 10^{-6} or less can reasonably considered "safe". Since this level of risk tolerance has been calculated from aggregate populations it should be applied to general population groups or "average" individuals in such a population.

One can develop a sense of how conservative such a guideline is by comparing it with comparing it with commonly experienced risks. Wilson (1980, 1982) has enumerated the following commonly tolerated risks. Wilson's data are consistent with Starr's conclusions about the risk-benefit relationship. Involuntary risks are less tolerable than voluntary risks and risks for activities with little or no benefit are less tolerable than risks with high concominant benefit. For example, tornadoes, hurricanes, and lightning have no benefit, are involuntary, and result in a low annual mortality risk. Auto racing is voluntary, with presumably a high payoff for the participating individual and a high risk level. The high air pollution risk level, while involuntary for the individual, is associated with the high societal benefits of energy production and is therefore tolerated.

		No. of deaths in 1975	Risk/years
Football	Averaged over participants		4×10^{-5}
Automobile racing			1.2×10^{-3}
Horse racing			1.3×10^{-3}
Motorcycle racing			1.8×10^{-3}
Powerboating			1.7×10^{-4}
Boxing (amateur)	40 hr/year engaged in sports		2×10^{-5}
Skiing			3×10^{-5}
Canoeing			4×10^{-4}
Rock climbing (U.S.)			10^{-3}
Sunbathing, mountain climbing (skin cancer risk curable)		300,000 cases	5×10^{-3}
Fishing (drowning)	Averaged over fishing licenses	343	1.0×10^{-5}
Drowning (all recreational causes) all over U.S.		4110	1.9×10^{-5}
Bicycling (assuming one person per bicycle)		1000	10^{-5}

Risks in sports

	Number of fatalities (in 1975 unless stated)	Risk/year
Mining and quarrying (accident only)	500	6×10^{-4}
Coal mining		
Accident (average 1970–1974)	180	1.3×10^{-3}
Black lung disease (1969)	1135	8×10^{-3}
Agriculture		
Total	2100	6×10^{-4}
Tractor driver (one driver/tractor)		1.3×10^{-4}
Trade	1200	6×10^{-4}
Manufacturing	1500	8×10^{-5}
Service	1800	9×10^{-5}
Government	1100	1.1×10^{-4}
Transportation and utilities	1600	3.3×10^{-4}
Airline pilot		3×10^{-4}
Truck driver (one driver/truck)	400	10^{-4}
Jet-flying consultant and professor		10^{-4}
Steel worker (accident only) (1969–1971)	66	2.8×10^{-4}
Railroad worker (1974) (all accidents excluding grade crossing)	688	1.3×10^{-3}
Fire fighters (1971–1972 average)		8×10^{-4}

Current occupational risks   Accuracy approximately 30%.

	No. of deaths in 1974	Risk/year
Motor vehicle (in 1975)		
Total	46,000	2.2×10^{-4}
Pedestrian (certainly involuntary)	8,600	4×10^{-5}
Home accidents (1975)	25,500	1.2×10^{-5}
Alcohol		
Cirrhosis of the liver (1974)		1.6×10^{-4}
Cirrhosis of the liver (moderate drinker)		4×10^{-5}
Air travel		
One transcontinental trip/year		3×10^{-6}
Jet-flying professor		10^{-4}
Accidental poisoning		
Solids and liquids	1,274	6×10^{-6}
Gases and vapors	1,518	7×10^{-6}
Inhalation and ingestion of objects	2,991	1.4×10^{-5}
Electrocution	1,157	5×10^{-6}
Falls	16,339	7.7×10^{-5}
Tornados (average over several years)	160	5×10^{-7}
Hurricanes (average over several years)	118	4×10^{-7}
Lightning (average over several years)	90	4×10^{-7}
Air pollution		
Total U.S. estimate (sulfates)	30,000	1.5×10^{-4}
Urban U.S. (benzo(a)pyrene)—cancer risk		3×10^{-5}
Vaccination for smallpox (per occasion)		3×10^{-6}
Living for 1 year downstream of a dam (calculated)		5×10^{-5}

Commonplace and therefore accepted risks of death (noncancerous)

	Risk/year	Estimated uncertainty (factor of 3)
Cosmic ray risks		
One transcontinental flight/year	5×10^{-7}	3
Airline pilot 50 hr month at 35,000 ft	5×10^{-5}	3
Frequent airline passenger	1.5×10^{-5}	3
One summer (4 months) camping at 15,000 feet	10^{-5}	3
Living in Denver compared to New York	10^{-5}	3
Other radiation risks		
Average U.S. diagnostic medical X rays	10^{-5}	3
Increase in risk from living in a brick building (with radioactive bricks) compared to wood	5×10^{-6}	3
Natural background at see level	1.5×10^{-5}	3
Eating and drinking		
One diet soda (saccharin)	10^{-5}	10
Average U.S. saccharin consumption	2×10^{-6}	10
4 tb peanut butter/day (aflatoxin)	4×10^{-5}	3
One pint milk per day (aflatoxin)	10^{-5}	3
Miami or New Orleans drinking water (chloroform)	1.2×10^{-6}	5
½ lb charcoal broiled steak once a week (benzopyrene) (cancer risk only; heart attack, etc. additional)	4×10^{-7}	10
Alcohol		
Averaged over smokers and nonsmokers	5×10^{-5}	3
Light drinker (one beer/day)	2×10^{-5}	3
Tobacco		
Smoker		
Cancer only	1.2×10^{-3}	3
All effects (including heart disease)	3×10^{-3}	3
Person in room with smoker	10^{-5}	10
Miscellaneous		
Taking contraceptive pills regularly	2×10^{-5}	10

Commonplace risks of daily life (cancer risks)

In almost all discussions of quantitative risk evaluation mortality risk is used to estimate tolerable risk. One might question how to proceed if exposure to toxic agents could produce an effect other than death. Mortality was used by Starr and others as a measure of risk because the statistics are easily obtained. Tolerable risk for consequences other than death will surely be higher; therefore, a tolerable annual mortality risk level of 10^{-6} would provide a lower bound for tolerable risk and will introduce a measure of conservatism if used for all general population environmental exposures.

An annual mortality risk of 10^{-6} translates to a lifetime risk of 7×10^{-5} assuming 70 years of continuous exposure and simple additivity of risk over the entire period. Considering the admitted crudeness of Starr's calculations, the criticisms of the exact quantitative relationship (minor at the low risk end of the curve), the variable nature of tolerable risk for individuals within the general population, and the need to avoid overestimating tolerable risk, it would seem an appropriate value of tolerable lifetime general population mortality risk should be about 10^{-5}.

Recommendation

Reexamination of the tolerable risk issue has revealed no new information that changes the conclusions of HRA's 1981 report. Therefore, the Minnesota Department of Health recommends the continued use of a lifetime tolerable risk level of 10^{-5} as a basis for action regarding nonthreshold agents.

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APPENDIX XII.

TABLE--GROUNDWATER STANDARDS VS. AMBIENT CONCENTRATIONS

PROPOSED RULES, PT. 7035.2815, SUBP. 4(F), SUBITEM NUMBER:	SUBSTANCE	AMBIENT GROUND WATER QUALITY: MEAN DETECTION LIMIT (UG/L)	NUMBER OF SAMPLES	NUMBER DETECTED	MEDIAN CONCENTRATION (UG/L)	NINETIETH (90) PERCENTILE CONCENTRATION (UG/L)	HEALTH DEPT. RECOMMENDED ALLOWABLE LIMIT (RAL) (DRINKING WATER) (UG/L)	MEDIAN AMBIENT QUALITY AS A % OF RAL'S (PER CENT)	NINETIETH PERCENTILE AMBIENT QUALITY AS A % OF RAL'S (PER CENT)	PROPOSED GROUND WATER QUALITY STANDARD (UG/L)	NUMBER OF SAMPLES EXCEEDING PROPOSED STANDARD	PERCENT OF SAMPLES EXCEEDING PROPOSED STANDARD
1	Acrylamide	---	---	---	---	---	0.1	---	---	0.025	---	---
2	Acrylonitrile	---	---	---	---	---	0.67	---	---	0.17	---	---
3	Alachlor	---	---	---	---	---	10	---	---	2.5	---	---
4	Aldicarb	---	---	---	---	---	9	---	---	2.3	---	---
5	Aldrin	---	---	---	---	---	0.03	---	---	0.0075	---	---
6	Allyl chloride	0.5	200	0	ND	ND	29.4	<1.7	<1.7	7.35	0	0
7	Arsenic	1.0	248	78	ND	5.4	50	<2	10.8	12.5	11	4
8	Asbestos: medium and long (greater than 10 microns) fibers per liter	---	---	---	---	---	7100000	---	---	1800000	---	---
9	Barium	5.0	361	352	66	200	1500	4.4	13.3	375	7	2
10	Benzene	0.6	243	0	ND	ND	12	<5	<5	3	0	0
11	Bis(2-chloroethyl)ether	---	---	---	---	---	0.31	---	---	0.078	---	---
12	Cadmium	0.01	498	357	0.019	0.14	5	0.4	2.8	1.25	3	1
13	Carbofuran	---	---	---	---	---	36	---	---	9	---	---
14	Carbon tetrachloride	0.2	228	0	ND	ND	2.7	<7.4	<7.4	0.67	0	0
15	Chlordane	0.1	35	0	ND	ND	0.22	<45.5	<45.5	0.055	0	0
16	Chlorobenzene (monochlorobenzene)	0.5	228	0	ND	ND	60	<0.8	<0.8	15	0	0
17	Chloroform	0.2	228	8	ND	ND	5	<4	<4	1.3	3	1
18	Chromium	0.5	497	204	ND	1.6	120	<0.4	1.3	30	2	0
19	Copper	0.5	361	348	7.5	44	1300	0.6	3.4	325	1	0
20	DDT	0.09	43	0	ND	ND	1	<9	<9	0.25	0	0
21	Dibromochloropropane (DBCP)	---	---	---	---	---	0.25	---	---	0.063	---	---
22	1,2-Dibromoethane (Ethylene dibromide, EDB)	0.7	200	0	ND	ND	0.008	<8750	<8750	0.002	0	0
23	1,2-Dichlorobenzene (ortho-)	1.2	243	0	ND	ND	620	<0.2	<0.2	150	0	0
24	1,3-Dichlorobenzene (meta-)	1.2	243	0	ND	ND	620	<0.2	<0.2	150	0	0
25	1,4-Dichlorobenzene (para-)	1.2	243	0	ND	ND	75	<1.6	<1.6	18.8	0	0
26	Dichlorobenzidine	---	---	---	---	---	0.21	---	---	0.052	---	---
27	1,2-Dichloroethane	0.2	228	6	ND	ND	3.8	<5.3	<5.3	0.95	0	0
28	1,1-Dichloroethylene	0.2	228	1	ND	ND	7	<2.9	<2.9	1.8	0	0
29	1,2-Dichloroethylene (cis-)	0.2	200	3	ND	ND	70	<0.3	<0.3	17	0	0
30	1,2-Dichloroethylene (trans-)	0.2	228	1	ND	ND	70	<0.3	<0.3	17	0	0

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31	Dichloromethane (methylene chloride)	1.0	228	25	ND	1.1	48	<2.1	2.3	12	0	0
32	2,4-Dichlorophenoxyacetic acid (2,4-D)	0.14	46	8	ND	1.4	70	<0.2	2.0	17	0	0
33	1,2-Dichloropropane	0.2	228	0	ND	ND	6	<3.3	<3.3	1.5	0	0
34	Dieldrin	---	---	---	---	---	0.01	---	---	0.0025	---	---
35	2,4-Dinitrotoluene	---	---	---	---	---	1.1	---	---	0.27	---	---
36	Diphenylhydrazine	---	---	---	---	---	0.45	---	---	0.11	---	---
37	Epichlorohydrin	---	---	---	---	---	35.4	---	---	8.9	---	---
38	Ethylbenzene	0.6	243	0	ND	ND	680	<0.1	<0.1	170	0	0
39	Heptachlor	---	---	---	---	---	0.1	---	---	0.025	---	---
40	Heptachlor epoxide	---	---	---	---	---	0.006	---	---	0.0015	---	---
41	Hexachlorobenzene	---	---	---	---	---	0.21	---	---	0.053	---	---
42	Hexachlorobutadiene	---	---	---	---	---	4.5	---	---	1.1	---	---
43	Hexachlorocyclohexane (alpha-)	---	---	---	---	---	0.03	---	---	0.0075	---	---
44	Hexachlorocyclohexane (beta-)	---	---	---	---	---	0.19	---	---	0.047	---	---
45	Hexachlorocyclohexane (gamma-) (Lindane)	---	---	---	---	---	0.2	---	---	0.05	---	---
46	Hexachlorodibenzodioxin	---	---	---	---	---	0.00006	---	---	0.000015	---	---
47	Hexachloroethane	---	---	---	---	---	24.6	---	---	6.2	---	---
48	Lead	0.2	499	442	0.9	7.1	20	4.5	35.5	5.0	71	14
49	Mercury	0.1	485	279	0.12	0.42	3	4.0	14.0	0.75	9	2
50	Methyl ethyl ketone	5.0	243	0	ND	ND	172	<2.9	<2.9	43	0	0
51	Methoxychlor	---	---	---	---	---	340	---	---	85	---	---
52	Nickel	2.2	496	121	ND	5.3	150	<1.5	3.5	38	0	0
53	Nitrate	10	743	468	30	8100	10000	0.3	81.0	2500	151	20
54	Nitrite	10	299	77	ND	30	1000	<1	3.0	250	5	2
55	N-Nitrosodimethylamine	---	---	---	---	---	0.014	---	---	0.0035	---	---
56	N-Nitrosodiphenylamine	---	---	---	---	---	71.1	---	---	17.8	---	---
57	Total carcinogenic polynuclear aromatic hydrocarbons (PAH)	---	---	---	---	---	0.028	---	---	0.007	---	---
58	Polychlorinated biphenyls (PCB's)	---	---	---	---	---	0.08	---	---	0.02	---	---
59	Pentachlorophenol	---	---	---	---	---	220	---	---	55	---	---
60	Selenium	1.0	361	96	ND	2.8	45	<2.2	6.2	11	5	1

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61	Styrene	1.0	47	0	ND	ND	140	<0.7	<0.7	35	0	0
62	2,3,7,8-Tetrachlorodibenzo-p-dioxin (-TCDD)	---	---	---	---	---	0.000002	---	---	0.0000005	---	---
63	1,1,2,2-Tetrachloroethane	2.0	200	0	ND	ND	1.75	<114.3	<114.3	0.44	0	0
64	Tetrachloroethylene	2.0	228	0	ND	ND	6.9	<29	<29	1.7	0	0
65	Toluene	0.6	243	2	ND	ND	2000	<0.03	<0.03	500	0	0
66	Toxaphene	0.09	43	0	ND	ND	0.3	<30	<30	0.075	0	0
67	1,1,1-Trichloroethane	0.2	228	0	ND	ND	200	<0.1	<0.1	50	0	0
68	1,1,2-Trichloroethane	0.2	228	1	ND	ND	6.11	<3.3	<3.3	1.5	0	0
69	Trichloroethylene	0.2	228	3	ND	ND	31.2	<0.6	<0.6	7.8	0	0
70	2,4,6-Trichlorophenol	---	---	---	---	---	17.6	---	---	4.4	---	---
71	2,4,5-TP (Silvex)	0.01	46	9	ND	0.43	52	<0.03	0.8	13	0	0
72	Vinyl chloride	---	---	---	---	---	0.15	---	---	0.037	---	---
73	Xylene	0.6	243	1	ND	ND	440	<0.1	<0.1	110	0	0

NOTES:

ND Non-detectable

Includes data collected 1978 through 1984 for all monitored aquifers. Source of information on Minnesota ambient ground water concentrations:
Sabel, Gretchen, 1985, Ground Water Quality Monitoring Program: An Appraisal of Minnesota's Ground Water Quality, 1985, Minnesota Pollution Control Agency, Division of Solid and Hazardous Waste, and more recent retrievals from the STORET ambient ground water quality data base.

APPENDIX XIII.

PROBABILITY OF FACILITY DESIGN BEING EXCEEDED ONE OR MORE TIMES DURING THE ACTIVE LIFE OF THE FACILITY

Appendix XIII

Probability of Facility Design Being Exceeded One or More Times During the Active Life of the Facility

	RAINFALL EVENT				
Facility Active Life (Years)	1 year	10 year	25 year	50 year	100 year
1	1	.10	.04	.02	.01
5	1	.41	.18	.10	.05
10	1	.65	.34	.18	.10
20	1	.88	.56	.33	.18
30	1	.96	.71	.45	.26
50	1	.99	.87	.64	.39

J, or more = $1 - (1-p)^{N}$*

where:

J, or more = probability of the facility design being exceeded one or more times during the active life of the facility
P = average probability of occurrence
N = active life of facility in years

* From: Linsley, Ray Jr., M. Kohley and J. Paulers, 1975, Hydrology For Engineers, McGraw-Hill Book Company, Page 350.

APPENDIX XIV.

ANALYSIS OF DESIGN PARAMETERS AFFECTING THE COLLECTION EFFICIENCY OF CLAY LINED LANDFILLS

BY PETER KMET, etal.

ANALYSIS OF DESIGN PARAMETERS AFFECTING THE COLLECTION EFFICIENCY OF CLAY LINED LANDFILLS

Peter Kmet[1], Kenneth J. Quinn[2] and Cynthia Slavik[3]

Abstract

A recent development in the analysis of clay lined landfills has been the derivation of an analytical model by Wong (1977) to determine leakage from these sites. In the course of reviewing Wong's equations it was discovered that certain simplifying assumptions and an error made in the derivation could lead to erroneous results. The equations are modified to cover a wider range of conditions and corrected to include porosity. The assumptions used in the derivation are qualitatively discussed and it is concluded the model is a reasonably valid representation of a clay lined landfill. A sensitivity analysis for key parameters shows that the difference in the hydraulic conductivity of the liner and the material overlying the liner is the most critical design parameter. A new method for determining the initial leachate head for use in the model equations is presented. The sensitivity analysis is utilized to develop limiting values for each design parameter as well as an optimal overall design based on the principle of minimizing leakage.

Introduction

A primary objective in the design of sanitary landfills or secure hazardous waste disposal sites is the protection of groundwater quality. Numerous studies have shown that sand and/or gravel soils do not provide the necessary degree of groundwater protection for major landfills in a humid climate such as that which exists in Wisconsin (Kimmel and Braids, 1980; Johnson and Cartwright, 1980; Gerhardt, 1977; Shuster, 1976). Thus it has been a commonly accepted design practice to locate landfills in areas of natural clay deposits whenever possible. However, in many instances a landfill site with an extensive natural clay deposit is unavailable due to local geologic conditions or political climate. In these instances a fairly common design concept utilized is the modification of an otherwise unsuitable site by installing a groundwater protection system. This system generally consists of a natural clay

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liner and leachate collection pipe network at the base of the landfill. The purpose of this system is to intercept and remove leachate prior to it entering the groundwater flow system. The design of these systems is often based on rules of thumb, opinion, regulatory experience o otherwise justified criteria upon which few experts in the field agree. Recently, the efficiency with which these systems actually collect leachate has also been questioned (Johnson and Cartwright, 1980).

One promising development in the design of these systems has been the derivation of an analytical model by Wong (1977) to determine the collection efficiency (and hence leakage) of a clay liner as a function of several key design parameters. To the authors' knowledge Wong's model is the only set of analytical equations specifically derived for this purpose.

This paper examines the Wong model in detail to provide additional insight in its application to landfill design and the factors affecting the collection efficiency of clay lined landfills.

Equation Derivation

A schematic diagram of the Wong model and the key design parameters it incorporates are shown in figures 1 and 2. The model is based on a liner configuration consisting of a series of broad corregations or "v" shaped notches sloped to facilitate drainage of leachate to collection pipes for removal. The collection efficiency and leakage are expressed as a function of liner slope, liner thickness, leachate head, leachate flow distance and the ratio of the liner's saturated hydraulic conductivity (permeability) to that of the material overlying the liner. The derivation of the model equations can be found in Appendix A of Wong's article and will not be repeated here. The key equations utilized for the analysis in this paper are as follows:

The percent leakage of leachate through the liner:

$$Q_L\ (\%) = \left(1 + \frac{d/\cos\theta}{h_o}\right)\frac{1}{k}\ [e^{-k(t/t_1)}\ (-k + k(t/t_1) + 1) + (k - 1)] \times 100$$

The time it takes for the trailing edge of the leachate volume to drain to the collection pipe:

$$t_1 = \frac{s_o\ \phi}{K_1(\sin\theta)} \tag{2}$$

The time it takes for the leachate volume to leak through the liner:

$$t_2 = t_1/k\ \ln\left(1 + \frac{h_o}{(d/\cos\theta)}\right) \tag{3}$$

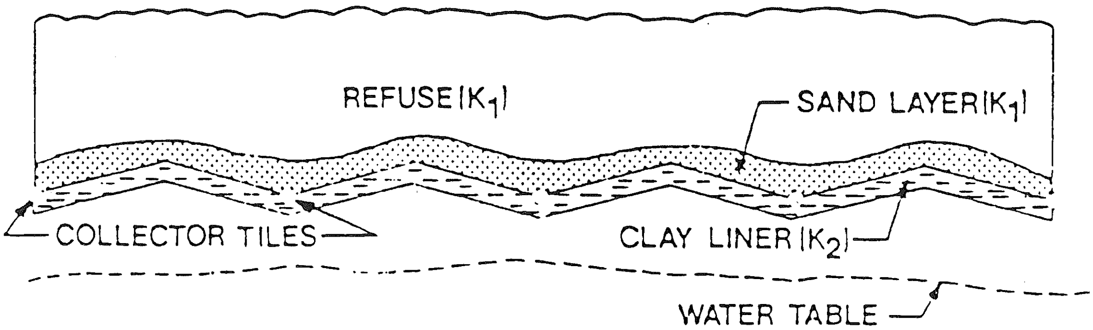

Figure 1. Typical clay liner cross section

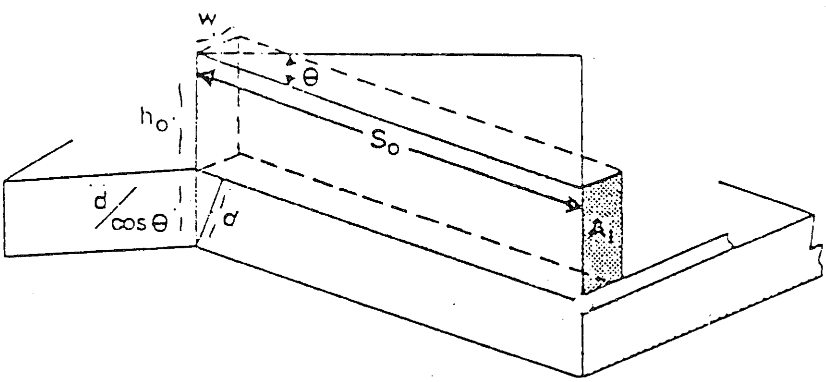

Figure 2. Wong model geometry

A simplifying constant:

$$k = \frac{s_o}{d} \, \frac{K_2}{K_1} \cot \theta \tag{4}$$

The head on the liner at time t:

$$h = h_o \left(1 + \frac{d/\cos \theta}{h_o}\right) e^{(-kt/t_1)} - \frac{d/\cos \theta}{h_o} \tag{5}$$

The length of the saturated volume at time t:

$$s = s_o \, (1 - t/t_1) \tag{6}$$

The symbols in these equations are defined at the end of this paper.

A comparison of these equations to those presented by Wong will reveal three differences which need explanation.

The liner thickness has been corrected for slope by substitution of $d/\cos \theta$ for d. Since the liner thickness is measured perpendicular to the slope, the term $d/\cos \theta$ represents the vertical flow distance through the liner. This substitution is necessary only for cases of substantial liner slope, as recognized by Wong. For shallow liner slopes (generally those less than 10 degrees) the above equations can be simplified by substitution of d for $d/\cos \theta$.

The term $(-k + kt/t_1 + 1)$ has been included in equation (1). This term was dropped by Wong in the final integration. This term is necessary for cases when the time for the trailing edge of the leachate volume to drain to the collection pipe is greater than the time it takes for the head to dissipate through the liner ($t_1 > t_2$). This will occur for inefficient designs only.

Lastly, the term porosity (ϕ) has been added to the numerator of the equation for t_1. This is perhaps the most significant modification to the Wong equations. The need for incorporating porosity was not recognized in the original article. Incorporation of porosity in the equation for t_1 is necessary since the derivation of the equation begins by changing the discharge term in Darcy's law to the change in saturated volume through time. The derivation of the equation for t_1 is presented in the appendix at the end of this paper. A careful examination of the equations will reveal that the porosity cancels out of the equation for liner leakage and thus does not directly affect the value calculated. However, its use is important in obtaining values for t_1 and t_2. These values are necessary for determining the time for complete system drainage and are used to determine the initial leachate head level as discussed later in this paper. Thus the use of porosity does indirectly affect liner leakage through affecting the leachate head level.

Equation Assumptions

There are a number of simplifying assumptions used in this model. The assumptions and a qualitative discussion of their validity follows.

1. The assumed liner configuration is that in figures 1 and 2.

Construction of a liner in this manner is readily achievable provided the dimensions are reasonable. Two recently constructed landfills in the State of Wisconsin have a nearly identical configuration to that assumed in the model demonstrating it is achievable in the field. Obviously not all landfills are designed in this configuration but it should still be possible to divide up most landfill designs into discrete segments so that the model can be applied between collection pipes. When doing this, caution is advised to insure the other assumptions in the model are not violated.

2. The site is above the water table so that no pore pressure exists below the liner to reduce the leakage rate through the liner.

This is a valid assumption for most lined sites since they are usually designed with the liner above the water table to avoid construction difficulties. Should the water table unexpectedly rise after construction or the clay liner be designed for a saturated clay environment (zone of saturation design) the model should provide a conservatively high estimate of leakage through the liner.

3. The leachate collection pipes are in a free draining condition.

This is a valid assumption provided the pipe network is designed to gravity drain to a tank exterior to the landfill and provided the collected leachate is routinely removed for treatment. Failure to remove accumulated leachate will increase the head on the liner and consequently the leakage through it.

4. All materials are at field capacity so that any infiltration of precipitation into the refuse results in gravity drainage to the bottom of the site.

For humid climates this is a valid assumption provided the model is not applied to a newly constructed landfill. The time required for the refuse and liner to reach field capacity can be theoretically determined (Fungaroli 1971, and Moore 1980). Although theoretical methods hypothesize that it would be several years before the system reaches field capacity, experience with clay lined sites in Wisconsin has indicated that a significant quantity of leachate is generated within 1-2 years of beginning site operation. A liner will start to show evidence of flow through it at about the same time. These observations suggest the liner and bottom layers of refuse reach field capacity much faster than anticipated by theoretical calculations, supporting the validity of the model for predicting leakage relatively early in site life.

5. An instantaneous head of leachate appears on the liner. The instant it appears it begins to drain to the collection pipes and leak through the liner. This continues until the total volume is discharged before another event occurs.

If one considers the "instant" begins when the head has built up to a maximum level and there is no infiltration during the drainage, then this assumption is reasonable. Water balance analyses for landfills in Wisconsin generally show that a majority of infiltration occurs during a relatively short portion of the year in spring and early summer. Since it may take several months or years for this infiltration to completely drain (from equation (2)), on a relative basis, it could be considered an instantaneous event. However, because of the time delay for drainage to occur several infiltration events may be superposed on the liner. This obviously violates the third part of this assumption and is a weak point of the model. A method of handling a series of infiltration events is discussed by Wong. A modification to that method is presented later in this paper. The sensitivity analysis in this paper assumes a single infiltration event.

6. The leachate saturates a rectilinear volume above the liner and retains this shape with the dimensions proportionally decreasing until the total volume is discharged.

Variations to the rectilinear shape can be evaluated using the Dupuit assumptions. Using this method Wong demonstrates that the rectilinear shape is a valid assumption provided the saturated length is at least 30 times the saturated height. Considering that for most landfills the ratio of the typical flow distance to the anticipated leachate head buildup would be much greater this assumption appears reasonable. It should be noted that the assumption of a rectilinear shape results in a greater head on the liner than that predicted by the Dupuit assumptions and this should result in a conservatively high estimate of leakage.

7. The sand blanket overlying the liner has the same hydraulic conductivity and porosity as the overlying refuse.

The materials used for a sand blanket could exhibit a wide range of hydraulic conductivity and porosity depending on the soil texture and density. In Wisconsin, such blankets are generally specified as clean sands and/or gravels with measured hydraulic conductivities within an order of magnitude of 1×10^{-3} cm/sec (DNR files). This is consistent with values reported in the literature (Hough, 1969; and Davis and DeWiest, 1966). Typical values for the porosity of loosely compacted, clean sands and gravels reported in the literature are in the range of 0.30 to 0.50 (Lutton, 1980; Hough, 1969; and David and DeWiest, 1966).

The hydraulic conductivity and porosity of municipal refuse is even more variable depending on the waste composition, density and stage of decomposition. Its hydraulic conductivity has been reported as ranging from 1×10^{-2} to 1×10^{-5} cm/sec (Hughes, 1971; Fungaroli and Steiner, 1979) with a majority of the measurements within an order of magnitude of 1×10^{-3} cm/sec. Porosity data is more limited with values reported in the literature up to 0.79 for loosely compacted refuse (Hughes, 1971), but more likely averaging around 0.60 (L.A. County, 1973). As can be seen from a comparison of these values to those above it is clearly possible that overlying refuse may not have the same properties as the sand blanket. For cases where the leachate head is less than the sand blanket thickness this difference is of little consequence as the sand blanket will control horizontal flow. For cases of higher head the situation can be handled by prorating values for hydraulic conductivity and porosity based on the relative saturated thickness of the sand blanket and refuse. Caution is advised in prorating values, however, since they will vary as a function of the leachate head until the head drops below the refuse-sand interface. A simpler method would be to assign a K_1 value from the material with the lowest hydraulic conductivity and a ϕ value from the lowest porosity material. This will result in a conservatively high estimate of the percent leakage anticipated.

The difference between the refuse and sand blanket properties may not be as great as the above ranges indicate. A majority of the hydraulic conductivity values for refuse and sand typically fall within an order of magnitude of 1×10^{-3} cm/sec. Refuse porosity data is very limited and not from field situations where overlying refuse may decrease the porosity of lower layers substantially. The sand blanket and lower layers of refuse may become partially clogged due to transport of fines from overlying refuse or biological activity within the materials. In such cases the hydraulic conductivity and porosity of the refuse and sand blanket may approach the same (lower) value. The validity of this hypothesis needs to be verified by careful monitoring of the performance of active landfills. For the sensitivity analysis later in this paper it is assumed the refuse and sand blanket have the same porosity and hydraulic conductivity.

From this qualitative discussion it can be concluded that the assumptions used in the model are reasonable and that this model is a reasonably valid method for predicting the collection efficiency of a clay lined landfill. It is important to note however that although the model does include several design parameters it does not consider variations from design criteria during site construction and operation, the leachate's effect on the refuse, sand blanket or clay liner properties, and the attenuative capacity of the liner soils and underlying soils and groundwater flow system. Thus, the model does not predict the ultimate impact of a clay lined landfill on groundwater quality nor is it the intent of this paper to address that issue.

Example Calculation

To demonstrate use of the Wong equations the following example is presented.

Given: Assumed liner configuration in figures 1 and 2

Clay liner: thickness (d) = 5 feet
hydraulic conductivity (K_2) = 1×10^{-7} cm/sec
slope (θ) = 1 percent or 0.573 degrees
maximum flow distance = 100 ft.

Sand blanket: thickness = 2 feet
hydraulic conductivity (K_1) = 1×10^{-3} cm/sec
porosity (ϕ) = 0.40

Applied leachate: Initial length (s_0) = 100 ft.
Initial head (h_0) = 2 ft.

Step 1: Using equation (4), k = 0.20

Step 2: Determine the controlling time for the leachate head to dissipate.

Using equations (2) and (3), t_1 = 3.87 years and t_2 = 6.51 years. Since t_1 is less than t_2 the controlling time (t) for equation (1) is equal to t_1. This means the applied leachate head will flow to the collection system prior to completely dissipating through the liner.

Step 3: The percent leakage calculated using equation (1) = 33%.

Sensitivity Analysis

As previously discussed, the Wong model expresses the percent leakage as a function of several key design parameters. By assigning a value for each parameter it is relatively easy to calculate the percent leakage for a given design using this model. Through the following sensitivity analysis one can also begin to examine the effect of variations to the given design.

The analysis begins by considering each parameter's effect on liner leakage as a function of the liner thickness. The liner thickness was chosen as the independant variable since it is probably the most costly variable and as such may be the most controversial parameter. Secondly, the effect of varying each parameter on liner leakage is examined by holding the liner thickness constant at 10 feet. A 10 foot thickness was chosen because this represents a condition where thickness is approaching infinity and leakage is relatively insensitive to changes in thickness for nearly all examples.

Figures 3 through 10 vary each design parameter from a basic design using:

s_0 = 100 ft.
θ = 1 percent or 0.573 degrees

h_0 = 2 ft.
$K_2/K_1 = 1 \times 10^{-4}$
(d) = variable

Hydraulic Conductivity Ratio

The effect of changing the ratio of the hydraulic conductivity of the liner to the material overlying the liner (K_2/K_1) is illustrated in figures 3 and 4. Intuitively, one can expect that as this ratio decreases (i.e. as the difference in hydraulic conductivity between the liner and overlying sand blanket increases) more leachate will be collected. This is confirmed by figure 3 where it can be seen that for a given liner thickness, a decrease in this ratio from 1×10^{-3} to 1×10^{-5} reduces leakage substantially. This relationship is true for all liner thicknesses, with the greatest change in leakage occurring at greater liner thicknesses.

The effect of liner thickness can be eliminated by examining the leakage at a given liner thickness. This is done in figure 4 where the percent leakage is plotted as a function of the hydraulic conductivity ratio for a liner thickness of 10 feet. From figure 4 it can be seen that an increase in this ratio beyond 1×10^{-3} results in little change in leakage. At these ratios the liner and sand blanket are of nearly the same permeability resulting in very inefficient designs with nearly 100% leakage. Similarily, a decrease in this ratio beyond 1×10^{-5} results in little change in leakage. These ratios represent a very efficient design with nearly all leachate being collected. However, a change in this ratio between 1×10^{-3} and 1×10^{-5} results in a dramatic change in the percent leakage.

The significance of the shape of this curve becomes evident when one considers that a "typical" design may provide for a clay liner with a hydraulic conductivity of 1×10^{-7} cm/sec and a sand blanket with a hydraulic conductivity of 1×10^{-3} cm/sec, resulting in a ratio of 1×10^{-4}. These hydraulic conductivities could easily vary by a half order of magnitude during construction as a result of borrow sources quality control, uneven compaction or testing variability. Even greater changes in these hydraulic conductivities may occur through time due to reactions between leachate and the sand blanket and clay liner. Thus, it is clear that the hydraulic conductivity ratio is an extremely sensitive design parameter.

Slope

The effect of changing the slope of the clay liner is illustrated in figures 5 and 6. Intuitively, one can expect that as the liner slope increases the leachate will flow to the collection system faster and less leakage will occur. This is confirmed by figure 5 which shows that for a given liner thickness, an increase in slope results in a decrease in leakage. This is true for all liner thicknesses, with the greatest change in leakage occurring at greater liner thicknesses.

Figure 6 expresses leakage as a function of liner slope for a liner thickness of 10 feet. From this figure it can be seen that for liner slopes of less than 2% the amount of leakage rapidly increases. Liner

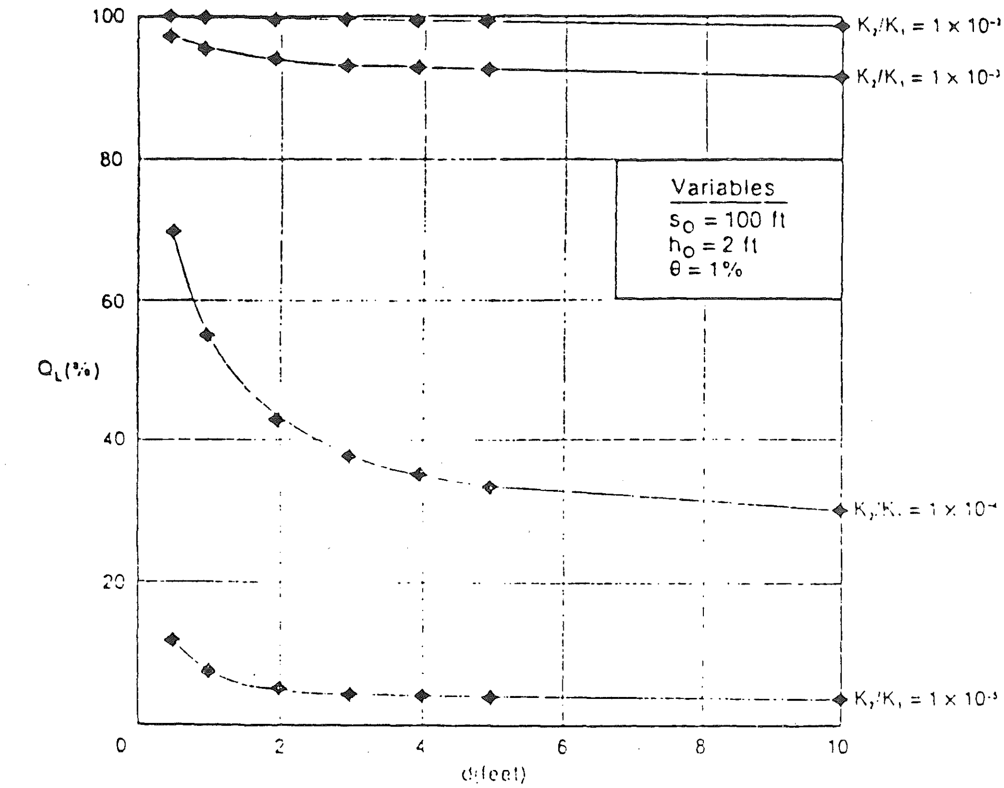

Figure 3. Percent leakage as a function of liner thickness for various hydraulic conductivity ratios

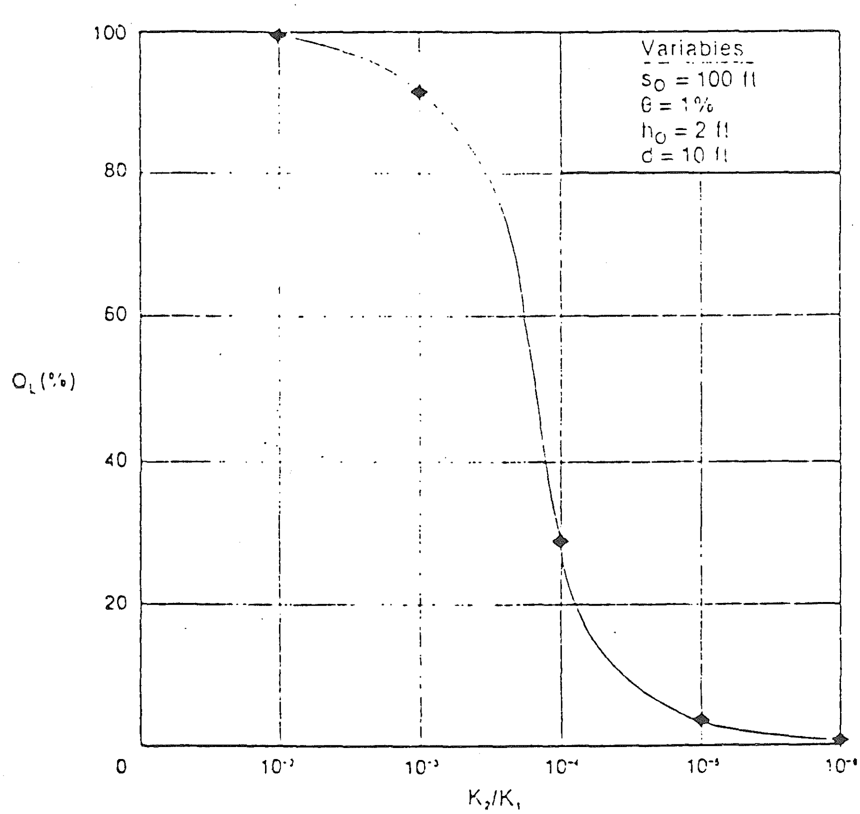

Figure 4. Percent leakage as a function of the hydraulic conductivity ratio

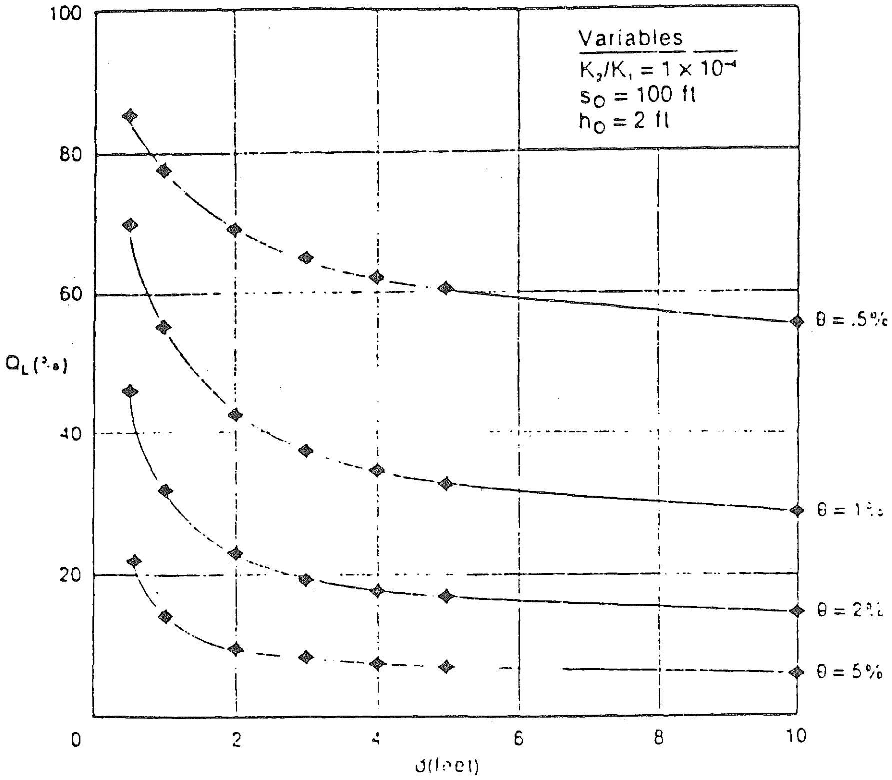

Figure 5. Percent leakage as a function of liner thickness for various liner slopes

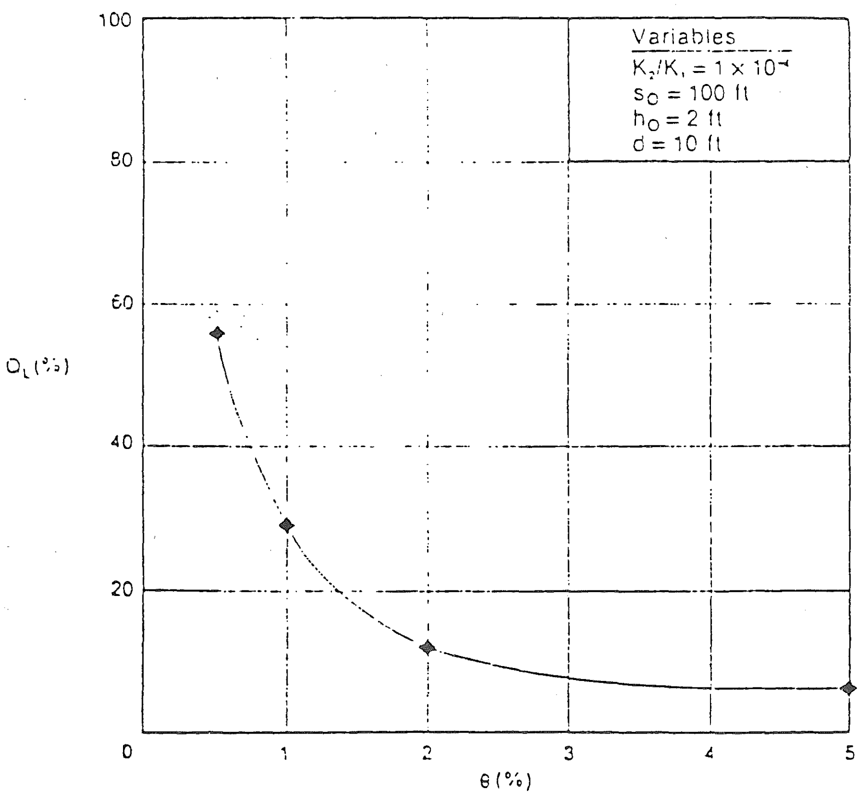

Figure 6. Percent leakage as a function of the liner slope

slope increases to 5% provide additional reductions in leakage. Liner slopes greater than 5% in this case provide little additional benefit of reduced leakage.

Flow Distance

The effect of changing the leachate flow distance is illustrated in figures 7 and 8. As one would expect, the percent leakage decreases as the flow distance decreases. Figure 7 shows that this relationship holds true for all liner thicknesses. Figure 8 expresses leakage as a function of flow distance for a liner thickness of 10 feet. From this figure it can be seen that, unlike the other parameters, there is no apparent point of diminishing return for decreasing flow distance. This is because the change in leakage is linear with respect to flow distance for distances up to 150 feet. Thus, for a decrease in flow distance under 150 feet there is a corresponding large decrease in leakage. For flow distances greater than 150 feet the percent leakage asymptotically approaches 100% leakage with flow distances of greater than 400 feet resulting in little additional increase in leakage due to the system inefficiency.

Thickness

The effect of changing liner thickness is illustrated in figures 3, 5, and 7. These figures provide a basis for examination of the effect of thickness on liner leakage under a wide variety of possible designs. As one would expect, as the liner thickness increases, the percent leakage decreases. From these figures it can also be observed that for inefficient designs the percent leakage is relatively insensitive to change in liner thickness, apparently because the other controlling parameters override its significance. However, for efficient designs the effect of liner thickness is clearly evident. For all these cases a liner thickness of less than 2 feet generally results in a sharp increase in leakage. As liner thickness is increased to 4 feet there is a correspondingly large reduction in leakage. A thickness of from 4 to 6 feet appears to be a point of diminishing return for increased efficiency as substantially greater thicknesses result in only a minor reduction in leakage.

Initial Head

As shown above the liner efficiency is dependent primarily on controlled design parameters (K_2/K_1, S_0, θ) of the liner system itself. However, the initial head, which is determined by climatic and other landfill surface features controlling percolation, is an important variable as well.

The initial head on the liner is a particularly difficult parameter to deal with in a sensitivity analysis due to the inverse relationship between the head and leakage. This relationship is shown in Figures 9 and 10. One would expect that as the head increases the amount of leakage increases. A first glance the larger percent leakage for smaller initial head shown in Figure 9 does not seem accurate. It can be

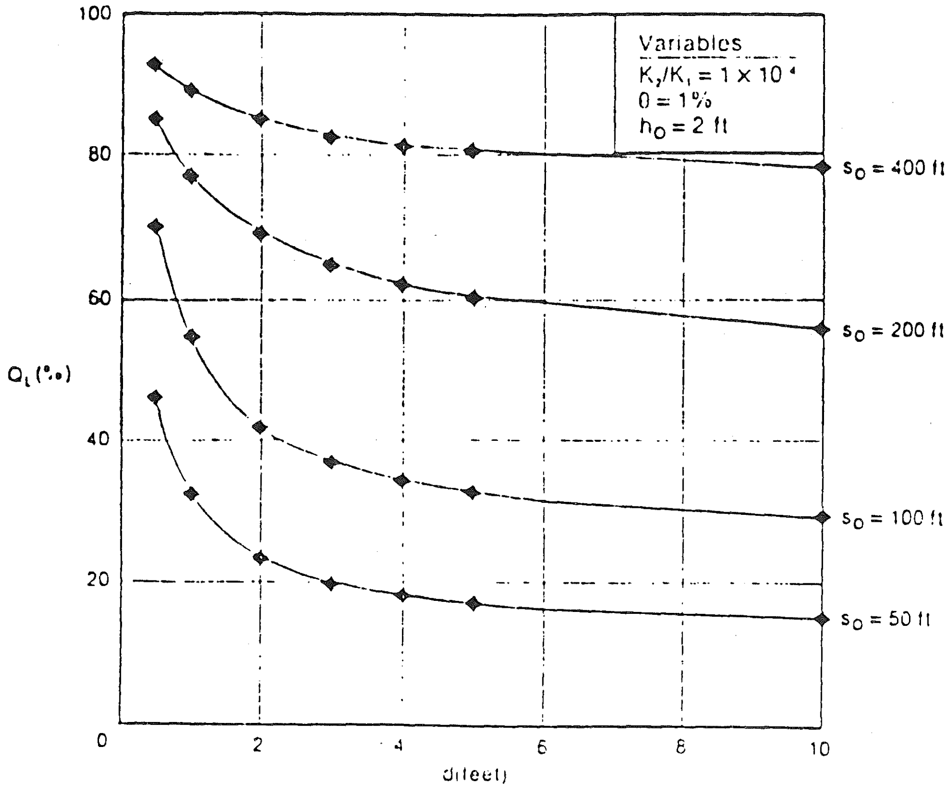

Figure 7. Percent leakage as a function of liner thickness for various leachate flow distances

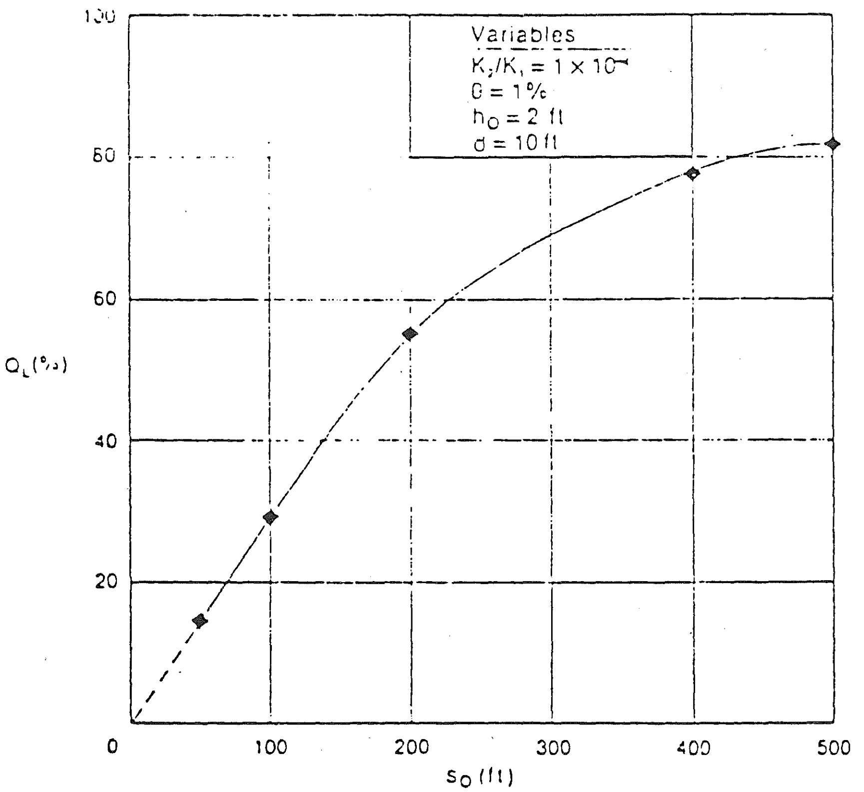

Figure 8. Percent leakage as a function of the leachate flow distance

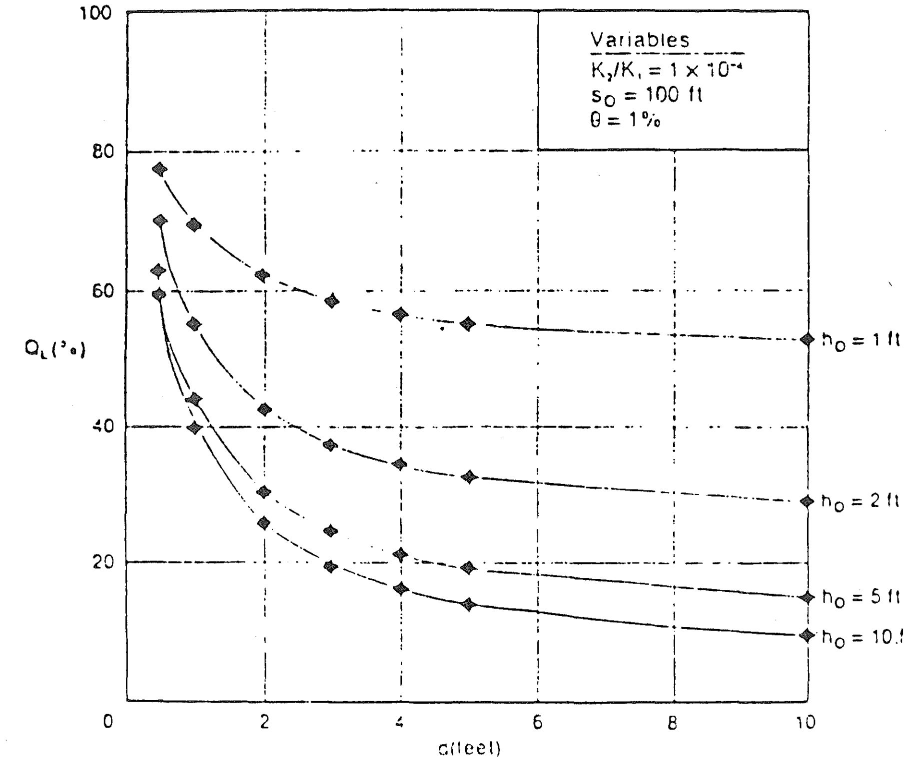

Figure 9. Percent leakage as a function of liner thickness for various initial heads

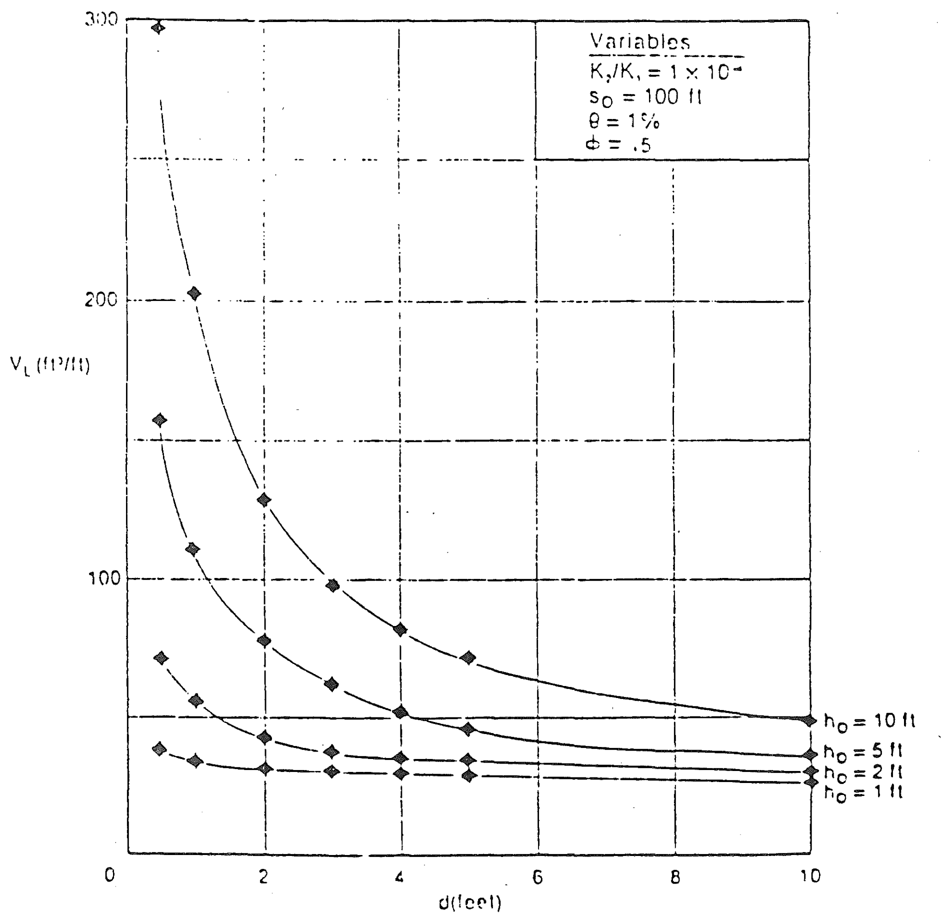

Figure 10. Total volume of leakage as a function of liner thickness for various initial heads

explained that the small initial head corresponds to a small initial volume. When the leakage is expressed as the volume leaked divided by the total initial volume the percentage is quite high. Yet, the actual volume leaked for a large initial head is substantially higher than that for a small initial head. This is shown in Figure 10 where the leakage is expressed as a volume rather than a percentage. As an example, for a liner thickness of 5 feet and all other parameters being equal, in Figure 9, if the leachate head is changed from 2 feet to 10 feet the percent leakage decreases from 33% to 14%. However, Figure 10 shows the volume of leakage actually increases from 33 cf/ft to 70 cf/ft. Thus, the intuitive conclusion is supported by this figure.

Figure 10 also demonstrates that the total volume leaked from sites with a low head is insensitive to the liner thickness. However, if the head is allowed to build up through the failure of a collection line or excessive recirculation, the volume leaked (Figure 10) and the efficiency (Figure 9) is very sensitive to the liner thickness.

The Additive Redistribution Method for Estimating h_o

The sensitivity of the Wong equations to the initial height of the leachate head on the liner has been shown in the preceeding section. The sand drainage blanket design is also dependent on the maximum head expected to be developed on the base of the liner (Moore, 1980). Therefore, the effort expended to determine the head on the liner should result in a much better evaluation of the liner design.

The maximum head on a liner is a function of the quantity and time distribution of rainfall percolation reaching the liner, the pore water release from the waste, the rate of head dissipation through the liner, and the rate of leachate collection. The assumptions set forth earlier in this article still apply.

Harr (1962) presented a method to calculate the head on top of a horizontal impermeable base with uniform recharge over that area. Moore expanded this method to predict the maximum head on sloping impermeable bases. The strength of the Moore method is that it takes into consideration the gradient on the leachate free surface and the liner slope. A weakness of both these methods is that they assume a constant steady state recharge rate with a resulting constant head. In humid, temperate climates, such as in Wisconsin, it is generally accepted that major recharge events occur over a two to four month period in the spring. This is demonstrated in the water budget methodology presented by Fenn et. al. (1975) when using humid temperate climatic data.

The initial head (h_o) used in the Wong equation should be the maximum head expected to be developed during a given spring recharge event. However, since for most landfill designs the time it takes for this leachate head to drain to the collection pipe (t_1) is greater than one year, the effective h_o must consider the residual leachate volume from the previous years. In order to determine this quasi-steady state h_o an iterative process must be used. Wong proposed a method where individual infiltration events would be allowed to partially dissipate before another event would be added to it. His method merely adds the head of the infiltration event to the head remaining from the previous event. This results in a rather unrealistic head distribution on the liner. Wong recognized that this method would result in a conservatively high estimate of liner leakage.

It is proposed that further refinement of Wong's method of determining h_0 would be to redistribute the volume of leachate left after one year as a uniform head over the entire liner. The next subsequent infiltration event is then added to this head. This additive redistribution method assumes that the leachate head remaining on the liner and the head produced by the infiltration event combine to produce a uniform head. While this redistribution is not supported by observations in the field it is the authors' opinion that it is a compromise between the Wong method which results in an excessive initial head and the uniform recharge theory proposed by Moore which results in a low initial head. A step by step approach using this process is as follows:

1. Determine the average yearly percolation from a water budget calculation. Assuming this percolation occurs over a relatively short time span (two to four months) it can be considered an instantaneous event relative to the time it takes to dissipate to the collection pipe (generally greater than one year).

2. Determine the head resulting from the percolation event by dividing the amount of percolation by the porosity of the sand blanket.

3. The head on the liner after a recharge event for each successive year can be computed by the equation:

$$h_{o(n)} = (h_{(n-1)} \frac{s}{s_o}) + \frac{Perc}{\emptyset} \qquad (7)$$

   Where the subscript n is the year of concern (n = 1, 2, 3, ...).

The $h_{(n-1)}$ term is the head of leachate left on the liner from the previous year. The quantity $h_{(n-1)}$ s/s_o represents this head redistributed over the entire liner. The second term is the additional head provided by the recharge event at the beginning of the next year. The working form of this equation is obtained by substituting from equation (5):

$$h_{(n-1)} = h_{o(n-1)}\left(\left(1 + \frac{d/\cos e}{h_{o(n-1)}}\right) e^{(-kt/t_1)} - \frac{d/\cos e}{h_{o(n-1)}}\right)$$

and from equation (6):

$$s = s_o (1 - t/t_1)$$

Into equation (7) to give

$$h_{o(n)} = h_{o(n-1)}\left(\left(1 + \frac{d/\cos\theta}{h_{o(n-1)}}\right) e^{(-k/t_1)} - \frac{d/\cos\theta}{h_{o(n-1)}}\right)(1-1/t_1) + \mathrm{Perc}/\delta \qquad (8)$$

Note: Using t_1 in years; t cancels out since it equals one year.

Step 3 is repeated until $h_{o(n)}$ is sufficiently close to $h_{o(n-1)}$ that no significant change would result in the subsequent liner leakage calculation. This quasi-steady state head ($h_{o(n)}$) is then used as the input to equation (1) as the initial head (h_o). The subject design can then be evaluated for its long term collection efficiency or more importantly, the total volume which leaks through the liner.

For a comparison of this additive redistribution method with Moore's method the following liner design and percolation values were subjected to both methods.

s_o = 100 ft	K_2 = 1 x 10^{-3} cm/sec
θ = 0.573 degrees	Perc = 0.25 ft during two months of the year
K_1 = 1 x 10^{-3} cm/sec	δ = 0.3

The equation presented by Moore assumes a uniform recharge rate. Using this equation the 0.25 feet per year of percolation must be converted to a saturated thickness by dividing by porosity. The resulting 0.83 feet per year is divided by 365 days to give the uniform recharge rate of 2.27 x 10^{-3} feet per day. The resulting maximum head is 2.1 feet by the Moore method.

A similar calculation using the additive redistribution method outlined above results in a steady state maximum head level of 2.3 feet.

The discrepancy between these two methods is expected since the Moore method assumes a uniform recharge rate while the additive redistribution method predicts the maximum head assuming a instantaneous recharge event.

Summary

The Wong model represents a significant step in predicting the performance of clay lined landfills. The model expresses leakage as a function of liner slope, liner thickness, leachate flow distance, the ratio of the liner's hydraulic conductivity to that of the material overlying the liner and the initial head of the liner. In this paper the model equations have been modified to cover a wider range of conditions. These modifications include the addition of the porosity of the material overlying the liner as an essential variable to consider in determining the timr required for leachate flow to the collection pipe, the initial leachate head and consequently the liner efficiency for a series of infiltration events. From a qualitative examination of the assumptions used for the model it can be concluded they are reasonable and the model is valid.

A sensitivity analysis of the key parameters in the model confirms several intuitive concepts in clay liner design:

as	hydraulic conductivity ratio decreases leachate head decreases flow distance decreases liner thickness increases slope increases	leakage decreases

The analysis also shows that the hydraulic conductivity ratio is clearly the most sensitive parameter affecting liner leakage.

From a base design the optimal and lower efficiency limits for each parameter established by this analysis are as follows:

Parameter	Optimal Value	Lower Efficiency Limit
K_2/K_1	1×10^{-4}	5×10^{-4}
d	4 to 6 ft	2 ft
θ	5%	2%
s_0	50 ft*	150 ft

*No apparent optimal value for this parameter. 50 feet has been chosen as a lesser flow distance is not considered practical in the field.

The optimal value represents values where a further decrease (or increase in the case of d and θ) would not gain appreciable reductions in leakage. These parameters yield a collection efficiency of 93%. The lower efficiency limit represent values where a increase (or decrease in the case of d and θ) would result in substantial additional leakage. Since all these parameters are bordering on an inefficient design, a design utilizing all these values would result in an extremely inefficient design with a leakage of 82%.

The K_2/K_1 is specified as 1×10^{-4} in the optimal design rather than 1×10^{-5} to recognize that while a design may call for 1×10^{-5} and may even achieve it during construction, changes in hydraulic conductivity of the sand blanket, the refuse or the clay liner through time will likely increase the ratio to a value of 1×10^{-4}.

It must be emphasized that these limits are based on a specific initial design chosen to demonstrate the effect of each parameter on leakage. For a given design there will usually be one or more controlling parameters around which the other design variables must be selected. A sensitivity analysis similar to the one presented in this paper provides the opportunity to examine the effect of each parameter to choose an optimum design.

A new technique, the additive redistribution method, has been proposed for determining the leachate head level for a series of infiltration events for use in the Wong model. This method provides the ability to consider the volume or rate of liner leakage under the assumption of a non-uniform recharge rate.

In conclusion this paper has shown that while natural clay liners can provide very efficient means for collecting leachate they can also be very inefficient under certain designs. The Wong model and the analysis presented herein provide a sound analytical tool for making informed design decisions.

List of Symbols Used in this Paper:

A = saturated cross sectional area (L^2)

d = liner thickness normal to surface (L)

h = height of saturated volume at time t

h_o = initial height of leachate on liner (L)

i = hydraulic gradient

k = dummy variable = $\frac{s_o}{d} \frac{K_2}{K_1} \cot \theta$

K_1 = hydraulic conductivity of material overlying liner (L/T)

K_2 = hydraulic conductivity of liner (L/T)

Perc = height of water which percolates below the root zone (L)

Q = discharge (L^3/T)

Q_L = percent leakage (dimensionless)

s = length of the saturated volume at time t (L)

s_o = maximum leachate flow distance (L)

t_1 = time for leachate slug to flow to collection pipe (T)

t_2 = time for leachate slug to flow through the liner (T)

V = volume (L^3)

V_L = volume of leakage

w = unit width (L)

θ = slope of liner (degrees)

ϕ = porosity (dimensionless)

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Appendix A

Derivation of Equation (2)

For Figure 2, from darcy's law the discharge to the collection pipe can be expressed as follows:

$$Q = \frac{V}{t} = -K_1\ i\ A$$

or, by substitution

$$\frac{s \times w \times h \times \phi}{t} = -K_1\ \frac{s\ (\sin\theta)}{s}\ h \times w$$

Note that the inclusion of porosity is necessary because of the conversion of the change in volume of leachate above the liner to a change in the linear dimension of length which this volume occupies.

This equation simplifies to:

$$(\quad s) = \frac{-K_1\ (\sin\theta)}{\phi}\quad t$$

Integrating this equation with the boundary condition $s = s_0$ when $t = 0$ the equation yields

$$s = s_0 - \frac{K_1\ (\sin\theta)\ t}{\phi}$$

At the time when the trailing edge of the applied leachate has moved to the collection pipe $t = t_1$ and $s = 0$ the equation becomes:

$$s_0 = \frac{K_1\ (\sin\theta)}{\phi}\ t_1$$

or

$$t_1 = \frac{s_0\ \phi}{K_1\ (\sin\theta)} \qquad \text{(equation 2)}$$

A similar rationale is used in deriving the equation for flow through the liner. Porosity is, therefore, in both the equation for flow to the collection pipe and the equation for flow through the liner. The porosity cancels out when the two terms are combined to yield Wong's equation A 4

$$h = h_o\left(\left(1 + \frac{d/\cos\theta}{h_o}\right) e^{(-kt/t_1)} - \frac{d/\cos\theta}{h_o}\right)$$

as well as subsequent equations including that for the dummy variable k. Thus, although the inclusion of porosity is necessary to determine t, it does not appear in the equation for determining leakage.

APPENDIX XV.

TABLE--VOLATILE ORGANIC COMPOUNDS

APPENDIX XV

VOLATILE ORGANIC CHEMICALS IN ORDER OF FREQUENCY OF OCCURRENCE IN GROUND WATER AT MINNESOTA MIXED MUNICIPAL LANDFILLS

CAS REGISTRY NUMBER	CHEMICAL	VOC'S IN GROUND WATER AT MINN. LF'S (NELSON AND BOOK, '86) SITES PRESENT	SITES TESTED	% OCCUR.	DENSITY (g/cc)	MDH RAL (ug/l)	NPDWR MCL (ug/l)	NPDWR 1989 MCL's	NPDWR MCLG (PPD. MCLG) (ug/l)	NPDWR REQ'D. VOC MONI-TORING	RCRA APPEND. VIII HAZ. CONSTIT	RCRA APPEND. IX GW MON.	CERCLA HAZ. SUBST. LIST	CWA/ NPDES PRIOR POLLUT.
156-59-2	cis-1,2-Dichloroethylene	41	47	87.2(A)	1.2837	70		X	(70)	X				
156-60-5	trans-1,2-Dichloroethylene	41	47	87.2(A)	1.2565	70		X	(70)	X	X	X	X	X
75-34-3	1,1-Dichloroethane	47	59	79.7	1.1776					X	X	X	X	X
95-47-6	o-Xylene	28	38	73.7(B)	0.8968	440(B)		X	(440)(B)	X		X	X	
108-38-3	m-Xylene	28	38	73.7(B)	0.8684	440(B)		X	(440)(B)	X		X	X	
106-42-3	p-Xylene	28	38	73.7(B)	0.8968	440(B)		X	(440)(B)	X		X	X	
79-01-6	Trichloroethylene	40	58	69.0	1.462	31.2	5	X	zero	X	X	X	X	X
109-99-9	Tetrahydrofuran	30	49	61.2	0.888								(G)	
71-43-2	Benzene	35	60	58.3	0.8787	12	5	X	zero	X	X	X	X	X
71-55-6	1,1,1-Trichloroethane	34	59	57.6	1.3492	200	200	X	200	X	X	X	X	X
108-88-3	Toluene	33	60	55.0	0.8669	2000		X	(2000)	X	X	X	X	X
75-09-2	Dichloromethane (methylene chloride)	33	61	54.1	1.335	48		X		X	X	X	X	X
100-41-4	Ethyl benzene	30	57	52.6	0.8672	680			(680)	X		X	X	X
67-64-1	Acetone	24	48	50.0	0.7908							X	X	
127-18-4	Tetrachloroethylene	26	54	48.1	1.623	6.9		X		X	X	X	X	X
78-93-3	Methyl ethyl ketone	23	48	47.9	0.8054	172					X	X	X	
107-06-2	1,2-Dichloroethane	28	59	47.5	1.256	3.8	5	X	zero	X	X	X	X	X
74-87-3	Chloromethane	26	56	46.4	0.92					X	X	X	X	X
60-29-7	Ethyl ether	21	46	45.7	0.714								(G)	
75-71-8	Dichlorodifluoromethane	25	57	43.9	1.486					(F)	X	X	(G)	
78-87-5	1,2-Dichloropropane	25	58	43.1	1.1558	6		X	(6)(E)	X	X	X	X	X
108-10-1	Methyl isobutyl ketone	20	48	41.7	0.801							X	X	
75-69-4	Trichlorofluoromethane	21	57	36.8	1.494					(F)	X	X	(G)	
67-66-3	Chloroform	22	61	36.1	1.4916	5	100(D)			X	X	X	X	X
75-00-3	Chloroethane	20	56	35.7	0.9028					X	X	X	X	X

CAS REGISTRY NUMBER	CHEMICAL	VOC'S IN GROUND WATER AT MINN. LF'S (NELSON AND BOOK, '86) SITES PRESENT	SITES TESTED	% OCCUR.	DENSITY (g/cc)	MDH RAL (ug/l)	NPDWR MCL (ug/l)	NPDWR 1989 MCL's	NPDWR MCLG (PPD. MCLG) (ug/l)	NPDWR REQ'D. VOC MONI-TORING	RCRA APPEND. VIII HAZ. CONSTIT	RCRA APPEND. IX GW MON.	CERCLA HAZ. SUBST. LIST	CWA/ NPDES PRIOR. POLLUT.
75-35-4	1,1-Dichloroethylene	18	59	30.5	1.218	7	7	X	7	X	X	X	X	X
75-43-4	Dichlorofluoromethane	13	45	28.9	1.426									
98-82-8	Cumene	13	48	27.1	0.864					X			(G)	
108-90-7	Chlorobenzene (monochlorobenzene)	13	57	22.8	1.1064	60			(60)	X	X	X	X	X
75-01-4	Vinyl chloride	11	58	19.0	0.9106	0.15	2	X	zero	X	X	X	X	X
75-27-4	Bromodichloromethane	10	58	17.2	1.98		100(D)			X		X	X	X
79-00-5	1,1,2-Trichloroethane	8	61	13.1	1.4405	6.11		X		X	X	X	X	X
76-13-1	1,1,2-Trichlorotrifluoroethane	6	47	12.8	1.5635									
74-83-9	Bromomethane	7	57	12.3	1.732					X	X	X	X	X
106-46-7	1,4-Dichlorobenzene	7	58	12.1	1.533	75(C)	75		75	X	X	X	X	X
79-34-5	1,1,2,2-Tetrachloroethane	5	58	8.6	1.5984	1.75				X	X	X	X	X
107-05-1	Allylchloride	4	48	8.3	0.9397	29.4					X	X	(G)	
56-23-5	Carbon tetrachloride	4	59	6.8	1.5942	2.7	5		zero	X	X	X	X	X
75-25-2	Bromoform	3	55	5.5	2.8899		100(D)			X	X	X	X	X
95-50-1	1,2-Dichlorobenzene	3	58	5.2	1.3048	620		X	(620)	X	X	X	X	X
541-73-1	1,3-Dichlorobenzene	3	58	5.2	1.2881					X	X	X	X	X
3018-12-0	Dichloroacetonitrile	2	48	4.2	1.374									
142-28-9	1,3-Dichloropropane	2	49	4.1	1.1896					X			(G)	
110-75-8	2-Chloroethylvinyl ether	2	57	3.5	1.0525						X	X	X	X
74-95-3	Dibromomethane	1	48	2.1	2.4921			X		X	X	X	(G)	
78-88-6	2,3-Dichloro-1-propene	1	48	2.1	1.204								(G)	
76-01-7	Pentachloroethane	1	49	2.0	1.6796						X	X	(G)	
630-20-6	1,1,1,2-Tetrachloroethane	1	49	2.0	1.5532					X	X	X	(G)	
124-48-1	Chlorodibromomethane	1	56	1.8	1.451		100(D)			X			X	X
10061-01-5	cis-1,3-Dichloro-1-propene	1	58	1.7	1.217					X	X	X	X	X
106-93-4	1,2-Dibromoethane (ethylene dibromide,EDB)	0	52	0.0	1.5389	0.008		X	(zero)	(F)	X	X	(G)	
563-58-6	1,1-Dichloro-1-propene	0	48	0.0	1.1764					X				
10061-02-6	trans-1,3-Dichloro-1-propene	0	58	0.0	1.224					X	X	X	X	X
96-18-4	1,2,3-Trichloropropane	0	49	0.0	1.394					X	X	X		

Footnotes:

A Occurrence data is for combined cis- plus trans-1,2-dichloroethylene.

B Numbers are for combined o- plus m- plus p-xylene.

C RAL for 1,4-dichlorobenzene revised based on EPA Maximum Contaminant Level.

D Maximum Contaminant Level is 100 ug/l for the sum of these four trihalomethanes.

E Proposed Maximum Contaminant Level Goal given in 51 Federal Register, p. 4618, February 6, 1986.

F Monitoring conditionally required.

G Hazardous substances listed in federal Superfund regulations but not listed as required analytical parameters in the EPA Contract Laboratories Program, October 1984 "Information for Bidders" (Reference 127).

APPENDIX XVI.

"UNIVERSITY OF MINNESOTA COMPOST/CO-COMPOST RESEARCH PROJECT"
FINAL REPORT

University of Minnesota Compost/Co-compost Research Project
Final Report to the Metropolitan Council: Narrative Summary

The University of Minnesota Compost Co-compost Research Project was initiated on July 1, 1985. Funding for a two year period (through June 30, 1987) was provided by the Legislative Commission on Minnesota Resources and the Metropolitan Council of the Twin Cities Area. The major focus has been on the use of compost products. Specific objectives as outlined in the project work plan were:

A. Survey literature and agricultural use on composting/co-composting with respect to their use as soil amendments and their acceptability by potential consumers.

B. Collect samples of solid waste compost/co-compost materials and characterize samples by biological, chemical, and physical analyses.

C. Perform greenhouse plant growth and response experiments with compost-soil mixtures and survey potential horticultural users.

D. Hold meetings with farmers, nursery managers, and other prospective utilizers of compost/co-compost material and publish results of the project.

Several activities were carried out in meeting these objectives. Each activity is described below according to the most appropriate objective. A brief summary of results and conclusions is also included. For a more complete presentation, the reader is referred to the indicated attachment(s).

A. Literature Review and Agricultural Survey

Literature reviews summarizing characteristics of solid waste composts and co-composts and the use of composts and co-composts on agricultural lands (Attachments A and B) were prepared for the project. Research has shown that compost products can improve soil physical properties, reduce erosion, increase soil pH, supply plant nutrients, and increase yields. Major limitations and problems are related to compost maturity, contaminants such as trace metals, and the potential for nitrogen immobilization. Soluble salt content and high pH are additional concerns when compost is used as a component of horticultural media. Research results have not always been consistent. This is probably due largely to differences in compost products and quality. Nonetheless, it does appear that, with proper management, there are definite benefits that can be derived from the use of compost in agriculture and horticulture.

Meetings were held with groups of farmers from in and around the seven county Metropolitan Area. Slide presentations were used to show how compost is made and to present research results. Benefits and limitations of compost use in agriculture were discussed. A questionnaire was used to survey interest in using compost. Results of the survey are reported in Attachment C. Briefly summarized, they are:

1. Reuse/recycling, composting, and incineration are the solid waste options most favored by those farmers surveyed.

2. The most important compost characteristics are contaminant levels, the presence of glass and plastic, and cost.

3. The most important benefits from compost use are increased nutrient and water holding capacities of soils.

4. Farmers are definitely interested in using compost, especially good quality composts.

5. Many feel more research is necessary in the area of agricultural compost use.

6. Potential exists for the agricultural use of vast quantities of solid waste compost.

7. Little, if any, income should be expected from compost sales to agricultural markets.

8. The State should develop rules regulating the quality and use of solid waste compost.

B. Research and Characterization

Yard waste compost samples were collected from eleven Metropolitan Area yard waste compost sites. Nine sites were sampled in 1985. The same nine sites plus two additional sites were sampled in 1986. Objectives of the yard waste compost monitoring were to provide information on nutrient levels and other quality parameters and to address concerns relating to the potential for yard waste composts to contain unsafe levels of lead. Chemical analyses showed that the nutrient concentrations of yard waste composts are more similar to those of a rich topsoil than commercial fertilizer materials or manures. Thus, yard waste compost is most appropriately used as an amendment which, when worked into soil will improve physical properties and provide small amounts of nutrients over a period of time. Compost is also an excellent mulch material for the home lawn and garden. The highest lead concentrations were found in composts produced at sites in the most urban areas. However, the lead levels of all yard waste compost samples were considerably lower than limits proposed by the Minnesota Pollution Control Agency (MPCA) for a class I compost or those recommended by the Environmental Protection Agency and the Food and Drug Administration for the production of fruit and vegetable crops. Levels of cadmium, nickel, copper, chromium, and zinc were also all well below limits. Results of the yard waste compost monitoring are reported in Attachment D.

Solid waste compost and co-compost samples were obtained from U.S. and overseas locations throughout the project period. All samples were analyzed for nutrient and trace element concentrations, carbon content, pH, and electrical conductivity. Trace metal concentrations found in several of the compost samples exceed the limits proposed by MPCA for a class I compost. Zinc and lead concentrations were those most often in excess. Cadmium, chromium, and nickel concentrations were consistently below limits. It appears that sewage sludges can contribute substantially to the concentration of trace elements in co-composts. However, zinc and lead concentrations in some composts produced without sewage sludge also exceeded MPCA proposed limits.

Incubation experiments were performed to determine the amount of nitrogen mineralized (converted to forms that can be utilized by growing plants) from compost-soil mixtures. Characterization of nitrogen release patterns of compost can help define compost quality, suggest process differences, and develop criteria for determining mature composts. A high quality compost would be one that released ample quantities of nitrogen over a reasonable period of time. A preliminary 28 day experiment with five composts was followed by a 140 day experiment with twelve composts. Four types of nitrogen release patterns were observed which support the following conclusions:

1. Mature composts (those that have been adequately decomposed) can reduce the nitrogen fertilizer needs of a crop.

2. Co-composts mineralize more nitrogen than composts that do not contain sewage sludge or animal manure. However, the trace metal concentrations of products containing sewage sludge can be higher.

3. Maturity of composts are very important if the materials are to be applied to growing crops.

Chemical composition of solid waste composts and co-composts, along with results and discussion of the incubation experiments are presented in Attachment E.

Physical characterization of compost (Attachment F) involved testing composts and compost-soil mixtures for bulk density, particle density, water retention, saturated hydraulic conductivity, unsaturated hydraulic conductivity, thermal conductivity, and wetting angle. A yard waste compost and a solid waste compost were used in combination with three different soil types: a silt loam, a clay loam, and a sand. Results showed that compost addition influences the physical properties of soil, however, the beneficial effects of compost addition are greatly dependent upon the type and amount of compost and the soil used. The solid waste compost had a greater influence on soil physical properties than the yard waste compost. However, effects such as increased available water and increased drainage were minimal for the silt loam and clay soils. The sand soil showed definite improvements in the amount of available water, but a considerable amount of compost had to be added in order to bring about this change. In general, unsaturated hydraulic conductivity decreased with the addition of compost. Low unsaturated hydraulic conductivities can lead to slower drying of soil in the spring and could also decrease the rate at which water is available to the plant roots. Compost, being a poor heat conducting material, reduced the thermal conductivity of soil when mixed with compost. Decreased thermal conductivity of the compost mixtures can lead to slow warming of soils in the spring and reduced crop emergence. Compost high in organic matter showed hydrophobic characteristics over the short term. Increased hydrophobicity of soil-compost mixtures can result in less infiltration and thus increased runoff on steep slopes.

Biological characterization of composts (Attachment G) involved the use of the earthworm Eisenia fetida as a bioassay in compost-soil mixtures. Eisenia fetida is a common inhabitant of naturally composting organic wastes. This fact was used to test compost from five different sources. Three patterns of earthworm behavior were observed and used to characterize compost in terms of toxicity and stability. It was concluded that composts were stable if earthworms introduced into a sample did not grow, since food sources were exhausted. By adding cellulose to such composts, earthworms grew if the compost was not otherwise toxic. Potentially toxic composts caused severe decrease in worm weight or death. Culturing the earthworm requires little labor or expense, and the bioassay can be performed in 14 days. Eisenia fetida can be used by municipal solid waste compost operations to routinely and inexpensively test compost for stability and toxicity.

C. Greenhouse Research and Horticultural Use Survey.

A questionnaire mailing was used to survey potential compost users in horticultural and other non-agricultural sectors. Objectives of the survey were to assess interest in the use of compost products, to identify concerns and product specifications, and to determine the types and quantities of materials currently used that are similar to or that could be replaced or supplemented with composted waste products. Results of the survey showed that there is a definite interest in the use of solid waste compost. It appears that non-agricultural markets do exist and could be further developed in the State - particularly in the seven county Metropolitan Area. The high response rate (greater than 24 percent of all questionnaires were returned) was viewed positively as was the proportion of respondents (64 percent) who said that they would like more information on compost products. Although some industries, notably sod growers and arborists, showed a lack of interest, other sectors such as landscape contractors and public agencies displayed a strong willingness to try and regularly use compost products. It appears that these would be the most likely areas in which to initiate marketing efforts. Cost and availability of products were the major concerns expressed by nearly all groups surveyed. Results are reported in Attachment H.

A nursery study (Attachment I) was performed to evaluate the feasibility of utilizing waste products for the production of woody ornamentals. A solid waste compost, a manure compost, and a shredded solid waste fraction were used as components of various media mixtures. The addition of all materials increased the soluble salt contents of the media. The pH of media was increased with the addition of both composts. Potassium and phosphorus levels were increased with the addition of manure compost. The other waste materials contributed small amounts of potassium. The addition of compost appeared to increase available water holding capacity. This was most evident with the manure compost. The hydraulic conductivity of all mixes was satisfactory by container media standards. Total porosity was increased by the presence of compost, but air-filled porosity was often decreased. This quality is not desirable since plant roots need oxygen and excessive water filled pore space decreases aeration in the container. Quality of plant growth was best for those plants which received fertilizer treatments. However, plant quality was also related to medium pH. The mixes which produced the poorest quality of growth were also the ones with the highest pH values at the end of the first season. Plants grown in media containing solid waste compost contained higher levels of boron than plants grown in either shredded solid waste or the control mix. Zinc levels were higher in plants grown in the solid waste compost and the shredded solid waste as compared to the controls. Although these differences were statistically significant, levels of boron and zinc in all plants were well within normal ranges. Results suggest that composted waste materials can provide some desirable qualities to container media. Among these are decreased bulk density, increased water holding ability, and increased porosity. However, careful attention must be paid to managing negative aspects such as high soluble salts and nitrates, high pH, and the tendency for some materials to reduce aeration. These problems are not unlike those encountered with other organic soil amendments.

Two additional plant growth studies have been initiated as a result of the project. They are: 1. the establishment of test plots to evaluate the performance of waste composts as aids in establishing vegetation on a marginal soil on a highway right-of-way (Attachment J) and 2. a greenhouse study to evaluate waste composts as components of media for the production of bedding plants (Attachment K). These studies will be carried through the 1987 growing season.

D. Education and Publication

Several papers on the research characterization activities will be submitted for publication in technical journals. Abstracts have also been submitted for presentations at the American Society of Agronomy annual meeting scheduled for this winter.

Results of the yard waste compost monitoring and chemical characterization of composts will be reported in Soil Science Department bulletins.

Various presentations, supporting the educational objective, have been made by project participants. Examples are:

A project open house was held on September 17, 1986 to provide an update of composting activities in Minnesota and to give an overview of the University project. Participants toured various campus locations to observe studies in progress. The open house was attended by approximately 60 individuals including county and city solid waste personnel and staff from the Metropolitan Council, Minnesota Pollution Control Agency, and the Minnesota Waste Management Board.

Discussion and preliminary results from the horticultural container study were presented at the Minnesota Nurserymen's 61st Annual Convention and Trade Show on January 6, 1987. The convention was attended by approximately 2000 individuals including nursery operators and representatives from nursery related industries.

A presentation on the market assessment component of the project was made at the Fourth Annual Solid Waste Seminar. The seminar, which is sponsored by the Minnesota Pollution Control Agency and the Minnesota Waste Management Board, was held on February 18 and 19, 1987. Participants included several hundred industry and government representatives interested in solid waste management issues.

The compost/co-compost research project was included in the University of Minnesota 1987 County Extension Day Tour held on March 20, 1987. A presentation covering project objectives and activities was made to two tour groups of approximately 40 individuals each. Participants included county board members, Minnesota Extension Service Staff, and selected Minnesota farm families.

A presentation covering project activities and compost characteristics was made at a compost seminar on April 15, 1987. This seminar, also sponsored by the Minnesota Pollution Control Agency and the Minnesota Waste Management Board, was attended by approximately 180 individuals including county commissioners and solid waste planning staff; industry consultants and vendors; staff from the Minnesota Pollution Control Agency, Minnesota Waste Management Board, and Metropolitan Council; and other interested parties.

ATTACHMENT A

THE UTILIZATION OF SOLID WASTE COMPOSTS, CO-COMPOSTS, AND SHREDDED REFUSE ON AGRICULTURAL LANDS

--- A LITERATURE REVIEW ---

This project was supported by the Legislative Commission on Minnesota Resources and the Metropolitan Council of the Twin Cities Area

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I. INTRODUCTION

Landfilling is the most widely used and cheapest option for solid waste disposal. Nonetheless, throughout Minnesota landfills are closing. These closures are primarily due to either stringent pollution control requirements or to simply running out of landfill space. Because of this problem, the 1980 state legislature adopted a law, the Waste Management Act, which requires each Minnesota county to develop and implement a solid waste management plan.

In the seven county Twin Cities metropolitan area the landfill space problem is critical. Approximately 90% of the Twin Cities garbage is hauled to less than a dozen landfills. Permitted landfill space will be exhausted in just a few years. Each county has prepared a landfill abatement plan.

The Metropolitan Council reviews and approves the solid waste planning efforts of the seven county metropolitan area. The Council believes that recycling and recovery are the most preferred solid waste management practices.

Several metropolitan counties are preparing to develop moderate to large-scale garbage to energy facilities which could handle up to 1000 tons of garbage per day. These facilities would incinerate garbage and produce steam. The steam could be used for heating or in the production of electricity.

In addition to the waste-to-energy facilities, the Metropolitan Council has recommended that counties and cities investigate the potential for composting facilities in their landfill abatement strategies.

Composting is a common solid waste processing practice in Europe and Asia. In the Netherlands, 17% of the domestic refuse is composted (11). Most of the compost produced (more than 90%) is applied in amenity areas (27). The main producer of solid waste compost in the Netherlands is the VAM Waste Disposal Company, which produces 100,000 metric tons per year.

In West Germany, about 1 million metric tons of compost are produced annually by 17 facilities throughout the country (88, 91). Approximately 3.4% of the domestic refuse generated each year is being recycled as compost on the land (36).

In Switzerland, from 3 to 10% of the total municipal waste is composted (45, 88). The majority of the compost is used in vineyards.

There are 15 full-scale composting plants operating in Austria with daily production rates varying from 600 to 1200 tons (87). This activity accounts for 21% or 408,000 tons per year of the municipal solid waste generated (88). The majority of the compost is used in agriculture and landscaping.

France has over 100 composting plants producing 800,000 tons of compost per year (101). In Czechoslovakia, there are 20 composting plants which process 450,000 tons of wastes annually (57). In Sweden, 24% of the domestic refuse generated is composted (88). About 10% of the refuse generated in Spain is composted (52). Over half of Spain's compost is applied to vineyards.

In Japan, the composting of municipal refuse, using mechanical devices, started in the mid-1950s. More than 30 composting facilities, primarily the Dano type, were constructed by 1963 (84). By the mid-1970s most of the plants were abolished. Only seven plants are now in operation with the present compost production estimated at 20,000 tons annually. The construction of a second generation of municipal refuse composting facilities is presently underway (138).

In Hong Kong, about 5% of the total municipal refuse collected goes to composting (18). In 1982, about 9000 metric tons of refuse compost were produced. The city of Bangkok, Thailand produces approximately 100 tons of commercial grade compost per day (78). In Morocco, municipal refuse is composted at plants in Aden, Casablanca, and Rabat (94).

Perhaps the largest composting facility in the world is located in Moscow, USSR. This plant has the capacity to process 200,000 tons of refuse per year (135). The facilities in Leningrad process 140,000 tons per year (135). Facilities in Rome, Italy process 170,000 tons per year (135).

The country with the most widespread use of composting is India. Here, 2500 small urban settlements produce a total of 3 million tons of compost annually (135).

In South America, Brazil has twelve operating composting facilities (8). Other Central and South American countries which have composting plants include Costa Rica, Peru and El Salvador (99).

In the United States, composting of municipal solid waste has been practiced in California, Arizona, Alabama, Florida, Pennsylvania, Michigan, Tennessee, New York, and Washington (99). Generally composting has not proven successful due to the lack of steady markets, high initial investment and operating costs, and/or poor compost quality (11). One problem with the idea of solid waste composting in the United States is the notion that it must be profitable in order to be successful. Many others, however, believe that the concept behind composting should be similar to that of other public services, such as waste water treatment, which do not generate a profit but are necessary to protect the environment and public health.

Even though composting of solid waste may not provide monetary returns, there are many intangible benefits that must be considered. First and foremost is the reduced dependency on landfills. The siting of future landfills, whether they be for the disposal of municipal solid waste or ash produced by waste to energy incinerators, will undoubtedly be expensive and controversial.

A second non-monetary benefit of composting is the production of a material which would be useful in modern day agriculture. The Soil Conservation Service estimates that on the average every acre of Minnesota cropland loses 6.4 tons of topsoil per year (67). The addition of compost to cropland can protect the long-term productivity of our soils. Compost has been used successfully in the reclamation of mine tailings (70), strip mine areas (126), gravel pits (33), ash ponds (31), and radioactive waste disposal sites (129), as well as in the stabilization of highway roadbanks (27, 87).

The agronomic value of organic waste amendments has been known for years. The application of manure, crop residues, sewage sludge, or solid waste compost to agricultural soils can provide a source of nutrients and organic matter. The principal questions to be resolved regarding the use of solid waste compost on agricultural soils are (1) what are the beneficial and detrimental chemical constituents of compost, (2) what are the responses by various crops to compost application, (3) what changes in soil properties can be expected from compost application, and (4) what residual or long-term effects may result from high rate compost applications.

It is the purpose of this report to summarize some of the literature which addresses these questions. Unless otherwise noted, all research results and findings are from studies utilizing municipal solid waste compost, which will be referred to just as compost, or municipal solid waste and sewage sludge compost, which will be referred to as co-compost.

II. CHEMICAL COMPOSITION OF COMPOSTS

The chemical composition of any waste material applied to cropland is extremely important. A farmer must be aware of the quantity of beneficial plant nutrients which are available from the organic amendment. In order to obtain optimal crop yields, certain nutrients may have to be supplemented if the material has a low concentration of that element. Other nutrients, if applied in too high of a quantity, may be detrimental to plant growth and vigor. Certain trace metals are an example of this. For instance, crops require copper and zinc for growth. However, high soil concentrations of these metals may have a phytotoxic effect.

Presented in Tables 1 through 4 are analyses of composts from around the world. The tables provide data of more than 37 individual compost sources and summaries of compost composition from 8 countries. In Table 5, the data is summarized and compared to the mean chemical composition of unamended soil (146) and the median chemical composition of more than 250 sewage sludge samples from approximately 150 wastewater treatment facilities located in the north central and eastern regions of the US (133).

The chemical analysis of compost can vary widely as shown in Table 5. This variability is primarily due to the composition of the raw materials that were used to make the compost, as well as, to the composting method. Some composts are made from solid waste which have had the "light fraction" (e.g. paper and plastics) removed. These composts would tend to have higher nutrient levels compared to their carbon level. Conversely, composts made from solid wastes high in paper and plastic will normally have low nutrient levels.

Many solid waste composting processes require the addition of a nitrogen source to obtain a satisfactory carbon to nitrogen (C:N) ratio. Potential nitrogen sources include mineral nitrogen (e.g. urea, ammonium nitrate, etc.), septic tank pumpings, animal manures, and sewage sludges. The addition of sewage sludge as a compost ingredient can have a great influence on the chemical composition of the final compost product. Typically, the addition of sewage sludge will increase the nutrient level of the compost and, depending on the sludge composition, may significantly increase the compost's trace metal content.

From Table 5, it is apparent that when compared to sewage sludge, solid waste compost is lower in nitrogen, phosphorus, and sulfur. Compost is higher in potassium, however. Sewage sludges are generally higher in trace metal content. Even though composts are lower in trace metals, the application rates used are typically higher as will be presented in the following sections. Because of this, the total load of certain trace metals to agricultural soils may be equivalent from sludge and compost applications.

Several other chemical constituents have been analyzed in compost. Co-compost from Johnson City, Tennessee and compost from Blaubeuran, Germany were found to have 7000 and 7670 mg/kg of aluminum, respectively (152). The average chloride content of compost samples in two studies conducted in Belgium were 1175 mg/kg (157) and 1400 mg/kg (25). deHaan (27) presented chloride contents of 3200 mg/kg and 5000 mg/kg for composts from the Netherlands and France, respectively, Molybdenum ranges from a low of 3 mg/kg to a high of 32 mg/kg in various composts from Switzerland (45). The range for cobalt is 4 to 38 mg/kg in these sample composts.

Recently, there has been much concern over the presence of toxic organic compounds and pesticides in sewage sludges that are landspread on agricultural lands. The same concerns would apply to compost application. Table 6 presents pesticide levels found in composts produced from two different processes. Benzene hexachloride (BHC), heptachlor expoxide, aldrin, endrin, and an organophosphate screen were also analyzed for but were not detected in either compost material (90).

Concentrations of four to six ring polyaromatic hydrocarbons (PAHs) were analyzed in twelve composted municipal wastes of different origin and age (93). The average concentrations are presented in Table 7. These results show that the concentration of PAHs in raw compost materials (fresh compost) are higher than that found in the final compost product (ripe compost). This would indicate that these aromatic compounds are degraded or volatilized during the composting process. This finding was followed up by a degradation study carried out with radioactive labelled PAH compounds. It was found that the microbial populations of ripe composts possess considerable capabilities to mineralize these recalcitrant molecules. In each compost sample analyzed there appeared to be a relationship or ratio between the amounts of individual PAHs found. Because of this finding, it was recommended that benzo (a) pyrene be used as a general indicator or index for contamination of PAHs.

Table 1. Chemical composition of composts and co-composts from Europe.

Source	Sevilla Spain	Puerto Real Spain	Granada Spain	Granada Spain	France	Netherlands	Blaubeuran W. Germany	West Germany[1]	West Germany[2]	Leicester England[3]
Reference	52	52	52	105	27	27	152	36	36	72
							%			
OM[4]	49.0	38.8	44.0	58.4				37.6	18.7-60.2	
C				25.5			27.1	23.8	9.9-29.4	
N	1.4	1.0	1.5	1.4	0.9	0.96	1.18	0.7	0.1- 1.8	1.45
P	0.6	0.4	0.2	0.38	0.3	0.33	0.37	0.2	<0.1- 0.7	0.34
K	0.7	0.3	0.6	0.65	0.3	0.27	0.20	0.4	0.1- 1.9	0.51
Ca	7.5	5.5	8.5	8.72	4.0	2.13	6.37	3.6	0.5-15.3	4.06
Mg	0.5	0.2	1.0	0.8	0.4	0.22	0.40	0.4	0.1- 5.9	
S	0.2	0.3	0.5	0.26	0.6	0.32				
Na					0.3	0.30	0.12			
							µg/g			
Fe	.2230	1250	3360				2467			16,500
Zn	700	4000	500		1000	1650	590	1000	421-2830	160
Cu	200	180	200		250	630	257	266	71-2800	280
Mn	500	1250	1100		600	400	520	511	304-1305	
Cd	0.04	0.09	0.09		7	6		3.7	0.8-7.4	6
As						9		7.2	0.6-16	
Cr	1.52	2.07	1.80		270	220				
Pb	8.69	12.4	10.8		600	900	6.3	229	24-1100	580
Hg					4	5	nd	2	0.2-6	
Ni	0.76	1.08	0.81		190	110	20			100
B	3	15	nd[6]		60	60	277	32	3-105	
pH				7.1				7.7		7.4
Cond.[5]				31.5						

1 Average for various locations
2 Range for various locations
3 Co-compost
4 Organic matter
5 Electrical Conductivity (mmhos/cm)
6 Not detected

Table 1. (Cont'd.) Chemical composition of composts and co-composts from Europe.

Source	Maidenhead England	Belgium	Belgium	Gand Belgium[1]	Gand Belgium[2]	Switzerland	Switzerland[3]	Switzerland[4]	Siggerwiessen Austria
Reference	46	23	157	25	26	27	45	45	87
	%								
OM[5]				19.6	17.1-21.8		42.5	25.0-63.0	48.5
C		10.6					23.0	11.0-40.0	18.1
N	0.88	1.1		0.58	0.52-0.65		1.0	0.7-1.5	0.9
P	0.34	0.03		0.22	0.18-0.22		0.4	0.1-1.0	0.3
K	0.35	0.01		0.23	0.19-0.26		0.3	0.2-0.5	0.3
Ca		>1.0		2.1	1.8-2.3		4.0	2.2-6.0	1.1
Mg		0.04		0.16	0.12-0.19		0.4	0.2-0.8	0.7
S									
Na									
	µg/g								
Fe									
Zn			1400			2330	2200	600-10,000	830
Cu			129			780	715	200-4300	500
Mn									630
Cd						12	11	4-31	7
As									5
Cr							179	36-420	350
Pb			433			1570	1460	400-5300	250
Hg							7	2-17	2
Ni						90	90	6-450	45
B							30	13-50	30
pH		7.8							
Cond.[6]									

1 Average of 1953 and 1954
2 Range for 1955 through 1958
3 Average for various locations
4 Range for various locations
5 Organic matter
6 Electrical conductivity (mmhos/cm)

Table 1. (Cont'd.) Chemical composition of composts and co-composts from Europe.

Source	Pistoria, Italy	Pistoria, Italy	Pisa, Italy[1]
Reference	112	123	111
		%	
OM[2]		28.4	50.3
C	39.5		29.2
N	1.78	1.3	1.6
P	0.25	0.3	
K	0.07	0.4	
Ca			
Mg			
S			
Na			
		µg/g	
Fe			
Zn	857		
Cu	422		
Mn			
Cd	8		
As			
Cr	215		
Pb	605		
Hg			
Ni			
B			
pH	7.7	8.1	
Cond.[3]		10.0	

1 Co-compost
2 Organic matter
3 Electrical conductivity (mmhos/cm)

Table 2. Chemical composition of composts and co-composts from Japan.

Source	Japan[1]	Japan[2]	Yokohama, Japan	Yokohama, Japan	Yokohama, Japan	Usuda, Japan	Usuda, Japan	Tokyo, Japan	Komoro, Japan	Toyohoshi, Japan	Ito, Japan
Reference	84	169	14	136	13	14	13	13	13	136	136
	%										
OM[3]											
C				33.1						27.2	32.8
N	1.24-2.30	2.1	2.38	2.6		2.83				2.2	2.5
P	0.21-0.69	0.8				0.83					
K	0.51-2.60	1.2									
Ca	2.27-6.74										
Mg	0.20-1.69										
S											
Na											
	µg/g										
Fe											
Zn	274-1670				760		147	792	86		
Cu	52-428				189		47	333	73		
Mn											
Cd	1.6-6.0	1.1			2.3		2.3	1.7	0.54		
As	0.1-6.0	1.2									
Cr											
Pb	64-911				173		1.3	119	18.0		
Hg	0.5-4.2	0.5			2.6		0.18	1.5	0.09		
Ni	14-49				32		9.0	3.4			
B											
pH	6.1-8.4		8.5			7.3					
Cond.[4]	1.28-7.80										

1 Range for seven different composts
2 Average from various locations
3 Organic matter
4 Electrical conductivity (mmhos/cm)

Table 3. Chemical composition of composts and co-composts from Asia.

Source	Chai Wan Hong Kong	Chai Wan Hong Kong	Chai Wan Hong Kong	Taichung Taiwan	Bangkok Thailand	Bombay India[1]	Bombay India[2]	India	Adem Yemen	Rabat Morocco
Reference	167	169	18	162	78	97	97	138	94	94
					%					
OM[3]		11.4		24.3					36.5	38.5
C	36.7		28.4			16.7	15.3	12.4		22.4
N	2.86	1.3	1.67	1.43	1.41	1.05	1.05	0.76	1.12	1.59
P			0.55	0.61	0.6	0.14	0.14	0.23	0.45	0.64
K			0.40	1.00	1.3			0.67	0.81	0.68
Ca			2.25						1.29	9.27
Mg			0.63							0.76
S										
Na			0.82							0.66
						µg/g				
Fe										
Zn	1489	382	75.9							
Cu	550	13.2	12.3							
Mn	1179	188	226							
Cd		7.6	3.3							
As										
Cr	362	25.6	98.0							
Pb										
Hg										
Ni										
B										
pH			7.4							
Cond.[4]		8.4	7.5	8.2						

1 Sieved compost
2 Granulated compost
3 Organic matter
4 Electrical conductivity (mmhos/cm)

Table 4. Chemical composition of composts and co-composts from the United States and Canada.

Source	United States[1]	United States[2]	Mobile Alabama	Phoenix Arizona	Phoenix Arizona	Berkeley California	Sacramento California	Sacramento California	Delaware[3]	Delaware[4]
Reference	147	147	121	3	44	3	43	44	90	90
	%									
OM[5]	43.8	24.0-77.3								
C				21.6				26.6		
N	1.12	0.64-1.66	0.9	0.83	0.91	0.44	0.92	1.55		
P	1.19	0.76-1.52	0.2	0.36	0.47	0.17	0.23	0.55		
K	0.69	0.25-1.14	1.6	0.63	0.57	0.32		0.41		
Ca	3.24	1.30-5.50								
Mg										
S										
Na										
	ug/g									
Fe										
Zn									426	507
Cu									63.7	46.5
Mn										
Cd									0.85	1.50
As									0.90	1.80
Cr									22.6	64.7
Pb									140	335
Hg									1.9	2.1
Ni									2.6	8.3
B										
pH				7.2		7.5	7.1			
Cond.[6]					7.5			4.5		

1 Mean of seven composts
2 Range of seven composts
3 Aerobic digester compost
4 Windrow compost
5 Organic matter
6 Electrical conductivity (mmhos/cm)

Table 4 (cont'd.) Chemical composition of composts and composts from the United States and Canada.

Source	Gaines-ville FL	Gaines-ville FL[1]	Largo FL	Largo FL	Savannah GA	Long Island NY	Norman OK	Downs-view Ontario	Pittsburgh PA	Johnson City TN[2]	Johnson City TN[2]
Reference	7	70	68	80	3	3	3	34	3	152	48
	%										
OM[3]											
C	33.8									21.2	
N	0.51	0.56	1.20	1.10	1.54	1.47	0.92	1.1	0.63	0.94	1.4
P	0.15	0.22	0.26	0.35	0.29	0.92	0.25	0.3	0.45	0.32	0.4
K	0.14	0.21	0.38	0.83	0.66	1.35	0.46	0.2	0.18	0.17	0.9
Ca	1.2	1.92	1.30	1.35						1.98	3.6
Mg	0.08	0.12	0.07							0.44	0.4
S	0.2										
Na	0.2			0.86						0.27	
	ug/g										
Fe				2800						2407	13000
Zn	500	639	250	460						776	1600
Cu	200		125	150						370	340
Mn	300	120	130							418	400
Cd	100										10
As											
Cr											500
Pb										4.83	450
Hg										0.18	
Ni										24	300
B		40	25							321	50
pH			6.9		7.8	7.6	8.0		7.4		7.2
Cond.[4]											

1 Average of two samples (1968 and 1969)
2 Co-compost
3 Organic matter
4 Electrical conductivity (mmhos/cm)

Table 5. Chemical compositions of composts, sewage sludge, and unamended soil.

Constituent	Composts Low	Composts High	Unamended Soil (146) Mean	Sewage Sludge (133) Median
			----------%----------	
C	9.9	40.0		30.4
N	0.1	2.9	0.1	3.3
P	<0.1	1.2	0.06	2.3
K	<0.1	2.6		0.3
Ca	0.5	15.3	1.4	3.9
Mg	<0.1	5.9	0.5	0.4
S	0.2	0.6	<0.1	1.1
Na	0.1	0.8	<0.1	0.2
			----------ug/g----------	
Fe	1250	16500	38000	11000
Zn	76	10000 (4000)[1]	50	1740
Cu	12	4300 (2800)	20	850
Mn	120	1300	850	260
Cd	<0.1	100	<0.1	16
As	0.1	16	6	10
Cr	1.5	500	100	890
Pb	1.3	5300 (1570)	10	500
Hg	<0.1	17 (7)	<0.1	5
Ni	0.8	450 (300)	40	82
B	<0.1	321	10	33

1 The values in parenthesis are for the second highest concentrations in Tables 1 through 4.

Table 6. Pesticide levels in two composts from different sources (90).

Parameter	Aerobically digested	Windrowed
	mg/kg	
Lindane	nd[5]	0.08
Heptachlor	nd	0.04
PCB[1]	0.32	0.41
Methoxychlor	0.07	nd
DDD[2]	0.08	0.17
DDE[3]	nd	0.03
DDT[4]	0.15	nd
Dieldrin	0.04	0.08

1 Polychlorinated biphenyl
2 1,1-dichloro -2,2-bis (p-chlorophenyl) ethane
3 dichloro diphenyl dichloroethylene
4 dichloro diphenyl trichloroethane
5 not detected

Table 7. Approximate[1] average concentrations of four to six ring polyaromatic hydrocarbons in fresh and ripe composts (93).

Compound	Compost	
	Fresh	Ripe
	mg/kg	
benz(a) anthracene/chrysene	15.5	5.1
benzo(b/j/k) fluoranthenes	11.0	5.5
benzo(e) pyrene	5.7	2.9
benzo(a) pyrene	4.0	1.8
perylene	0.8	0.4
dibenz(aj) anthracene	1.2	0.7
indeno (1,2,3-cd) pyrene	3.4	1.9
dibenz (ab/ac) anthracenes	1.0	0.7
benzo(ghi) perylane	3.2	1.8

1 Values estimated from bar graph.

III. CROP YIELDS IN RESPONSE TO COMPOST APPLICATION

Corn

More acres are planted to corn in Minnesota than any other crop. For this reason, it would appear that the agricultural use of compost in corn production would have a great potential. This potential would depend primarily on the benefits a farmer could derive from the compost.

Different composts were applied to a Mountview silt loam soil in two greenhouse experiments in Alabama (139, 140, 141). In one experiment, where a compost obtained from Largo, Florida was applied at rates equivalent to 5 and 10 tons/acre, nitrogen deficiency was induced in the corn. This problem was corrected by the addition of N fertilizer. The decomposing compost was immobilizing 37 and 63 pounds of nitrogen per acre for the 5 and 10 ton/acre application rate, respectively (139). It was concluded that on severely N-deficient soils, N should be applied with the compost to avoid N deficiency in the crop.

In the second experiment (141), a co-compost from Johnson City, Tennessee was applied to greenhouse pots at rates equivalent to 0, 4, 8 and 16 tons per acre. Even though the compost had a higher N level, corn yields were low at all application rates, due primarily to N deficiency. It was determined that N availability from the compost was only 16% of that for N in ammonium nitrate.

Co-compost from Johnson City, Tennessee was also applied at various rates (11, 56, and 224 mt/ha) to Hartsells fine sandy loam in a greenhouse pot experiment (48, 100). Supplemental N, P, K and Mg were also added to each pot. Three successive crops of corn were planted 0, 7, and 18 months after application and were allowed to grow for 7 weeks each. Corn forage yields were increased slightly by the higher rates of compost addition in the first and third crops only.

Co-compost from Johnson City, Tennessee was applied annually at various rates for a five-year period to Holston loam soil (32). All field plots received yearly addition of fertilizer P and K. Corn was grown each year and harvested for grain. Average corn grain yields are presented in Table 8. All rates of compost additions resulted in increased corn grain yield over the unfertilized control. On the average, corn yields were greater when receiving 50 to 200 tons/acre of compost compared to the fertilized control which received 160 pounds/acre of fertilizer N and no compost. Application of compost at rates greater than 50 tons per acre had little, if any, effect in increasing yields. However, the higher compost application rates did have a greater residual effect on corn grain yields.

Table 8. Effect of compost on corn grain yield (32).

Annual compost application (1969-73) (t/ac)	Corn grain yields average (1969-73)	Residual yield effects 1974	1975
	(bu/ac)		
0	39	20	14
0*	70	--	--
8	54	52	23
50	96	61	35
100	94	83	51
200	89	94	73

* 160 pounds/acre fertilizer N applied.

Sweet corn was grown in a four-year field study again utilizing co-compost from Johnson City, Tennessee (47, 48). The compost was applied annually at rates of 0 to 224 mt/ha to Sango silt loam. All plots received annual additions of 150 kg N/ha and 100 kg K/ha. Phosphorus was applied to all plots the second year only at a rate of 50 kg/ha. Forage yields increased significantly with application of compost with the exception of the fourth year (Table 9). No reason was provided for this effect other than ample moisture was provided during the growing season which probably negated any benefit from the compost in terms of moisture relationships.

Table 9. Effect of compost on corn forage yield (48).

Annual compost application (mt/ha)	Corn forage yield First year	Second year	Third year	Fourth year
	mt/ha			
0	3.05	7.07	7.67	8.15
56	4.96	8.90	9.29	6.42
112	5.50	10.6	9.50	6.24
224	6.04	10.01	9.24	6.86

In a field experiment conducted in Taiwan, compost was applied at 0, 5, and 10 mt/ha to a reddish brown clay-textured latosol (162). In addition to the compost, all treatments received 100 kg N, 60 kg P_2O_5, and 40 kg K_2O per hectare. Corn grain yields were significantly increased by 21 to 33% over the fertilized control as a result of compost addition (Table 10).

Table 10. Effect of compost on corn grain yield in Taiwan (162).

Compost addition	Corn grain yield Spring crop	Corn grain yield Fall crop
(mt/ha)	(mt/ha)	
0	3.05	3.20
5	3.70	3.82
10	4.05	3.92

Sorghum

Pelletized compost from the Fairfield Engineering Company was investigated as a soil amendment and nutrient source for sorghum forage in a greenhouse pot experiment (71). The pelletized compost was mixed with Arredondo sand at rates equivalent to 8, 16, 32, and 64 mt/ha. These treatments were compared to unfertilized and fertilized controls. The fertilized control received the equivalent of 2 mt/ha of 16-4.4-8.3 fertilizer. The application of 8 mt/ha or more of compost increased sorghum yields over the unfertilized control. However, only the highest rate of compost addition (64 mt/ha) produced greater yields than the fertilized control.

Results from a two year study in which co-compost from Johnson City, Tennessee was applied to Sango silt loam are reported in several sources (48, 95, 139, 140, 152). Co-compost was applied to field plots at various rates during the fall and/or spring over a two year period. Nitrogen fertilizer was also applied at 0, 90 or 180 kg/ha. Results from this study are presented in Table 11.

Table 11. Yield of forage sorghum as influenced by co-compost and fertilizer N (95).

Compost addition			Annual N	Forage sorghum yields		
1st yr.	2nd yr.	Total	addition	1st yr.	2nd yr.	3rd yr.*
(mt/ha)			(kg/ha)	(mt/ha)		
--	--	0	0	12.1	6.3	9.4
14	9	23	0	13.0	7.5	11.4
23	18	41	0	13.9	9.1	12.5
46	36	82	0	13.9	10.4	13.0
92	72	164	0	15.5	11.7	13.6
183	144	327	0	16.8	14.0	15.1
28	18	46	0	14.2	8.2	12.5
28	18	46	90	17.8	12.3	12.4
28	18	46	180	20.0	12.8	12.2
--	--	0	90	15.5	10.1	10.7
--	--	0	180	18.4	11.5	10.6

* This crop was grown without additional compost or fertilizer in order to measure residual effects.

Sorghum forage yields increased at a curvilinear rate with increases in co-compost rates. Fertilizer N plus co-compost resulted in greater yields than co-compost alone or N alone. Significant residual effects were obtained in response to compost addition, whereas there was little residual effect from the N only treatments. During the first year of the study, 28 metric tons of co-compost or more produced as much sorghum as 90 kg/ha of N. In the second year, a total of 82 metric tons of co-compost was necessary to produce yields equivalent to 90 kg of N.

Sorghum was also grown in a study using compost as an amendment in reclamation of phosphate mining sand tailings (70). Compost was incorporated into the tailings annually for two years at rates of 35 and 70 mt/ha, with and without N-P-K fertilizer. Sorghum was planted in the spring of both years of the investigation. During the first year, sorghum grain yields in the compost only plots approached zero. Grain yields were greatly improved the second year which possibly indicated a residual effect. In both years, compost plus mineral fertilizer resulted in superior yields compared to fertilizer only treatments.

Wheat and Barley

A greenhouse experiment conducted in Austria utilizing co-compost from Siggerwiesen found that a volume mixture of 50% compost and 50% topsoil produced 57% greater yield of barley grain compared to topsoil alone (87). Barley planted in 100% compost doubled the grain yield of barley grown in topsoil alone.

In a field experiment conducted during the 1940s in Great Britain (46), researchers found that the addition of 5.8 to 11.6 tons per acre of fermented town refuse to a clay loam soil increased barley and wheat yields by an average of 610 pounds per acre.

Duggan (30) reported that the incorporation of 15 to 30 tons per acre of co-compost in east Tennessee had produced favorable responses in wheat, barley, oats and rye growth. The application of co-compost and inorganic fertilizer to heavy clay soils have resulted in significant increases in small grain yields when compared to treatments receiving only inorganic fertilizer.

Greenhouse research conducted in India in which compost was added to potting soil at rates equivalent to 10, 15, 20, 25, and 30 mt/ha and planted to wheat found a linear relationship between yield and compost application rate (138). The addition of each 5 mt/ha increment of compost resulted in a 28 to 44% increase in grain and dry matter yield.

In a field study also conducted in India, two compost materials from Bombay were applied to a black clay vertisol soil (97). One material was sieved (2mm) and the other granulated. Both composts were applied at 5 mt/ha. All treatments except the control received 100, 22, and 42 kg/ha of N, P, and K, respectively. Table 12 presents the results of this study. The application of N-P-K with the composts did not significantly increase the wheat yield over the NPK control.

Table 12. Effect of two compost types on the yield of wheat (97).

	Wheat yield	
Treatment	Grain	Straw
	------- kg/ha	------
Control	710	724
NPK control	3069	4267
Sieved compost	3420	5481
Granulated compost	3522	5047

Oats

Compost from Largo, Florida was applied to Leon fine sand at rates equivalent to 0, 2, 8, 32, 128, and 512 mt/ha in a greenhouse pot experiment (68). The soil, which had a pH of 4.4, was limed at a rate equivalent to 4,500 kg/ha. The oats planted in the highest rate of compost (512 mt/ha) germinated 3 to 5 days later than the other seeds. After 6 to 7 weeks of growth, N deficiency symptoms appeared in the control pots. After 12 weeks, N deficiency was apparent for the 2 and 8 mt/ha treatments, also. Total yields of oat foliage were increased significantly over the control by all treatments. Results from a similar study by the same researchers (69) did not show a significant yield increase from compost addition with the exception of the 512 mt/ha application rate. At this rate, the oat foliage yield was approximately twice that of the control after 5 weeks of growth.

The effects of fresh compost (composted 1 week) and ripe or rotted compost (composted 6 to 9 months) application have been compared in a potato-rye-oats rotation (36, 143). The compost materials were applied at the start of the three year rotation. After three 3-year rotations (total 9 years), the average oat yields were approximately 3100, 3600 and 3800 pounds per acre for the control, ripe compost, and fresh compost treatments, respectively (143). The fresh compost had a negative yield effect, however, on potatoes which were grown the year of compost addition. After the fresh compost had stabilized in the soil for one year, it resulted in higher yields compared to ripe compost for the crops grown in the second (rye) and third (oats) year of the rotation.

Compost from Gainesville, Florida was applied at 35 and 75 mt/ha per year for a two year period to reclaim phosphate-mining sand tailings (70). In addition to the compost, 2 tons/ha of a 10-4.4-8.3 fertilizer was applied each year. Oats were planted in the fall of each year following the harvest of sorghum from the same research plots. The yields of oat forage were significantly increased by the compost treatments, even though they were extremely low compared to normal agricultural yields (Table 13).

Table 13. Oat forage yield from compost amended phosphate-mining sand tailings (70).

Compost applied	Oat forage yields	
	First year	Second year
(mt/ha)	(kg/ha)	
0	998	2144
35	1295	3191
70	1292	3860

Field Beans

A three year field study investigated the response of field beans to co-compost application (47, 48). Co-compost from Johnson City, Tennessee was applied at rates of 56, 112, and 224 mt/ha annually for three years.

Field beans were planted after harvest of sweet corn in July and harvested in October. Prior to planting the beans 50 kg/ha of N was disked into the soil. Half of the treatment plots received no further co-compost additions other than the first one so that residual effects could be investigated. Tables 14 and 15 present the yield data obtained from this study. In general, the annual application of co-compost either increased or had no effect on vine yields. Pod yields were generally unaffected by co-compost addition. There did not appear to be any significant trend that could be attributed to residual co-compost effects. Even though this research did not find major yield benefits attributed to co-compost addition, one point must be considered. Large volumes of co-compost were applied throughout the course of this study, 224 to 896 mt/ha without apparent negative effects on the crop. Perhaps, the results would have shown a more beneficial effect if the research plots had not received annual applications of N fertilizer.

Table 14. Response of field beans to annual co-compost additions (48).

Annual compost addition* (mt/ha)	First year V	First year P	Second year V	Second year P	Third year V	Third year P	Fourth year V	Fourth year P
	Yields of vines (V) and pods (P) (kg/ha)							
0	990	1327	1677	1254	1011	645	1606	516
56	1463	1060	1425	1278	1214	774	1630	582
112	1625	1084	1583	1264	1419	749	1685	544
224	1425	1425	1538	1398	1472	577	1584	548

* All treatments received annual additions of 50 kg N/ha.

Table 15. Response of field beans to a single co-compost addition (48).

Initial compost addition* (mt/ha)	First year V	First year P	Second year V	Second year P	Third year V	Third year P	Fourth year V	Fourth year P
	Yields of vines (V) and pods (P) (kg/ha)							
0	990	1327	1592	1296	1119	757	1658	558
56	1463	1060	1629	1020	1244	785	1538	610
112	1625	1084	1602	1199	1195	571	1746	534
224	1425	1425	1481	1275	1260	855	1680	529

* All treatments received annual additions of 50 kg N/ha.

Forage and Turf Grasses

The effect of compost on the yields of corn, oat, and sorghum forages in both field and greenhouse studies has been discussed in preceding sections. This section will focus on the effects of compost on the yields and growth of bermuda grass, tall fescue, and turf grasses. Before these results are discussed there is one important point or precaution that must be considered when utilizing solid waste composts on forage or pasture land. One must be aware of the possible presence of foreign materials, such as glass and metals in compost. Grazing animals could potentially ingest these materials and be harmed if the particles are large enough. Compost used on pasture land should be finely ground or screened to remove objectionable materials.

Bermuda grass, a common forage species to the southern United States, was grown in a two-year field study evaluating co-compost from Johnson City, Tennessee (48, 95, 139, 140, 152). Co-compost was topdressed at rates of 0, 9, 18 and 27 mt/ha to established bermuda grass sod. At the beginning of the second year, co-compost was applied to the same plots at triple the rates of the first year. Nitrogen was also applied to the co-compost plots at 0 and 180 kg/ha. Table 16 shows the effects of co-compost and N on the yield of bermuda grass. All N fertilizer treatments significantly increased bermuda grass yields. Of the co-compost only treatments during the first year, only the high compost rate produced significantly more forage than the untreated control. During the second year, all compost rates out-yielded the control.

Table 16. Effect of co-compost and N fertilizer on bermuda grass yield (48, 140).

Compost Rate		Annual N	Forage Yield		
First year	Second Year	Rate	First year	Second year	Ave
--------(mt/ha)--------		(kg/ha)	------------(mt/ha)------------		
0	0	0	6.5	2.7	4.5
0	0	180	11.4	5.6	8.5
9	?7	0	7.4	4.0	5.6
9	27	180	11.2	6.5	8.7
18	54	0	7.6	6.3	5.8
18	54	180	12.5	7.2	9.9
27	81	0	7.8	4.7	6.3
27	81	180	11.9	13.4	9.2

The effects of co-compost, limestone, and NPK fertilizer on the yield of tall fescue were measured in a greenhouse pot experiment (141). Co-compost from Johnson City, Tennessee was mixed with a very acid, eroded Hayesville soil at rates equivalent to 0, 45, and 90 mt/ha, with and without NPK fertilizer, and with and without ground limestone. The tall fescue responded markedly to applications of NPK fertilizer plus lime or co-compost, compost alone, and lime with co-compost. Essentially no yield was obtained from fertilizer without lime or co-compost.

An unpublished field study in Canada evaluated the suitability of compost as a soil amendment used to grow turf grass subjected to wear stress (34). Compost from Downsview, Ontario was applied to a Fox sandy loam soil at rates equivalent to 5, 10, 20, 40, and 100 mt/ha. The plots were seeded with a mixture of Kentucky bluegrass, red fescue, and perennial ryegrass. The compost treatments were compared to plots receiving the equivalent of 20, 40, and 80 mt/ha of sphagnum moss peat. All plots received sufficient P and K. The researchers found that compost was easier to apply and work into the soil than was the moss peat. At 71 days after seeding, seedling growth was generally better on the compost treatment compared to the moss peat treatments. After one year, turf density tended to be less on the peat-treated plots but was not sufficiently different from the compost-treated plots. For equivalent application rates, there was no significant difference in the wear tolerance of turf between the two organic amendments. However, turf on the peat treatments did not recover from wear stress as well as the turf on the compost treatments. It was concluded that compost appeared to be more suitable as an organic soil amendment than moss peat for well-drained, low fertility soils.

Tomatoes

Minnesota is not a large producer of tomatoes. Generally, tomatoes are grown for local markets by truck farms and roadside vegetable stands. Tomatoes are also grown in greenhouses for commercial distribution. The following research results indicate that compost should be supplemented with mineral fertilizer to obtain optimum yields.

Various mixtures of Phoenix, Arizona compost and Mohave sandy clay loam, with and without additional fertilizer N, were used to study the effects on tomato plant growth (44). The compost:soil ratios used were 1:0, 1:1, 1:2, 1:4, and 0:1 on a volume basis. The mixtures were placed in greenhouse pots and planted to tomatoes. The compost treatments (without N fertilizer) outyielded the unfertilized control treatment by 2.6 to 3.1 fold. These treatments produced yields approximately equivalent to the fertilized control. The compost only and soil only treatments produced yields that were approximately equal. There was a definite interaction between N and compost additions. Highest yields were obtained when treatments consisted of both N fertilizer and compost. Results of this study are provided in Table 17.

Table 17. The effect of compost and N fertilizer on yield of the aerial portion of tomato plants (44).

Treatment*	Compost Rate**	Yield (g/pot)
Unfertilized control		0.91
Fertilized control		2.55
Compost	low	2.86
	medium	2.38
	high	2.45
Compost plus N	low	6.73
	medium	7.60
	high	6.54

* Equivalent rates of N (0.1%) were added to the fertilized and compost plus N treatments.

** Compost:soil ratio = low (1:4), med. (1:2), high (1:1).

In another study, the effect of compost, N and P fertilizers on tomato growth was investigated in the greenhouse (43). Compost was obtained from Sacramento, California. Soil types included Mohave sandy loam and Mohave clay loam. Compost applied alone, at rates equivalent to 2 and 10 tons/acre only slightly influenced dry matter yield on the clay loam soil and had no significant influence on the sandy loam soil. It was determined that compost did not contribute N and P to the crop during its initial stages of decomposition. These elements were apparently immobilized by the microorganisms contained in the soils which were of low native fertility. Whenever compost was fortified with either N or P, better tomato growth resulted. The highest dry matter yields were obtained from treatments receiving compost fortified with both N and P.

The effect of compost on greenhouse tomato yields was also studied in Hong Kong (18). Compost from Chai Wan was mixed with a sandy soil at rates equivalent to 25, 50, 75, 100, 125 and 150 mt/ha. An unfertilized and fertilized (300 kg N/ha, 180 kg P/ha, and 300 kg K/ha) control were used for comparison. All treatments significantly increased tomato yields compared to the unfertilized control. The highest total dry matter yield was obtained by the fertilizer treatment followed by the 125 mt/ha and 75 mt/ha compost treatments. Highest fruit yields were obtained by the fertilized control.

Leafy Vegetables

The literature shows various responses to the application of compost by leafy vegetables, such as cabbage and lettuce. In a field study conducted in England during the 1940's, compost and/or mineral N fertilizer were applied to research plots (9). The N fertilizer was applied at a rate of 32 pounds N per acre. The compost application rate was not provided. The results of this study are presented in Table 18.

Table 18. Effect of compost and fertilizer N on cabbage yields (9).

Treatment	Fresh weight yield (tons/acre)
Control	14.1
N only	16.9
Compost only	19.2
Compost plus N	20.6

The addition of compost significantly increased cabbage yields over the control and N fertilizer only treatments. The application of both compost and N fertilizer further increased cabbage yields.

In another field study conducted in Scotland, compost application rates equivalent to 25, 50, and 100 mt/ha did not significantly increase cabbage yields in either season of the two-year study period (115). Yields of lettuce, which was grown during the second year only, did not respond to compost addition either.

In Japan, the continuous cropping of cabbage results in progressively poorer yields. The yield reductions are attributed to damage caused by bacterial soft rot and sclerotinia rot. The use of compost in cabbage production on a Kuroboku soil was investigated by Nishimune et al. (104). Continuous cropping of cabbages resulted in a 50% yield reduction over a five year period as compared with yields in new fields. Repeated applications of compost alleviated the depression of cabbage growth by continuous cropping and increased marketable yields. The effects, however, were not enough to exceed the yields in new or rotation fields.

In Germany, spinach, lettuce, and cabbage were grown on two different soil types which received high rates of compost in a greenhouse pot experiment (63). The compost was applied at rates equivalent to 0, 100, 150, 300, 600, and 900 mt/ha. In general, the compost applied to the alkaline soil had little effect on vegetable yields. However, compost applied to the acid soil increased yields significantly at the higher application rates.

In a greenhouse study conducted in Hong Kong, two varieties of cabbage were grown in compost/soil mixtures equivalent to compost additions of 8.4, 25.1, 126, and 168 mt/ha (167). The equivalent of 2 mt/ha of a 15-21-18 fertilizer was added to the sandy soil to represent a fertilizer control. The fertilizer control out-yielded all compost treatments. All compost treatments, with the exception of the highest rate, produced significantly greater yields compared to the unfertilized control. The cabbage yields of the 126 mt/ha compost treatment was approximately 60% of the yield obtained by the fertilized control. In a second greenhouse study, the same varieties of cabbage were grown using the same soil type and compost material (18). This time, however, the compost application rates were equivalent to 25, 50, 75, 100, 125, and 150 mt/ha. As with the previous experiment (167), the fertilized control produced significantly greater yields than the compost treatments. Of the compost treated soils, yields of the 50, 75, 100, and 125 mt/ha treatments were non-significantly higher than that of the unfertilized control. The highest compost application (150 mt/ha) resulted in a significantly lower yield than the unfertilized control.

The responses of lettuce and celery to a refuse compost produced in Belgium were opposite (157). Increasing quantities of compost resulted in a decrease in the yield of lettuce whereas it produced a yield increase in celery. The highest compost application rate reduced lettuce yields by 60% and increased celery yields by 40%.

Vlamis and Williams (158) grew lettuce in greenhouse pots to which various mixtures of Red Bluff clay loam and compost had been added. The compost application rates were equivalent to 20, 40, and 60 tons/acre. The 20 and 40 ton/acre application rates more than doubled and tripled lettuce yields, respectively. The 60 ton/acre rate produced a yield equivalent to the 20 ton/acre rate fortified with 200 lbs/ac of N.

Root Crops

Most of the literature reviewed indicates that root and tuber crops respond positively to compost addition. This effect is likely due not only to the nutrients provided by the compost material but also to improving soil physical characteristics.

Carrots grown in a sandy soil amended with compost produced as much or more total yield (roots plus tops) than with fertilizer alone (18). The compost was obtained from the Chai Wan refuse composting plant in Hong Kong and was mixed with soil at rates equivalent to 25, 30, 75, 100, 125 and 150 mt/ha. The mixtures were placed in a greenhouse and carrots were harvested after 150 days of growth. The compost treatments were compared to unfertilized and fertilized (300 kg N/ha, 180 kg P/ha, and 300 kg K/ha) treatments. The edible root yield of plants grown in the 75, 100, and 125 mt/ha compost treatments were equivalent to yields obtained by the fertilizer treatment. The 25 and 150 mt/ha compost treatments produced less root yield compared to the fertilizer treatment. The highest root yield was obtained by the 50 mt/ha compost treatment which produced a yield approximately 50% greater than the fertilizer treatment.

Turnips were grown in field plots in Austria (87). Treatments included topsoil only, co-compost only, and topsoil plus co-compost mixed at a 50:50 ratio. The co-compost was obtained from the composting facility in Siggerwiesen. Bulb weight yields of the co-compost only and topsoil only treatments were equivalent. However, when the co-compost was mixed into an equal volume of topsoil, turnip yields were 62% greater than either topsoil or co-compost alone.

Researchers in Germany collected soils from vineyards which were formerly amended with increasing rates of compost, up to 900 mt/ha (63). Carrot, radish, and onion yields of the compost treated soils were equivalent to or significantly greater than those yields obtained from untreated soils.

Hortenstine and Rothwell (68) mixed various rates of compost from Largo, Florida with Leon fine sand. The mixtures were placed in greenhouse pots and seeded to oats. After two cuttings of oat foliage, the oat roots were removed and radish seeds planted. The mixtures represented compost application rates of 2, 8, 32, 128, and 512 mt/ha. Yields of fresh radish roots and tops were significantly increased by the highest rate of compost addition only. It was thought that most of N was removed by the oat crop in the other treatments.

A second greenhouse study was conducted by Hortenstine and Rothwell (69) utilizing the same soil type and compost as those discussed in the preceding paragraph. The compost application rates were also the same as those used in the earlier study (68). Oats, turnips and radishes were grown consecutively. Oat foliage was cut at 5 weeks, turnip and radish at 6 weeks. Turnip foliage yield increased significantly in the three highest compost treatments. Nitrogen deficiency symptoms appeared in the two lower compost and control treatments. Radish foliage yields were greater in the 128 and 512 mt/ha compost treatments only. Nitrogen deficiency symptoms were apparent in the other compost treatments. It was concluded that for this particular compost, that additional N should be applied if compost application rates were less than 32 mt/ha. This addition would be necessary to overcome initial immobilization of N by soil microorganisms.

Field research in Scotland located at a site having a sand and gravel soil (Darvel series) determined the effect of compost on potato yields (115). Field plots were treated with compost from Edinburgh at rates of 0, 50, and 100 mt/ha. In addition, all plots received inorganic fertilizer. Potato tuber yields from both compost treatments were significantly greater than that of the control.

Miscellaneous Crops

Several examples of compost research exist which do not fit within the crop categories previously reviewed. The following paragraphs will present the effects of compost on yields of peas, tobacco, cotton, rice, and grapes.

Compost from Edinburgh, Scotland was applied to a sandy soil at rates of 0, 50, and 100 mt/ha in a field experiment (115). The compost treatments resulted in significant increases in yields of peas and pods over that of the no compost treatment. It was thought that the responses were due to improved soil physical conditions.

In Tennessee, more than 100 farm demonstration plots were established over a three-year period to determine the value of co-compost as an organic amendment for growing burley tobacco (30). Results indicated that positive yield responses were obtained at rates of 15 to 40 tons/acre. The most significant increases in tobacco yields resulted from co-compost applications on heavy clay soils. Limited responses were obtained with rates less than 15 tons per acre.

Cotton was grown in greenhouse pots containing various mixtures of compost (Sacramento, CA), nitrogen fertilizer, and/or phosphorus fertilizer (43). Compost treatments were equivalent to 2 and 10 tons/acre. Cotton was planted after the potting mixtures had first been used to grow tomato plants. Thus the results obtained by growing cotton represented a residual effect of the various treatments. The addition of compost, with or without fertilizer, was found to increase the dry matter yield of cotton plants over the soil alone. Highest yields were generally obtained by the nitrogen plus compost treatments. Two tons of compost appeared to give the same response as 40 pounds or more of N.

Iron chlorosis of rice is a problem of some highly calcareous soils of India. The response of rice to various iron carriers, with and without compost, was studied in India by Sakal, et al. (120). A field experiment was conducted on a calcareous sandy loam soil (pH 8.9) to which various rates of $FeSO_4$, pyrite and compost were applied. All plots received a basal dose of 110 kg N/ha, 25 kg P/ha, 33 kg K/ha, and 5 kg Zn/ha. Selected results are provided in Table 19.

The response to $FeSO_4$ or pyrite was enhanced when applied in conjunction with compost. It was thought that the production of chelating agents from the compost may have helped in keeping Fe soluble, and consequently more available to the rice. It was concluded that the efficiency of applied Fe may be improved by mixing Fe carriers with compost before adding to soil.

Table 19. Effect of compost and iron carriers on yield of rice (120).

Treatment	Yields: Grain	Yields: Straw
	(q/ha)	(q/ha)
Control	34.0	59.3
10 q pyrite/ha	36.7	65.3
10 mt compost/ha	40.0	69.0
50 kg $FeSO_4$/ha	42.7	72.7
10 q pyrite + 10 mt compost/ha	44.7	74.0
50 kg $FeSO_4$ + 10 mt compost/ha	48.0	78.3

The response of rice to compost from Bangkok, Thailand was studied in the field at eight locations throughout Thailand over a period of four years (78). In general, the application of 1.8, 3.1, and 6.2 mt/ha of compost increased rice yields proportional to the amount used. Average yield increases over the four year period were approximately 11, 21, and 30 percent, respectively, for the 1.8, 3.1, and 6.2 mt/ha compost treatments. Yields were further increased by supplementing the compost with N and P fertilizer. The combination of compost plus fertilizer produced better rice yields than the compost or fertilizer treatments did alone.

IV. CHANGES IN SOIL PHYSICAL PROPERTIES IN RESPONSE TO COMPOST APPLICATION

Bulk Density

Bulk density (BD) is the weight of oven-dry soil per unit soil volume. BD is an index of a soil's general physical condition in that it is related to a soil's porosity, hydraulic conductivity, aggregation and composition.

Table 20 summarizes the findings of several studies which investigated the effect of compost addition on changes in BD. In general, compost addition decreased soil BD. Soil BD values decreased as the rate of compost application increased. The reduction in soil BD may last for as long as 36 months at relatively high compost application rates (32, 48).

Soil BD values were reduced regardless of soil texture for the medium and fine textured soils summarized in Table 20. Research determining the influence of compost addition on the BD of coarse-textured soils could not be found. The reduction of soil BD appeared to be influenced primarily by the rate of compost addition. The reduction in soil BD was probably due not only to the dilutional effect of adding less dense organic matter to the more dense mineral matter but also to increased soil aggregation.

Table 20. The influence of compost addition on soil bulk density.

Reference	Soil type	Application period (yrs.)	Cumulative application rate (mt/ha)	Bulk density (g/cm^3)	Measurement taken (mo)
48, 152	Sango sil	2	0	1.37	6
			46	1.32	
			163	1.22	
			326	1.12	
48	Sango sil	2	0	1.50	36
			46	1.45	
			163	1.44	
			326	1.43	
32	Holston l	4	0	1.56	1
			200	1.44	
			200	1.28	
			800	0.85	
32	Holston	4	0	1.71	36
			200	1.41	
			400	1.29	
			800	1.12	
162	Clay latosol	1	0	1.16	1
			20	1.12	
			40	1.15	
164	Guelph l	2	0	1.38	33*
			376	1.25	
80	Cecil c	1	0	1.66	1
			9	1.64	
			18	1.62	

* Uncomposted municipal solid waste

Water-Stable Aggregation

Aggregation, or the binding together of individual soil particles, gives rise to what is known as soil structure. Typically, a well-structured soil has greater resistance to the forces of erosion and has improved air-water relationships. In general, hydraulic conductivity, infiltration rate, air diffusivity, surface drainage, and ease of root penetration will increase with increasing aggregation.

Improving or increasing aggregation is more desirable on finer textured soils such as silt loams, clay loams, and clays. A fine textured soil will behave much like a coarse one, if its clay and silt particles are bound together into granular aggregates. Modern-day farming techniques such as conventional tillage, row cropping, and complete vegetation removal can decrease the percentage of aggregates in surface soils and can completely destroy surface soil structure. The need to increase soil aggregation in many situations is apparent. The aggregates formed however, must be resistant to destruction by the forces of water (e.g., rain drop impact, erosion) and tillage operation.

Table 21 summarizes the findings of two studies in which the percentage of water-stable aggregates were determined in soils amended with compost. These limited results suggest that the addition of compost has little or no effect on the number of stable aggregates. This finding was to be expected since the unamended soils already had high levels of water-stable aggregates. Research is needed to study the influence of compost addition on structureless, fine textured soils (puddled) with low levels of water-stable aggregates.

Table 21. The influence of compost addition on the percentage of stable soil aggregates.

Reference	Soil Type	Application Period	Cumulative Application Rate	Stable Aggregates	Measurement Taken
		(yrs.)	(mt/ha)	(%)	(mo)
164	Guelph l	2	0	51.0	33
			376	54.0	
162	Clay latosol	1	0	56.8	1
			20	59.4	
			40	59.1	

Pore Size Distribution

Another important soil physical characteristic is that of pore size distribution. According to Greenland (54), pores smaller than 50 m are considered storage pores. Storage pores are important water and nutrient reservoirs for plants and microorganisms. The addition of compost to a clay soil appears to decrease the percentage of storage pores (123) (Table 22).

Table 22. The influence of compost addition on pore size distribution.

Reference	Soil Type	Application Period (yrs.)	Cumulative Application Rate (mt/ha)	Pore Size Classes (%)			Measurement Taken (mo)	Remarks
				a	b	c		
123	Marine clay	1	0	5	52	43	after 6 wetting/ drying cycles	a = 30-50 μm
			88	2	70	28		b = 50-500 μm
			176	2	68	30		c = 500-1000 μm
105	Loam	1	0	2.8	57.9	39.3	8	a = <75 μm
			60	1.8	60.2	38.0		b = 75-525 μm
								c = >525 μm
								ryegrass crop

Pores larger than 50 μm are generally drained at field capacity. Pore diameters ranging from 50 to 500 μm are considered transmission pores by Greenland (54). These pores are important for the movement of water and the exchange of gases. Transmission pores are also important for root penetration. According to the results summarized in Table 22, the percentage of transmission pores are increased by compost application.

Lastly, pores greater than 500 μm in diameter are termed fissures. A high percentage of fissures is usually considered an index of poor soil structure (107). Table 22 shows the addition of compost decreases the percentage of fissure sized pores.

Moisture Retention

The addition of compost increases soil moisture retention at both field capacity (0.1 or 0.33 bar) and wilting point (15 bars). This effect is summarized in Table 23. The increase in water-holding capacity (weight basis) at various matric potentials of compost-treated soils is probably due to the increase in total porosity and the water absorption capacity of organic matter.

The greatest percentage increases in moisture retention at both field capacity (FC) and wilting point (WP), were generally for treatments on coarser textured soils or when using higher application rates (Table 23). For instance, a total application of 376 mt/ha of compost to Guelph loam over a two year period caused an increase in percent of water held at both FC and WP of only 7 and 3%, respectively (164), whereas a lesser application rate (256 mt/ha) on Arrendondo sand increased percent water at these parameters by 43 and 40% (7).

The changes in plant available water holding capacity (AWC), or the difference between moisture retained at FC and WP (weight basis) were variable (Table 23). Two studies, one on a fine sand (69) and the other on a loam (164), found very little increase in AWC even at application rates as high as 512 mt/ha. In another study where compost was used to reclaim sand size tailings from phosphate-mining, available water holding capacity almost doubled from the addition of 70 mt/ha of compost, and almost quadrupled when 140 mt/ha was applied (70).

Runoff and Soil Loss

The application of compost has been found to reduce runoff and resultant soil loss. Unpublished data from Eggens and Wright (33) show research plots in a land reclamation project without any type of soil protection had 23% erosion. However, when 400 m^3/ha of compost were applied to plots having the same slope (22%), no erosion was apparent.

In Germany, a large percentage of the compost produced is used on the hillside vineyards of the country. Table 24 summarizes the research results of Banse (6) from studies investigating the effect of compost on soil loss and runoff from 50% (30 degree) slopes of a vineyard at Bad Kreuznach, Germany.

Table 23. The influence of compost addition on soil moisture retention.

Reference	Soil type	Applic. period (yr.)	Cumulative Application rate (mt/ha)	Water Retention FC (% by weight)	WP	AWC	Measurements taken (mo)	Remarks
48, 95, 140	Sango sil	2	0	11.1			6	
			164	13.0				
			327	15.3				
7	Arrendondo s	2	0	4.77	3.38	1.39	1.5	greenhouse FC at 0.1 atm
			32	5.03	3.60	1.43		
			64	5.62	4.15	1.47		
			128	6.01	4.26	1.75		
			256	6.82	4.73	2.09		
70	Sand tailings	2	0	2.18	1.86	0.32	6	
			70	2.95	2.33	0.62		
			140	3.71	2.54	1.17		
69	Leon fs	1	0	6.42	3.84	2.58	5	greenhouse FC at 0.1 atm
			2	6.45	4.00	2.45		
			8	6.65	3.96	2.69		
			32	7.34	4.36	2.98		
			128	8.15	5.52	2.63		
			512	10.79	8.10	2.69		
162	Clay latosol	1	0	32.1			1	2 compost applications
			20	32.6				
			40	33.1				
164	Guelph l	2	0	21.7	10.9	10.8	33	uncomposted
			376	23.2	11.2	12.0		

1 FC = (field capacity) water retained at 0.33 bars unless otherwise noted.
WP = (wilting point) water retained at 15 bars.
AWC = (available waterholding capacity) moisture retained between FC and AWC.

Table 24. The effect of compost application on runoff and soil loss[1] (6).

Compost Application (tons/acre)	Runoff (gal/ac)	Soil Loss (cu ft/ac)
0	5500	150
79	3100	110
159	400	5

1 Values were approximated from a figure.

The results obtained show a dramatic decrease in both soil and runoff loss with increasing compost application. According to Tietjen and Hart (142), compost addition reduces erosion in three ways. First, soil structural strength (i.e., aggregate stability) is increased thus increasing resistence to erosional forces. Secondly, the compost mulch near the soil surface absorbs the energy of rain drop impact. And thirdly, soil waterholding capacity is increased, thus providing less water for runoff.

V. SUMMARY AND CONCLUSIONS

The results of research referenced in this review indicate that compost produced from municipal solid wastes could be useful in modern day agriculture. Chemically, the material is a low grade fertilizer with a typical analysis being in the range of 1-0.7-0.6 ($N-P_2O_5-K_2O$) percent. Because of this, large application rates would be necessary for crops to obtain sufficient nutrition. Also, due to relatively high carbon levels, nutrient availability from compost may be low. Based on nutrients alone, it would not be cost-effective for a farmer to apply compost. Farmers can buy and apply chemical fertilizers cheaper than they can apply compost, even if the compost could be obtained without cost (11).

Composts may contain substances that are harmful to crops and the consumer of the crops. Such constituents, trace metals, toxic organic compounds, and pesticides, are at very low levels and probably do not present any significant hazard to the user, however. The levels of these constituents are dependent upon the materials used to make the compost. Much research has been conducted investigating the uptake of trace metals by crops from land applied compost (18, 32, 47, 48, 63, 100, 115, 169). Also, recent findings have shown that certain toxic organic compounds degrade during the compost process (93, 102, and 124).

Compost may also contain pathogens depending upon the ingredients used to make the compost and the degree of compost treatment. Research would indicate that the potential for disease transmission from agricultural use of adequately treated composts is low (50, 51, 99, 153, 154, and 155).

Even though compost has relatively low fertility levels and may contain low levels of phytotoxic constituents, research results generally show an improvement in crop yields when compost was added to soil. In addition, the efficiency of mineral N fertilizers appeared to increase when applied with compost. This effect may be due to initial N immobilization induced by the compost application with subsequent N release later in the cropping season when crop N requirements are greatest.

The major attribute of compost is its organic matter content. Organic matter is particularly beneficial as a soil conditioner. The addition of organic matter, especially to marginal soils can markedly improve its physical condition. Physical properties, such as pore size distribution, porosity, bulk density, moisture retention, aggregation, and erosion capacity are improved by compost application.

Application to crop land is not the only agricultural use of municipal solid waste compost. Research has shown compost to be superior to wood shavings when used as broiler litter (90). Compost has also been used as a feed supplement for young suckling pigs (45).

There is some indication that compost may be useful in the protection of crops from certain plant diseases. Lumsden et al. (85) found a significant decrease in plant diseases by plants grown in soil amended with sludge compost. The diseases included lettuce leaf-drop, root-rot and damping-off of beans, cotton, radish and peas. A few diseases, however, were increased by the application of sludge compost. In another study, populations of certain plant parasitic nematodes were lowest in compost treated plots, whereas, another species of a parasitic nematode was not greatly reduced (75). Bacterial soft rot and sclerotinia rot of cabbage is suppressed by the application of compost (104). Composted hardwood bark has also been shown to suppress soil borne plant pathogens and have fungicidal properties (24, 64, 66, and 92).

Another interesting concept similar to the agricultural use of compost is the land application of shredded garbage - sometimes referred to as garbage farming (60). Research by Volk and Ullery (160) on a sandy soil in Oregon found decreases in bulk density and an increase in moisture retention. Also, soil losses resulting from wind erosion was reduced by 88% from the application of 200 tons/acre of the shredded garbage. After stand establishment, fescue and alfalfa yields were not markedly changed by application of up to 400 tons/acre of the waste (161).

Corn grain yields from plots receiving 188 mt/ha of unsorted, shredded municipal refuse were greater than the control and those receiving sewage sludge or sludge plus the refuse (81). Yields of rye forage were unaffected by treatment. Approximately 16 months after refuse application it was visually estimated that 80% of the paper in the refuse had decomposed to an extent that it was no longer discernible as paper. Webber (164) reported on changes in soil physical properties of this study. Refuse application increased water-stable aggregation and decreased bulk density. Moisture retention (volume basis) was not affected by refuse application.

Solid waste which had been composted only one week was compared to well-composted (6-9 months) garbage (144). In this study a total of 480 mt/ha of the two materials were applied to plots over a period of five-years. Potatoes, rye, and oats were grown. Various combinations of N and P were also applied. On the average, the total yields of the crops receiving the one week old compost did as well as those receiving the thoroughly composted material.

The foregoing results, as well as similar studies (159) should support the investigation of the land application of shredded refuse as an option when the production and distribution of composted municipal solid waste appears to be not cost-effective due to high production costs or low market potential.

Research results supporting improvement of crop yields by the application of composted or uncomposted solid waste were variable. Results were dependent upon compost characteristics, application rate, soil type, supplemental fertilization, and crop grown. Even though many studies did not find significant yield increases, one important finding should be remembered. Even at extremely high applications rates (approaching 1800 mt/ha), rarely did compost or refuse application cause a decrease in yields. This finding in itself should support the investigation of the agricultural sector as a potential consumer of vast quantities of compost or shredded refuse.

The use of compost-derived soil amendments in agricultural and horticultural applications has considerable potential to reduce waste disposal costs and provide positive environmental benefits. Incorporating composting options into the total waste management scheme can reduce the dependence on landfilling and waste incineration while increasing the degree of recycling and resource recovery. Composts can be used to lower total agricultural production costs by increasing fertilizer efficiency and reducing the total amount of commercial fertilizer needed for the same yield.

The organic matter in composts can reduce erosion dramatically and provide long-term improvements in soil physical characteristics. There is a continuing need for research on the applications of solid waste composts, co-composts and shredded refuse to agricultural land and reclamation projects. The initial research results offer many exciting prospects for future implementations of this technology.

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ATTACHMENT B

CHARACTERISTICS OF SOLID WASTE COMPOSTS AND CO-COMPOSTS AFFECTING THEIR USE AS SOIL AMENDMENTS

--- A LITERATURE REVIEW ---

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I. INTRODUCTION

Disposal of municipal solid waste is a problem of increasing importance in Minnesota. Environmental considerations and social pressures have made the siting and operation of new landfills extremely difficult. There is also a growing attitude that, whenever possible, municipal wastes should be managed as potential resources through recycling and other practices that result in reuse of materials. These factors have forced the State and individual communities to reevaluate their waste management practices and to consider alternatives to landfilling.

The production of compost products from the biodegradable portion of solid waste has gained much attention as a landfill abatement alternative. Briefly defined, composting is the biological decomposition of organic materials. Co-composting is a term applied to the composting of solid waste along with another material such as sewage sludge or animal manure. Ideally, the end product of composting is a dark colored, granular material with an appearance and odor similar to a rich topsoil. Proponents of composting argue that it is more economical and environmentally sound as compared to other solid waste management options. They also point to the fact that a usable product is created.

Although many municipalities now practice sewage sludge composting, solid waste composting and co-composting experiences in the United States are very limited. However, several communities in Minnesota and other states are currently considering or planning for solid waste composting operations.

The success or failure of a compost operation may depend largely on the ability to develop and maintain markets for the end product. Thus, if composting is to proceed in a reasonable fashion, it is essential that a good understanding of the products and their appropriate uses be developed. It is very important that composts and co-composts not be offensive in appearance and odor and that the materials are managed in such a way that will optimize beneficial effects on plant growth while minimizing negative effects on the environment.

The objective of this review is to provide information on characteristics of solid waste composts and co-composts that affect their use as soil amendments.

As with actual composting experience, research is somewhat limited. Results have not always been consistent. This is probably due largely to differences in starting materials, type and duration of the composting process, and other factors that affect the quality of the end products. Nonetheless, the majority of results suggest that many opportunities exist for compost use in agriculture, horticulture, soil reclamation, and public works projects.

II. COMPOST MATURITY

A major concern with the use of compost is product maturity. The addition of large amounts of organic matter, particularly fresh or only partially decomposed material, can result in negative effects on plant growth.

One of the more obvious problems is the relatively high carbon: nitrogen ratio of immature or inadequately composted materials. The addition of large amounts of highly carbonaceous materials can immobilize nitrogen and cause stunting and chlorosis (yellowing) of plants. This phenomenon has been observed in several studies involving the use of solid waste composts. Duggan (20), for example, noted that large applications of immature composts with carbon:nitrogen ratios greater than 30:1 caused observable nitrogen deficiency in young tobacco plants. He suggested that nitrogen immobilization may be corrected by adding supplemental inorganic fertilizers, reducing the rate of compost application, applying the compost early to permit adequate decomposition in the soil or by lengthening the composting period. A more thorough discussion of the carbon:nitrogen relationship is included in the section covering nitrogen.

In addition to immobilizing or tying up nitrogen, large amounts of fresh or partially decomposed organic matter can have negative effects on plant growth that are caused by compounds that are produced as the organic matter continues to decompose. Quite often these substances are only intermediate compounds; they do not persist but are further broken down into other compounds as decomposition proceeds. This phenomenon is not limited to the use of composted waste products. It is well known that the incorporation of certain crop residues into soil can cause growth problems and yield reductions in subsequent crops (37). Sweetclover residues, for example, contain water soluble substances that have been shown to depress corn germination and seedling growth (61). Lynch (58) observed a reduction in the growth of roots of young barley plants cultured in different soil slurries mixed with straw. He attributed the reduction to an accumulation of acetic acid produced by decomposition of the straw. Tousson et al. (97) identfied benzoic acid and phenyacetic acid as phytotoxins present in the decomposition products of barley sampled in the field.

Acetic acid has been identified as a phytotoxin also present in immature composts (19). Large amounts of the acid (12,000 - 26,000 parts per million) were found in both aerated and non aerated refuse compost during the first month of composting. The acetic acid was still at a toxic level of 500 parts per million after two months. After four months no acetic acid could be detected.

Golueke (34) points out that the decomposition of organic matter in soil may also lead to the production of ammonia which can be very damaging to plants especially when present near young plant roots.

Wong and Chu (109) noted severe suppression of germination when seeds were treated with extracts of fresh compost. Of the three crops treated (Chinese white cabbage, carrot and tomato) the inhibitory effect was most obvious with tomato. Less adverse effects were found with six - week old compost. With twelve - month old compost germination of white cabbage did not differ significantly from the control and germination of carrot and tomato showed significant differences only in extracts of high concentration (16% and 20%). Root elongation was retarded by all extracts with the extent of growth reduction most severe with fresh compost extracts and high concentrations. The workers speculated that many different factors could have influenced germination and root elongation including pH, salt content, ammonia content, ethylene oxide concentration, and heavy metals. They pointed out that the toxicity of composts extracts may be different from that of a compost - soil mixture in a field situation and that the effects of compost will be influenced by soil type, environmental conditions, method of application and many other factors.

Aliphatic hydrocarbons, fatty acids and phthalate esters have been found in composted municipal refuse by Gonzalez-Vila et al. (35). They claim that that the presence of phthalate esters is not surprising considering their resistance to microbial degardation. Wong and Chu (109) suggested that these compounds might play a role in the phytotoxic effects noted with some immature composts. However, Gonzalez-Vila points out that the levels of these compounds in composts are very low and claims that a normal application rate of approximately fifteen dry tons per acre would add only small amounts to the 0 - 8 inch surface layer of the soil and resulting concentrations would not be considered toxic.

Zucconi et al. (112) have studied the effects of composts for several years and have concluded that phytotoxicity during composting appears to be strictly associated with the initial stage of decomposition; that it is a transient condition possibly connected to the presence of readily metabolized material. They also noted that the phytotoxic effects of immature compost were particularly evident when unstabilized organic matter was placed in direct contact with an existing root system. They found little or no evidence of inhibition when analyzing well cured composts.

Zucconi and Bertoldi (112) experimented with different materials and found that toxicity problems were not limited to compost products. They also concluded that toxicity due to organic matter is not necessarily of the same origin for all materials. For example, specific rates of peat and manure were determined to be toxic to plant growth. But when the two were combined, each at one half the original level, the resulting toxicity was less than initially observed for either material applied separately suggesting that there was not an additive effect from the two. Similar results were obtained in experiments using manure and compost.

Their work has shown that generally all crops, with a few notable exceptions, are inhibited by immature composts. Various experiments were conducted using three categories of maturity: fresh, immature, and mature. Immature compost produced the most toxic responses with the effects of mature compost being noticeably less than those of the other materials.

Many methods have been proposed for estimating the degree of maturity of composts so that there can be some assurance that a given compost will not cause adverse effects on plant growth. A commonly proposed parameter for assessing maturity is the carbon:nitrogen (C:N) ratio of the finished product. As decomposition proceeds the amount of carbon is reduced through the evolution of carbon dioxide and as a result, the amount of carbon relative to the amount of nitrogen decreases.

Furrer and Gupta (30) give a carbon:nitrogen ratio less than 20:1 as one of the criteria for defining a well matured, quality compost. Other ratios, ranging from 15:1 to 30:1, have been suggested as limits for establishing maturity. While there is not a solid consensus on the exact value to use, there does appear to be a general agreement that a low carbon:nitrogen ratio is desirable and its measurement can provide some, although not always a complete, indication of compost maturity.

In 1979 Inoko et al. (50) characterized composts from various Japanese cities. They included samples at different degrees of maturity. In observing some of the organic constituents they noted several distinct trends accompanying the progress of maturity. Total carbon, hemicellulose, cellulose carbon:nitrogen ratio, and the rate of carbon in reducing sugars to total carbon all decreased with increased compost maturity while contents of total nitrogen, ash and lignin increased. In addition to having a high carbon:nitrogen ratio, the authors commented on the "dreadful reek" of immature products. They emphasized the need for sufficiently long composting and curing periods and also stressed the importance of maintaining aerobic conditions in producing a material that would not be offensive to handle.

They concluded that the ratio of carbon in reducing sugar to total carbon, the content of hot water soluble organic matter, and the carbon:nitrogen ratio are all useful parameters for estimating the maturity of refuse composts. Based on the results of their own work and other published data they suggested the following guidelines for assessing the maturity of refuse composts:

1. A carbon:nitrogen ratio below 20:1
2. A total nitrogen content greater than 2.0% on a dry weight basis
3. Rate of carbon in reducing sugars to total carbon less than 35%

Harada and Inoko (38,39) later speculated that the carbon: nitrogen ratio may not provide an accurate assessment of maturity, particularly if materials such as sewage sludge or manure are added to enhance the composting process. The addition of such nitrogen rich materials can result in a significantly lower carbon:nitrogen ratio from the very beginning of the composting process. The lower ratio reflects the higher nitrogen content rather than a reduction in carbon content as a result of decomposition. They found the carbon:nitrogen ratio and cation exchange capacity closely related with the carbon:nitrogen ratio decreasing and the cation exchange capacity increasing as compost matured. They developed a method for measuring cation exchange capacity on compost products and concluded that a refuse compost with a cation exchange of higher than 60 milliequivalents per 100 grams (on ash free material basis) could be considered suitably mature. They caution that while the test appears to be useful for refuse containing composts, it may not necessarily be applicable to other compost types.

Hirai et al. (40) also contend that the carbon:nitrogen ratio cannot be used as an absolute indicator of compost maturity because the range for well composted materials is very wide; from 5:1 to 20:1 depending on the type of raw materials used. They analyzed carbon and nitrogen concentrations of water extracts from composts produced from a variety of organic raw materials. They found that for the well matured composts the ratios of organic carbon to organic nitrogen (organic-C/organic-N) were almost always 5 to 6 regardless of type of raw materials and concluded that the organic ratio is a better indicator of compost maturity than the ratio of total carbon to total nitrogen.

Their conclusion is supported by experiments in which the effects of compost maturity on the growth of komatsuna using garbage and sewage sludge composts of different maturity were studied (41). Immature gargage compost had an inhibitory effect on plant growth at rates as low as 10 metric tons per hectare. The effect was attributed to the presense of low fatty acids, especially propionic and n-butyric acids that exist in immature composts. At high loading rates, high soluble salt content also caused inhibitory effects.

The relative yield of komatsuna correlated well with the ratio of organic carbon to organic nitrogen of water extracts from the composts.

Sugahara et al. (89) found a positive correlation between the degree of lightness of compost extracts and the carbon:nitrogen ratio. They termed the degree of lightness the stimulus value Y and showed that it decreased along with the carbon:nitrogen ratio as maturation proceeded. It was concluded that stimulus value Y can also be used as a criterion for determining the degree of maturity of refuse compost.

Yoshida and Kubota (111) performed gel chromatography on extracts of various composts. As composting advanced, the amount of high molecular weight molecules in water extracts increased markedly. The chromatograms produced using four different types of raw materials showed varying patterns while the chromatograms of the four refuse composts showed striking similarities. Even though the characteristic components of the chromatogram were not identified, it was proposed that the gel chromatogram of a water extract will give an effective measure to quantify the extent of compost degradation.

Growth tests have also been used in assessing compost maturity. One such standard growth test is the garden cress test in which evaluation is based on the percentage of seeds successfully germinating in the test substrate.

Anid (4) showed that percentage of cress germinating in composts of varying maturity increased in proportion to the age of the compost. It was only after temperatures began to decline in the composting process, causing a shift from thermophilic to mesophilic microbial populations, that cress populations began to rise significantly. Anid speculated that toxicity associated with immature compost may have its origins in the thermophilic microbial populations that are present in the early stages of decomposition. He also argues that residual toxicity, reflecting toxins produced early in the process, may not disappear totally and that toxicity problems may still occur unless the compost is properly diluted in an appropriate substrate. This opinion is shared by Hirai (41), Tietjen (94,95), and Parr (69) who indicate that there is an upper limit to the loading of garbage compost to soil irrespective of compost maturity.

Zucconi et al. (112) have also experimented with bioassays using water soluble compost extracts to germinate cress seeds. While the bioassay appears to provide quantitative information, Zucconi cautions that additional tests, using various plant species, are needed to better understand specific tolerances associated with different plants and growth stages. He proposes that future work in this area be directed at isolating the most sensitive plants that could be useful in specific bioassays. He concluded that bioassays may be considered an alternative or complement to other chemical, physical and biological analyses in assessing compost maturity.

Zucconi (113) summarizes current research efforts in this area by pointing out that there is still much that needs to be learned regarding compost immaturity and its associated problems. The types and numbers of potentially toxic substances and their effects have not been well defined. Even for those substances that have been identified, questions remain concerning concentration and duration of effects.

III. ORGANIC MATTER AND SOIL PHYSICAL PROPERTIES

Many of the benefits that might be derived from the addition of compost to soil can be directly or indirectly attributed to increasing the soil organic matter content. An appreciation for the importance of soil organic matter is essential in understanding changes that might result from the use of compost. Although the organic matter content of soil is relatively small, ranging between 0.5 and 5.0 percent in most mineral soils (27), its influence on soil properties and plant growth are very significant.

Soil organic matter can be defined as the fraction of soil that includes plant residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by soil organisms (earthworms, bacteria, fungi, and actinomycetes).

The starting material for most organic matter is plant residues. Typical residues are made up of approximately 50 percent carbon. Oxygen and hydrogen are also major components. In addition, plant residues contain low levels of nitrogen, phosphorus, potassium, and other plant nutrients. When plant residues or other organic materials such as manures, sewage sludges, or composts are added to soils they are decomposed by soil organisms. Thus soils contain numerous organic conpounds in various stages of decomposition. The term humus is used to refer to the organic fraction that has undergone extensive decomposition and is resistant to further breakdown.

As decomposition occurs plant nutrients are released from the organic matter and may become available for plant growth. The amount of nutrients available for plant growth and the time required for their release depends on many soil and climatic factors as well as the composition of the original material.

In addition to nutrient release, the decomposition of organic matter in soil results in the formation of various other compounds that may benefit plant growth by improving plant uptake of some nutrients, acting as growth regulators or stimulators, or by having positive effects on soil microbial populations. Other compounds, particularly those formed during the decompostion of fresh or undecomposed materials, may have negative or even toxic effects on plant growth.

As was pointed out above, the organic matter content of soils is relatively small. In addition, the level in soil tends to reach an equilibrium under a given set of conditions. Cultivation speeds up organic matter destruction in soils. Practices such as tillage increase aeration thus stimulating microbial activity and the breakdown of organic matter. During the first few years after initial cultivation there is a rapid decline in the organic matter level. The decrease becomes more gradual with further cultivation until a new equilibrium is reached. Once this has occured it is very difficult to significantly increase soil organic matter for an extended period of time. Even with management practices that routinely return large amounts of organic matter to soils in the forms of plant residues and/or manures, the organic matter content of a cultivated soil is rarely equal to that of its virgin counterpart.

In recent years, increasing concern over soil erosion and a growing interest in organic farming methods have resulted in much attention centered on the role of organic matter. Farmers have been aware of its importance long before it became a popular topic and considerable research, some dating back almost 100 years, has been devoted to trying to better understand the role of soil organic matter.

Perhaps the best known or most often discussed functions of soil organic matter are those relating to soil physical properties. Organic compounds aid in the formation of soil aggregates which impart the crumbly condition of soil referred to as tilth. A soil with good tilth provides a looser, less restrictive environment for root growth and development. The crumbly condition also reduces the occurance of surface crusting which frequently occurs on soils high in silt content. Crusting impedes water infiltration and seedling emergence. Soils high in organic matter are less subject to erosion and have higher nutrient and water holding abilities.

Several researchers have observed the effects of compost addition on various soil physical properties. Although the results vary, there appears to be a general conclusion that soil physical properties can be improved with relatively high application rates or with repeated applications of compost.

Duggan and Wiles (21) measured soil moisture content, bulk density and organic matter levels over a three year period on plots amended with compost at rates of 0, 8, 16, 50, and 200 tons per acre per year. Soil bulk density was lowest on plots receiving the highest appliction rate; 0.86 grams per cubic centimeter as compared to 1.56 grams per cubic centimeter on the control. Changes in organic matter content were most pronounced on plots treated with the highest compost rate. Values ranged from 1.39 percent for plots receiving no compost to 13.5 percent for plots that received compost at a rate of 200 tons per acre after three years.

Soil moisture content also increased with increasing application rates. The effect of greater moisture content in plots receiving higher applications rates was evidenced by less leaf curling of corn plants on plots that were treated with 50 or more tons of compost per acre.

Duggan (20) also made observations of demonstrations conducted on over 100 fields where municipal compost was used as an organic amendment for growing burley tobacco. He concluded that the most significant increases in yield resulted from compost applications on heavy clay soils. The positive effects were attributed to improvements in soil physical properties resulting from the addition of organic matter. Duggan noted improved aeration and tilth and reduced erosion on compost treated plots.

Hortenstine and Rothwell (46) conducted greenhouse studies in which four rates of refuse compost (8, 16, 32, and 64 metric tons per hectare) were added to a sandy soil. They observed an increase in water retention at 0.1 bar tension with each increment of compost applied as compared to the control. However at 15 bar tension, the lowest rate of 8 metric tons per hectare had no effect on water retention. There was no significant difference in water retention at 15 bar tension between rates above 16 metric tons per hectare.

Hortenstine and Rothwell (47) also observed changes in soil physical properties when using the same compost for reclamation of phosphate mine sand tailings. Tailings, which are one of the by-products of phosphate strip mining, are almost void of available plant nutrients and organic matter and have very little water-holding capacity. The tailings are pumped onto sections of land to a depth of 5 to 7 meters deep. Because of the poor condition of the soil these areas are very difficult to revegetate.

The addition of 35 and 70 metric tons of compost per hectare resulted in significant increases in organic matter content, cation exchange capacity (a measure of nutrient holding ability), and water holding ability. Plants grown on plots amended with compost only produced very poorly in the first year; the seedlings suffered nearly 100 percent mortality within 10 days of emergence. The authors speculated that the poor performance was due to immobilization of available nitrogen. However, oat yields were increased significantly where compost and fertilizer were applied as compared to fertilizer alone. They concluded that municipal solid waste compost had a beneficial effect on the sand tailings and could be utilized in reclaiming such waste areas.

Bengston and Cornette (5) showed significant effects on soil moisture content where compost was applied at rates of 4.4 and 44 metric tons per hectare to a two - year old plantation of slash pine. The soil in the study area was sandy and excessively drained. Samples taken during a period of little rainfall showed a prolongation of the period during which soil moisture remained in excess of the estimated wilting point. The most favorable moisture relationship occurred with the high rate of compost application. Disking the compost into the soil generally prolonged the period during which water was readily available to the trees. Application of fertilizer nitrogen along with the compost usually led to a more rapid decline. This phenomenon was attributed to the stimulation of weed growth from the fertilizer nitrogen; the weeds tended to deplete soil moisture more rapidly than on areas where compost only was applied and weed growth was not as prolific.

Cook et al. (15) also studied the effects of organic amendments on various soil physical properties. Small test plots were established in an area of Washington D.C. parkland. The area had been intensively used for recreational and festival activities and therefore the soil was very compacted. Materials included compost produced from sewage sludge and woodchips and composted
refuse. Each material was applied four inches thick. Bulk density was decreased by 23 percent with the sludge compost and 11 percent with the refuse compost as compared to the control which received no compost application. Water infiltration increased by over 50 percent both in intake per hour and in total intake over a three hour period on the sludge compost amended area. However the refuse compost decreased both the intake rate and total water intake. Pore space was calculated using measured bulk density and estimated particle densities. This showed an apparent 32 percent increase in total pore space with the sludge compost and an 8 percent increase with the refuse compost. The 8 percent increase was not a significant difference.

Wang (107) found only slight increases in aggregate stability and moisture holding capacity at 1/3 bar tension from refuse compost applications of 5 and 10 tons per hectare. No evident difference in soil bulk density was found from the compost treatments. Wang concluded that the single treatments showed no obvious effects on soil physical properties but speculated that greater changes would be expected from long term applications.

His opinion is supported by Volk (105,106) who maintains that sustained improvements in soil physical properties requires large and repeated applications of organic material, and by Reuser (76) who states that the maximum effects of composts on soil structure such as increased aggregation, pore space, and water holding ability as well as on crop yield, usually occur only after several years of application.

IV. NITROGEN

The importance of nitrogen in agriculture, horticulture, and to growing plants in general cannot be overstated. It is one of the three primary plant nutrients; the plant requirement is relatively large compared to many of the other essential elements.

Nitrogen is a constituent of every living cell. It is a part of many proteins which serve as enzymes and also is a part of the chlorophyll molecule. Nitrogen is a regulator which plays an important role in the uptake of potassium, phosphorus, and other nutrients. It encourages vegetative growth and gives plants a deep green healthy color.

The amount of nitrogen naturally occurring in soil is relatively small; most is associated with the soil organic matter in forms that are largely unavailable to growing plants. Microbial breakdown of the soil organic matter releases approximately two to three percent of the organic nitrogen annually (1).

Some plants, notably the legumes such as soybeans and alfalfa, have microorganisms associated with their root systems that are able to "fix" nitrogen from the atmosphere and make it available to the plant. Very little, if any fertilizer nitrogen is needed for these types of plants. Other plants, particularly some of the grasses and grains, require large amounts of the element and outside sources of nitrogen are needed for good growth and yields. This is traditionally supplied by chemical fertilizers or animal manures.

More than 90 percent of the fertilizer nitrogen produced in the world is ammonia or one of its derivatives. Anhydrous ammonia is the most commonly used material and accounts for more than 80 percent of the nitrogen used on Minnesota cropland. At normal temperatures and pressures it is a gas. It is stored and transported as a liquid under pressure and injected into soil as a gas. Anhydrous ammonia is the most concentrated form of nitrogen (82% N). It is relatively inexpensive compared to other forms of nitrogen fertilizer, and is readily available to growing plants. Various ammonium salts are also important forms of nitrogen fertilizer.

Depending on the rate and type of application, type of crop, and soil and climatic factors, from 50 to 80 percent of applied nitrogen is usually recovered in the growing crop (68). Another 10 to 20 percent may volatalize (escape as a gas) or be converted to forms that are not available to plants. Any remaining nitrogen may move with water percolating through the soil.

The nitrogen contents of animal manures vary considerably depending on the type of animal and how the material is stored and applied. Generally, manures contain less than two percent nitrogen on a wet weight basis or less than three percent on a dry weight basis. Manure provides a wide variety of nutrients in addition to nitrogen. It also supplies organic matter which improves the physical characteristics of soil and results in distinct beneficial effects on plant growth. However, its relatively low nutrient content and high labor and handling costs compared to inexpensive inorganic fertilizers, reduce its competitive economic value.

Composted solid waste products do not compare favorably with either inorganic fertilizers or animal manures as a nitrogen source. Typical nitrogen levels reported are generally less than two percent on a dry weight bases. Values close to one percent are not uncommon (9,14,18,22,29,31,33,45,54,57,62,66, 70,90,96,100,108).

In addition to the nitrogen level being relatively low, much of that which occurs in composts is present in organic compounds that cannot be taken up by plants. The nitrogen must first be converted to inorganic forms such as nitrate (NO_3) or ammonium (NH_4) before it can be utilized as a nutrient. The conversion to inorganic, available forms of nitrogen is termed mineralization and is accomplished largely through decomposition by soil microbes.

The organisms responsible for the decomposition of organic matter require carbon, nitrogen and other nutrients in order to proliferate. The relative proportion of carbon and nitrogen has a strong influence on the rate of decomposition and thus the conversion of nitrogen to plant available forms. If an organic material which has a small amount of nitrogen in relation to carbon is added to soil, microorganisms will utilize or tie up nitrogen in the soil, including forms that could otherwise be used for plant growth. The nitrogen becomes incorporated into microbial tissue and is unavailable to plants. As decomposition proceeds, carbon is released to the atmosphere as carbon dioxide. Thus there is a gradual net reduction in carbon. The period when nitrogen is unavailable to plants will persist until nitrogen is no longer limiting for microbial growth. This phenomenon is termed nitrogen immobilization by soil scientists and is sometimes referred to as nitrogen robbing.

If, on the other hand, the added material contains a higher content of nitrogen in proportion to the carbon (such as with animal manures or alfalfa or clover residues) it is much less likely that nitrogen will be immobilized.

The ratio of the percentage of carbon to that of nitrogen is termed the carbon:nitrogen (C:N) ratio and is used to define the relative quantities of the two elements in organic materials, or in the whole soil body. The C:N ratio of stable soil organic matter commonly ranges from 8:1 to 15:1, the median being between 10:1 and 12:1 (6). The ratio shows little variation within a given climatic region.

As a general rule, when organic materials with a C:N ratio of greater than 30 are added to soils there is immobilization of soil nitrogen during the initial decomposition process (1). For materials with ratios between 20 and 30, either nitrogen immobilization or mineralization may occur. If the organic materials have a C:N ration of less than 20 there is less possibility of nitrogen immobilization and there is usually a release of mineral nitrogen early in the decomposition process. A C:N ratio of 15:1 in organic residue is given by Broadbent (6) as the level below which nitrogen will be present in excess of microbial needs and therefore can become available for plant growth.

Because the nitrogen content of solid waste composts is relatively low it cannot be compared with inorganic sources of nitrogen. Furthermore, if the carbon:nitrogen ratio of a compost is relatively high, it is possible that addition of the material to soil may induce a nitrogen deficiency by immobilizing the nutrient. Several researchers have shown this to be the case when investigating plant growth in composted materials, especially when high rates of composts with high carbon:nitrogen ratios were used.

Hortenstine and Rothwell (47) for example, speculated that nitrogen immobilization was responsible for the nearly 100% mortality of germinated oat seeds within ten days of emergence when composted refuse was applied to phosphate mine sand tailings at rates of 35 and 70 metric tons per hectare. The effects were not as dramatic with a second application the following year but seedling mortality was still significantly higher than on plots receiving fertilizer only.

Hortenstine and Rothwell also conducted laboratory studies (77) to determine the amount of organic nitrogen in compost that was converted to the plant available form nitrate in a 65 day period. Very little nitrification occurred at any rate when compost was added at rates of 0, 2, 4, 6, 8, and 10 grams per 100 grams of soil. When mixtures of garbage compost plus sewage sludge or garbage compost plus chicken manure (50/50 weight basis) were mixed with soils at rates of 0, 1, 2, 3, 4, and 5 grams per 100 grams of soil considerably more nitrate was measured at the end of 65 days than with the compost alone. Chicken manure and sewage sludge are both materials with considerably higher nitrogen levels than the compost used in their studies.

Terman et al. (92) grew corn in an extremely infertile silt loam soil with compost applications equal to 5 and 10 tons per acre. No additional nitrogen fertilizer was used. They found the corn to be extremely nitrogen deficient. The deficiency was attributed to the very low available nitrogen in the soil along with the application of the highly carbonaceous material (27% carbon, 1.3% nitrogen, C:N=21:1). It was estimated that the compost immobilized 37 and 63 pounds of nitrogen per acre at the 5 and 10 ton rates, respectively. The authors recommended that on severely nitrogen deficient soils, fertilizer nitrogen should be be applied with the compost to avoid crop deficiency.

Duggan and Wiles (21) noted nitrogen deficiencies in corn plants grown with 200 tons per acre of compost. Four compost application rates (8, 50, 100, and 200 tons per acre) were compared. Yields of corn grain were greater from plots that received higher rates of compost, up to a rate of 100 tons per acre. The compost contained 1.3% nitrogen and had a carbon:nitrogen ratio of 21.

Duggan (20) also observed nitrogen deficiencies in greenhouse grown tobacco plants with large applications of compost that had carbon:nitrogen ratios greater than 30:1.

Bengston and Cornette (5) conducted field experiments with a compost that was considered of poor quality due to a high carbon:nitrogen ratio (66:1) and low nutrient content. The compost was applied at rates of 0, 4.4, and 44 metric tons per hectare to a two year old plantation of slash pine in central Florida. The higher application rate was associated with a lower nitrogen content in the needles during the first year of application. Although this effect had disappeared by the second year, it again suggests that nitrogen availability and therefore uptake, was reduced by the presence of large amounts of compost with a high carbon:nitrogen ratio.

Sikora et al. (86) concluded that the mineralization of organic nitrogen was the limiting factor in grass yield when four different rates of composted sewage sludge were used to grow Kentucky 31 fescue. The compost alone did not contain sufficient available nitrogen, even at the highest rate of 60 tons per acre, to support optimum fescue growth. Yields were significantly increased by the addition of fertilizer nitrogen, phosphorus, or nitrogen plus phosphorus. The largest yield increase was obtained with the addition of both nitogen and phosphorus, showing that yield was limited by both nutrients when only compost was used.

Hortenstine and Rothwell (48) on the other hand concluded that adequate amounts of nitrogen were provided to sorghum plants at application rates of 14 and 28 tons per acre. A pelletized refuse compost containing 2.27% total nitrogen and having a carbon:nitrogen ratio of 16:1 was used in their study. It should be pointed out that the nitrogen content of the compost was higher and the carbon:nitrogen ratio lower as compared to other solid waste composts used in this and many other studies involving materials produced in the United States. The estimated recovery of applied nitrogen by sorghum was 13 percent at the 14 and 28 ton per acre rates and 18 percent at two lower rates of 3.5 and 7.0 tons per acre.

Studies have been conducted in an attempt to quantify the amount of nitrogen that can be released or mineralized from composted products. Kumada (53) estimated that approximately 23 percent of the nitrogen in compost produced from cow feces and rice straw was available to six successive radish crops over an eight month period.

Terman et al. (92) estimated that nitrogen in a solid waste compost was approximately 16 percent as effective as the same amount of nitrogen applied as a readily soluble inorganic fertilizer.

Epstein et al. (25) measured nitrogen mineralization from sludge composts prepared from both raw and digested sludges along with woodchips. Three different rates of each compost were used and the samples incubated for a 15 week period. For the three rates the amount of nitrogen mineralized from the digested sludge compost and the raw sludge compost averaged 8.5 and 4.4 percent of the totals, respectively, showing that nitrogen in amendments which have been stabilized by composting with carbonaceous materials (woodchips) is not easily mineralized. Their work also showed that the amount of nitrogen mineralized can vary depending on the nature of materials composted. Several other factors also influence the rate of mineralization including the rate and type of application, soil type, temperature, and moisture content.

Tester et al. (93) conducted laboratory incubation studies and found that approximately 6 percent of the organic nitrogen in a sewage sludge compost was mineralized from a sand soil-compost mixture over a 54 day period. Only 1 percent of the organic nitrogen was mineralized from a silt soil-compost mixture over the same period. Their findings are supported by the work of Sikora et al (86) who later compared fescue yields from compost amended soils using the same soil types. The fescue yields on the compost amended sand soil were significantly higher than those from the compost amended silt soil.

It is interesting to note that several researchers obtained the highest yield increases when organic treatments were combined with conventional inorganic fertilizers. Hortenstine and Rothwell (47) for example, noted that fertilizer plus compost additions resulted in much superior seedling survival and yield on phosphate mine sand tailings than either fertilizer or compost alone. Bengston and Cornette (5) observed increased foliar nitrogen in slash pine trees as compared to the slightly deficient level found in trees treated with compost only.

Wong and Lau (110) carried out field experiments on fine-textured upland soils to compare the effects of three organic amendments (including a garbage compost) on crop yields and soil physical properties. All of the plots received chemical fertilizer at a rate of 100 kilograms of nitrogen, 60 kilograms of P_2O_5, and 40 kilograms of K_2O per hectare. Significant yield increases as compared to the check (fertilizer only) were noted with all of the amendments. There were not, however, consistent significant differences between the 5 ton per hectare and 10 ton per hectare rates of garbage compost.

In 1972 Vlamis and Williams (104) found that sewage sludge and garbage compost increased yields of tomato, barley, and lettuce grown in pots in a greenhouse experiment. Maximum yields were obtained by supplementing the organic wastes with chemical fertilizers.

El Bassam (24) maintains that yields can be increased with the proper combination of mineral (inorganic) and organic fertilization. He cites data from several years of field research at Volkenrode showing that the yields of various crops including sugar beets, wheat, oats, and rye were increased by combined application of organic and mineral fertilizer. Shuphan (84) supports this theory and claims that a combination of organic and inorganic fertilizer is superior to either product used alone for crop productivity and food value in human nutrition.

Eggert and Kahrman (23) demonstrated that very large applications of organic matter could produce yields of vegetable crops that equalled or exceeded yields of similar crops grown under inorganic soil treatments. They recommend that future work be aimed at optimizing the amount of organic natter applied and further investigate the possibility that combining organic and inorganic management systems could lead to greater production efficiency. The need for additional research in this area was also emphasized in the Report and Recomendations on Organic Farming that was prepared by a United States Department of Agriculture study team in 1980 (150).

V. OTHER PLANT NUTRIENTS

With respect to plant nutrients, the vast majority of research on compost and co-compost products has been concentrated on nitrogen. Because of its cost and the relatively large plant requirement, nitrogen is a major expense in many soil-fertilizer management programs. This, coupled with the potential for nitrogen immobilization from compost additions, has resulted in a focus on nitrogen with lesser attention given to other plant nutrients.

Some researchers have made observations on availability and/or uptake of some of the other plant nutrients. Although the results have not always been consistent or conclusive, there is evidence that suggests some compost products can supply meaningful amounts of plant nutrients in addition to nitrogen.

The results of experiments with town refuse and sewage sludge materials conducted for seven years (1940-1947) at various English experiment stations were summarized by Garner (33) in 1966. Tests on the products showed the average potassium content to be 0.42 percent (expresssed as K_2O). Of that approximately 75 percent was determined to be readily soluble. Fermented refuse and pulverized raw refuse both showed average K_2O levels of 0.20 percent. The readily soluble fractions of K_2O in the fermented and pulverized refuse were 34 and 37 percent, respectively. Effects of phosphorus were not examined in the experiments and any effects due to differences in the amount of the nutrient supplied by the organic materials were reduced or eliminated as all plots received applications of superphosphate fertilizer.

In greenhouse pot experiments where compost was applied to soils at rates equal to 9, 18, and 36 metric tons per hectare along with various combinations of nitrogen, phosphorus, and potassium fertilizer, Terman et al. (92) estimated that phosphorus and potassium in compost were 71 and 64 percent as effective respectively, as the same amounts of the nutrients supplied as soluble fertilizers. The compost used in these studies contained up to 20 percent by weight sewage sludge. Sewage sludges are typically high in phosphorus and, according to some researchers, the presence of sludge in a compost can dramatically affect the content and plant recovery of phosphorus. Sewage sludges are almost always low in potassium and no significant increases in the content of this nutrient would be expected when sludge is used as a component of compost.

DeHaan (18) concluded that refuse compost produced without sewage sludge had a negative effect on phosphorus uptake by certain plants and on the content of plant available (measured as water soluble) phosphorus in the soil.

Hortenstine and Rothwell (46) evaluated municipal refuse compost as a source of plant nutrients when applied to a sandy soil. Two annual compost applications significantly increased soil potassium, calcium, and magnesium contents. Initial compost applications of 35 and 70 metric tons per hectare had no significnt effect on plant uptake of these nutrients. However, by the second year of application there were significant increases in plant uptake of nitrogen, potassium, calcium, magnesium, zinc, and boron with compost plus mineral fertilizer applications as compared to fertilizer only. Yield increases were attributed in part to the nutritive value of the compost.

They also studied the performance of a pelletized municipal refuse compost as a nutrient source for sorghum (48). They estimated the recovery of applied phosphorus by sorghum from solid waste compost to be 25 percent at application rates of 8 and 16 metric tons per hectare. At application rates of 16 and 32 metric tons per hectare recovery was considerably less at 9 percent. Potassium recovery was relatively high from all treatments and was estimated to be 98 percent from the 16 metric ton per hectare rate of compost and 74 percent from the other compost treatments. The compost used in these greenhouse experiments contained 0.45 percent phosphorus and 0.20 percent potassium.

Duggan and Wiles (21) observed increased potassium uptake by corn plants with high rates (50 and 200 dry tons per acre) of refuse compost application. They concluded that the increased uptake indicated that although the potassium content of compost was low at 0.97 percent, it was readily available to corn plants.

Mays et al. (60) found that the potassium level of sorghum plants grown on compost amended plots tended to increase with increasing application rates. They concurred with Duggan and Wiles that even though composted products tend to be low in this nutrient, when high rates are applied the amount of potassium supplied can be considerable.

Increased uptake of some of the minor or trace elements such as boron, zinc, and iron have also been observed with compost applications. However this may or may not be viewed as an advantage. The plant requirements of these elements are relatively low compared to the levels often found in waste products. As is discussed in the section covering trace elements, successive or high rates of compost application may result in plant toxicity problems or undesirable accumulations of some elements in plants and/or soils.

VI. TRACE ELEMENTS

Many food products and consumer goods contain concentrations of low levels of trace elements such as mercury, cadmium, lead, arsenic, chromium, copper, zinc, manganese, fluorine, and boron. Thus, it is likely that varying, and sometimes relatively high, contents of these elements will be found in domestic wastes. Several of the elements are essential to plant and/or animal nutrition. Yet all of them can be toxic under certain conditions or if present in sufficient concentration. Cadmium and arsenic are extremely poisonous to humans; mercury, lead, nickel, nickel, fluorine, and chromium are moderately so; and boron, copper, manganese, zinc are relatively lower in toxicity (2).

The buildup of trace metals in soils has often been cited as one of the greatest potential hazards in applying sewage sludge to land and considerable research has been focused on this subject. Although there has been much less work addressing the problem as it relates to solid waste composts, it is reasonable to assume that the potential for trace metal contamination will be of equal concern with their use because of the diverse chemical nature of the waste stream.

The trace elements are of concern for two major reasons (64):

1. Some of the metals (including several of the micronutrients such as zinc, iron, and copper) can become toxic in plants causing severe develop ment problems and yield reduction.

2. Other metals, notably cadmium, can be concentrated in the plant suffi ciently to become toxic to animals and humans consuming them without being lethal to the plant itself.

One can expect the trace metal contents of solid waste composts to vary depending on many factors such as location, socio-economic conditions, portion of the waste stream being composted, whether or not sludge is used, quality of the sludge, and season of the year. Monitoring of solid waste composts has shown considerable variation in trace element contents of materials produced at eleven plants in Germany. Results are summarized in the table below.

TRACE ELEMENT COMPOSITION OF WASTE COMPOSTS FROM GERMANY (36)

Element	Number of plants	Duration of sampling	Number of samples	Range ----mg/kg-----	Average
Boron	7	1970-1975	72	3-105	32
Manganese	4	1972-1974	12	304-1305	511
Copper	11	1970-1975	86	71-2800	266
Zinc	11	1970-1975	90	421-2830	1000
Cadmium	10	1970-1975	66	0.8-7.4	3.7
Lead	10	1970-1975	87	24-1100	229
Mercury	4	1973-1975	28	0.2-6.0	2
Arsenic	4	1973-1975	28	0.6-16	7.2

In a review of crop and food chain effects of toxic elements in sludges and effluents, Chaney (10) discusses several soil factors that control metal toxicities to plants. Briefly summarized they are:

1. The amount and combination of metals present in the soil.

2. The pH of the soil. Chaney argues that this may be the most important factor of all because as the pH increases up to 7.0 the availability, and therefore toxicity, of most metals decreases.

3. The amount of organic matter. A higher soil organic matter level also tends to decrease the plant availability of most heavy metals.

4. The phosphate content of the soil. A high phosphate content in soil generally decreases the availability and toxicity of many of the metals.

5. The cation exchange capacity (CEC). CEC is a measure of a soil's ability to adsorb positively charged ions (cations). It is often used as an indicator of a soil's nutrient holding potential. Many of the metals occur as cations in soil and will be more tightly adsorbed, and therefore less available to plants, in soils with higher CEC values.

6. Reversion to unavailable forms. Generally, unless the soil pH is lowered, most of the toxic metals revert to a form that is insoluble and unavailable to plants. This occurs most rapidly in high pH soils.

The type of crop grown on a waste amended soil is also an important factor in metal uptake. Plants vary greatly in their tendency to concentrate metals. The green leafy vegetables such as chard, spinach, and lettuce are accumulators of metals while most grains tend to take up metals to a lesser extent. Different parts of a given plant will differ also in their concentration of the metals; the leafy portions concentrating more than the stem and seed parts (11,33,48).

Although the majority of research on trace metal uptake by plants has focused on the use of sewage sludges, some work has dealt specifically with solid waste composts or co-composts.

Terman et al (91) conducted experiments to study possible toxic effects of zinc buildup in an acid soil from heavy applications of a compost containing a relatively high concentration of zinc (1500 mg/kg). Increasing compost application rates resulted in increased uptake by corn plants. However no toxicity symptoms were observed. It was noted that the liming effect of the compost application tended to suppress zinc uptake thus preventing toxicity. Mays et al (60) also reported increased zinc and copper levels in sorghum plants grown on compost amended plots. Again, it was concluded that a lack of negative effects was due to increased soil pH as a result of compost application.

Results from several greenhouse studies reported in 1973 (92) indicated that the liming effect from sludge enriched solid waste compost prevented zinc toxicity even though zinc uptake increased.

Duggan and Wiles (21) showed a large increase in zinc accumulation in corn plant tissue of plants grown on plots receiving high compost applications (200 tons per acre). The increase was less pronounced in grain as compared to the leaf tissue or cob. Although the corn in these tests showed no adverse effects from zinc, it was pointed out that other plants with less tolerance might be affected. Analyses were conducted on leaf, grain, and cob samples for other metals including cadmium, chromium, nickel, and copper. There were no clear trends indicating increased concentration of these metals with increased compost application rates. They also noted a definite liming effect from compost application and concluded that the maintenance of nearly neutral soil conditions reduced the uptake of trace metals.

Hortenstine and Rothwell (48) observed no phytotoxic symptoms due to manganese and zinc when pelletized refuse compost was applied to a sandy soil at rates up to 64 metric tons per hectare. They maintained that the uptake of the two elements was not of a magnitude to cause concern. In another study (47), the same researchers did note significant increases in zinc and boron uptake by oat and sorghum plants with applications of 35 and 70 metric tons per hectare of solid waste compost to phosphate mine sand tailings as compared to fertilizer alone.

Giordano et al (32) observed slight increases in zinc and cadmium concentration of corn stover grown on compost amended plots. The increases in zinc concentration were less than those obtained with equivalent additions of zinc supplied from zinc sulfate or sewage sludge. There were no significant increases in metal concentrations of the grain as a result of compost applications. Beans grown on compost amended plots also showed slightly higher concentrations of zinc in both the vines and pods as compared to check plots which received no waste applications. Again, the increase was less than those observed with sludge or zinc sulfate treatments. There were no significant differences in concentrations of nickel, cadmium, or lead with compost addition as compared to the controls. Although repeated applications of waste products did not result in proportionally higher concentrations of metals in plants, the authors cautioned that the potential for toxicity exists with high rates of application.

Van Assche and Uyttebroeck (102) studied the effects of compost application on metal uptake by lettuce and celery. Analyses of the vegetables showed that the concentrations of copper, lead, and zinc all increased with increasing compost applications. The compost mixtures used in their experiments consisted of 1/8, 1/4, and 1/2, compost on a volume basis. Although phytotoxic effects were noted at higher compost rates, especially with lettuce, it was concluded from the use of an ion exchanger (which binds and immobilizes the ions of heavy metals) that the toxicity was not due completely to the heavy metal contents of the composts. High soluble salt concentration (mainly chlorides) was attributed with causing a reduction in the yield of lettuce. The reduction was estimated to be at least equal to the negative effects of metals.

High levels of boron in compost may be a problem to sensitive plants. In Scotland, beans grown in soil treated with a compost high in boron developed severe boron toxicity problems (115). Leaching the compost prior to use removed approximately one-third of the boron from the materials and allowed healthy bean plant development.

Several researchers have concluded that significant quantities of wastes containing heavy metals can be applied to cropland without causing crop toxicities (10,26,52,87,100). Purves (72), on the other hand, maintains that even restricted compost application rates could cause an increase in the available content of these elements in soils. His arguments are based on comparisons of extractable metal levels in rural agricultural soils with levels found in solid waste composts. He is especially critical of some of the newer proposed composting processes that shred and incorporate cans and pieces of metal into the compost and cautions that they may well result in higher levels of metals in the finished product.

In several European communities the production and use of solid waste composts has been practiced for many years. In some of these countries the use of composts is largely regulated on the basis of metal contents; both in the compost and in the soil to which compost is applied. In Austria for example, parameters have been established for land application of products derived from solid wastes. Tolerance values are given for seven trace elements (56).

Element	Upper tolerance value mg/kg - dry weight
Chromium	300
Nickel	200
Copper	1000
Zinc	1500
Cadmium	6
Mercury	4
Lead	900

Materials that will result in metal concentrations in finished compost greater than the tolerance levels are not to be used for compost production. The heavy metal content of the soil and the type of plants grown are also considered in determining compost application rates.

The Minnesota Pollution Control Agency has recommended trace metal limits for a Class I compost in its proposed Solid Waste Rules.

Element	Maximum concentration mg/kg - dry weight
Chromium	1000
Nickel	100
Copper	500
Zinc	1000
Cadmium	10
Mercury	5
Lead	1000

A Class I compost may be distributed in an unrestricted manner. The distribution and use of composts with metal concentrations in excess of these limits will be more stringently regulated as compared to a Class I compost

Based on the results of analyses of compost samples from several different countries (18,30,31,35,57,108) it appears that zinc and lead concentrations are those most likely to exceed Class I criteria. Sewage sludge, if used in compost, can make substantial contributions to the metal levels in the finished product. However, sludge quality varies considerably depending on industrial inputs. The metal concentrations of many sludges are well within the above limits. Also, metal concentrations in some composts that do not contain sewage sludge have exceeded the proposed limits.

VII. SOLUBLE SALT CONTENT AND pH

Various soil chemical properties are influenced by the addition of compost products. The addition of organic matter, nutrients, and the diverse mix of other elements present in compost products will cause many changes in a system as complex as the soil environment. The types of and degree of effects will be dependent on soil type, climate, nature of the compost and many other factors. Many of the effects are not well understood and some are probably of minor importance. There are however specific chemical influences that have been consistently noted in research and practice. In particular, large additions of waste products cause significant changes in soil pH and soluble salt content. Special condideration should be given to the possible effects on these soil properties.

The term pH is a measure of the degree of acidity or alkalinity of the soil. Values range from 0 to 14, with 0 through 6 being acid, 8 through 14 being alkaline, and 7 as the neutral point. Soil acidity or alkalinity depends on the presence of acid forming substances such as hydrogen and aluminum or base forming elements such as calcium and magnesium. The amounts of these elements is largely dependent on climate and the type of parent material in which the soil was formed. The importance of soil pH is universally understood. Routine soil tests in both agriculture and horticulture almost always include a pH determination.

Soil pH has considerable influence on nutrient uptake by plants. A pH that is either too high or too low is undesirable. Extremes in either direction can cause certain nutrients to be largely unavailable to growing plants. For example, in Minnesota some highly alkaline soils can present problems because plant availabilities of the nutrients phosphorus, potassium, zinc, and iron are drastically reduced at high pH values. Other elements may pose toxicity problems because they are extremely soluble at a given pH.

A soil pH range of 5.5 to 7.0 is best for growth of most plants. Some such as sweetclover and alfalfa require a relatively high pH (greater than 6.5) whereas some specialty crops such as potatoes, strawberries and blueberries thrive better on a slightly acid soil because of disease problems or specific nutritional requirements. Corn and soybeans, Minnesota's major agricultural crops are quite tolerant to wide range of soil pH.

In areas with acid soils, the application of lime is a common agricultural practice for increasing soil pH. It has been estimated that approximately one-third of Minnesota's cropland could benefit from liming. Most of these soils are located in the eastern two-thirds of the state (51).

Effects of compost application on soil pH have been reported by a large number of researchers that have studied the use of solid waste compost products. The liming effect of compost was demonstrated by Carnes and Lossin (8) who compared pH with increasing compost application rates. Soil pH ranged from 5.80 with no compost to 7.70 eight months after the application of 200 tons of compost per acre. The results of different application rates on soil pH are summarized below.

SOIL pH VERSUS RATE OF COMPOST APPLICATION (8)

Tons of compost per acre	Soil pH after 8 months
0	5.80
8	6.15
50	6.39
100	7.26
200	7.70

Bengston and Cornette (5) showed a significant increase in soil pH, from 5.10 to 6.26, when 20 tons per acre of refuse compost was applied to a sandy soil in central Florida. Soil samples were collected 28 months after compost application.

Duggan and Wiles (21) also observed a definite liming effect from the addition of composted refuse. They noted that the maintenance of nearly neutral soil conditions on plots that received high rates of compost (up to 200 tons per acre) helped reduce the uptake of heavy metals such as zinc. The initial pH value of a composite soil sample from the test area was 5.8. Effects of the different treatments are shown below.

Effect of Compost and Nitrogen Fertilizer on Soil pH, Johnson City, Tennessee.

Annual Application		Soil pH			
Compost tons/ac	N Fertilizer lb/ac	1969	1970	1971	1972
0	0	5.8	5.6	5.5	5.3
0	160	5.8	5.5	4.9	4.5
8	160	5.7	6.1	6.0	6.0
50	0	7.0	6.8	6.9	6.7
200	0	7.4	6.9	7.2	6.8

Composted refuse was tested as an amendment to raise the pH of highly acid eroded soil from the Copper Basin of southeastern Tennessee where an area of about 23,000 acres was denuded by sulfur dioxide fumes. The fumes were produced from copper smelting operations during the period from 1850 to 1905. Tall fescue grown in this experiment responded markedly to applications of nitrogen, phosphorus, and potassium fertilizer plus lime or compost, compost alone and lime without compost. Essentially no yield response was obtained from fertilizer without lime or compost. It was concluded that the the main response to compost was as a liming material. In some areas, the pH was increased from 4.1 to 6.1 within a five month period (91).

Wang (107) noted a slight increase in soil pH even when applications of refuse compost were as low as 5 and 10 metric tons per hectare.

Duggan and Scanlon (20) demonstrated that compost could be used beneficially to establish trees and grasses on an abandoned ash dewatering pond. However the compost, with a pH of 8.5, had little or no effect on the pH of the test area soil over a two year period. It sould be pointed out that the initial pH levels at the site were relatively high, ranging from 8.0 to 9.0. Decreases in pH were noted in both the treated and control plots but these were attributed to leaching processes rather than to effects of compost. The greatest decreases in pH occurred on the control plots which received no compost.

In many situations an increase in soil pH is a desired effect and can be considered one of the benefits to be derived from using compost products. This is the case with many agricultural soils and may be particularly true when working with disturbed soils such as the mine spoils described above. De Haan (18) concluded that the the most important positive effect in using refuse compost is due to its lime content. His opinion is based on on a review of the results of more than fifty years of research conducted in the Netherlands.

However not all soils benefit from liming. Some, in fact have pH levels already higher than optimum for growing many crops. Plants grown on these high pH soils may be subject to nutrient imbalances and deficiencies. Any additional liming effect would be detrimental.

In the western one-third of Minnesota there are many soils that contain considerable quantities of lime. Although many of them are not necessarily excessively alkaline or problematic, liming is not commonly recommended (51) and it is unlikely that any beneficial effects from liming would be noted on these soils. Additionally, some specialty crops such as strawberries, potatoes, and blueberries are best grown in slightly acid soils because of disease or nutritional problems that are more likely to occur at higher pH levels.

The term soluble salts refers to the inorganic soil constituents that are soluble in water. Elements contributing to salinity include calcium, magnesium and sodium in combination with chlorides, sulfates and sometimes nitrates.

A high soluble salt content increases osmotic pressure in the soil solution. The result is a decrease in availability of water to plants. Both seed germination and plant growth are adversely affected by a high soluble salt content. Plant growth may also be affected by direct toxic effects of specific salts. Salts containing sodium are of additional concern because high concentrations of the element are not only detrimental to plant growth but can also cause dispersion (breaking apart) of soil particles. This results in poor soil structure and reduced water infiltration rates.

The ability of a solution to conduct electricity is approximately proportional to its soluble salt content. Thus, the electrical conductivity of a soil extract is a commonly used indicator of soluble salt concentration. The conductance is often expressed as milli-mhos per centimeter (mmho/cm).

Plants vary considerably in their tolerances to high salt content or concentrations of specific salts or ions. A general guide of plant responses to salt content under average conditions has been established by the United States Department of Agriculture:

RESPONSE OF CROPS GROWN IN SOILS OF VARYING ELECTRICAL CONDUCTIVITY (EC) - VALUES AT 25° C (101)

Salinity EC	Crop Responses
mmhos/cm at 25° C	
0-2	Salinity effects mostly negligible
2-4	Yields of very sensitive crops may be affected
4-8	Yields of many crops restricted
8-16	Only tolerant crops yield satisfactorily
Above 16	Only a few very tolerant crops yield satisfactorily

Following is an approximate tolerance classification of some common Minnesota field crops:

Most tolerant	Barley, sugarbeets, birdsfoot trefoil, tall wheatgrass
Moderately tolerant	Bromegrass, corn, oats, perennial ryegrass, rape, reed canarygrass, rye, sorghum, sudangrass, tall fescue, wheat
Slightly tolerant	Alfalfa, flax, orchardgrass, sunflower, timothy
Nontolerant	Field bean,pea, soybean, clovers: alsike, red, ladino

Many ornamental and garden plants such as roses, strawberries, and raspberries are also affected by high salt concentrations.

Solid wastes and therefore solid waste composts can contain appreciable quantities of salts. This problem is not limited to refuse type composts; soluble salt concentrations are quite often necessary considerations when animal manures and sewage sludges or effluents are utilized on land.

Fortunately, there is a fairly good understanding of situations to avoid and how to manage waste application in a way that will prevent salinity problems. As pointed out by Stewart and Meek (88), salt accumulation is most likely to occur when organic wastes are applied as a means of disposal (at extremely high rates with little regard for possible negative influences on plant growth) rather than utilized and managed as a resource.

They give guidelines for preventing salinity problems from organic waste application which include the following recommendations:

1. Determine the soluble salt content of wastes before they are used.

2. Determine soil characteristics.

3. Time applications so that salts will leach somewhat before planting.

4. Apply rates to maximize utilization rather than disposal.

The Minnesota Pollution Control Agency (64) has recognized the salinity problems associated with land application of wastes by restricting sewage sludge application to soils with electrical conductivities of 4.0 mmho/cm or less.

In Austria various parameters have been established for categorizing and determining the suitablility of composts for land application. An electrical conductance of 5.0 mmho/cm is considered the upper tolerance. The acceptable pH range for land applied compost products is 7.0 to 8.5 (56).

Problems associated with undesirably high pH levels and/or salt content as a result of waste application are most likely to occur when very high rates are used. Hunt et al. (49) for example, concluded from various tests that seed germination may be adversely affected by high soluble salt concentration when compost is added at rates exceding 10 percent of the soil weight. With proper management and under normal field conditions, even rates as high as 50 dry tons per acre (about 5 percent by weight of the upper six inches of soil) should not result in deleterious salt or pH effects.

Problems have been most often noted when a large proportion of compost has been used as a component of growing media for various horticultural crops. Studies have been conducted in which compost was evaluated as a replacement for peat or some other component of growing media. Quite often pH and soluble salt content are cited as limiting factors.

Reneaume and Riviere (75) for example, concluded that the main difficulty in trials using composted solid waste as a component of blocking composts is due to the high pH and high soluble salt content of material.

Frey (128) attributed differences in crop responses to compost as a germinating medium to its relatively high soluble salt content. Conover and Joiner (17) noted relatively poor results when chrysanthemums were grown in 100 percent refuse compost as compared to plants growing in media containing one-half or one-third compost (volume basis). Again, high soluble salt content was cited as the probable reason for the negative effects observed at the higher rates.

Sawhney (80) reported that leaf compost generally contains excessive soluble salts and has a pH near neutral (7.0). A pH near 7.0 is normally considered optimum for most plants but, as cautioned by Sawhney, 7.0 is too high for plants such as azaleas and rhododendrons which require acid conditions. Attempts to lower the pH of compost by the addition of chemicals such as aluminum sulfate or calcium phosphate were only temporarily successful; the pH of the mixtures tended to increase back toward its original level over time. Furthermore, the addition of large amounts of chemicals necessary to reduce the pH of a highly buffered material such as compost is not economically practical according to Sawhney and such a practice can further increase the salt content to undesirable levels.

Still, it appears that composted products can be satisfactorily used for some horticultural media. The percentage used needs to be limited and it may be necessary to take special precautions in order to prevent problems associated with high pH and salt content.

Shanks and Gouin (82,83) conducted studies using composted sewage sludge. They reported that leaching media that contained one-third by volume compost prevented injury from soluble salts. They also pointed out that damage from salinity was probably avoided by the presence of soil, and to a lesser extent, bark in the mixtures. Verdonck et al (103) concluded that a combination of 90 percent composted bark and 10 percent tobacco waste can be satisfactorily used as a horticultural substrate.

Some researchers have pointed out that the relatively high pH may have some value if proper consideration and management is practiced. Gouin (36), who has conducted several tests using composted sewage sludge as a component of potting media reports that there is no need to amend potting soils containing screened composted sludge with limestone, as is quite frequently done.

Compost additions maintained soil pH at the level of the control treatment in greenhouse experiments conducted by Hortenstine and Rothwell (46). In comparison, there was a drop in pH as the result of mineral fertilizer applications made in the same study. Tobacco seedlings transplanted into potting media containing compost as a replacement for sphagnum peat remained wilted for a two-week period following transplanting. Sievert (85) attributed the extended period of transplant shock to the relatively high pH (7.5) of the media. He suggested that the amount of lime used in media containing compost be adjusted or possibly omitted altogether.

VIII. PLANT PATHOGEN SUPPRESSION

One of the potential benefits that might be derived from the use of composted waste products is the suppression of certain plant pathogens. When organic material is added to soil in relatively large quantities the soil ecosystem is altered. The organic matter is a food source for many microorganisms, thus some or all segments of the soil microbiota will be stimulated. The type and extent of the response will depend on many factors. Organic matter additions can selectively enhance the populations of certain microbiota; both those that may cause plant disease (plant pathogens) and those that are antagonistic to plant pathogens. As pointed out by Lumsden (55), organic matter is a significant part of the environment influencing plant diseases. At one end of the spectrum, disease can be increased by organic debris that enables proliferation and survival of plant pathogenic organisms. On the other end of the spectrum, disease may be reduced by organic matter.

Three of the major microbial groups found in soils are bacteria, fungi, and actinomycetes. Within each of these groups are numerous microorganisms known to be antagonistic to certain soil borne plant pathogens. Each group responds in its own particular way to different types of organic matter and thus may affect plant pathogens differently.

The ability of peat to suppress certain plant pathogens is well recognized by the horticultural industry and is often cited as one of the advantages in its use. Soil borne plant pathogens such as Rhizoctonia solani which causes damping off disease of young seedlings and Phytopthora sp. which are responsible for water mold diseases are particularly troublesome in controlled environments such as greenhouses where temperature and humidity levels favor pathogen survival . With the intensive production methods used in horticulture, the introduction and subsequent proliferation of pathogens can be devastating. Thus materials that have well understood abilities to suppress or be antagonistic to specific plant pathogens are of special interest to the industry.

Certain crop residues when incorporated into soil have been shown to have similar effects (58,61,97). Papavizas and Lumsden (67), for example, found that the addition of mature oat tissue to soil increased the number of soil microorganisms antagonistic to four soilborne plant pathogens that affect beans. They and other workers have found a large number of crop residues, including mature amendments such as barley straw, corn stover, sudan grass, oat straw and soybean tissue and immature amendments including timothy oats, corn, wheat, and sudan grass to be effective in suppressing the hypocotyl rot of bean caused by Rhizoctonia solani. The majority of effective residues, mostly mature grain straws, imparted considerable protection soon after incorporation, but their effectiveness was rapidly decreased with time. Studies on the effect of alfalfa hay and oat straw residues on the density of Rhizoctonia solani in soil demonstrated that the effect depended upon the nutrient status of the soil, the maturity of the residue, and the extent to which the residues were supplemented with nitrogen during decomposition.

Chet and Baker (13) have studied different soil types and their abilities to suppress plant diseases. They identified a strong population of Trichoderma haratum, a fungus known to be antagonistic to certain pathogenic microorganisms, in a highly organic Columbian soil. The soil was suppressive to Rhizoctonia solani infection of radish plants when compared to mineral soils.

Recent work with composted waste products indicates that some of these materials also possess properties that can suppress the incidence of certain soil borne plant diseases when added to soil or used as a component of growing media.

Lumsden et al (55) found that the addition of 10 percent by weight composted sewage sludge to soils artificially infested with Aphanomyces consistently and significantly decreased root rot of peas by 75 to 80 percent. Damping off of cotton caused by Rhizoctonia solani and sclerotina drop off of lettuce were both decreased up to 50 percent. Variable control or no effect occurred with Thielavioppsis root rot of cotton, Fusarium wilt of melon, Pythium blight of bean, and Phytopthora blight of pepper.

Composted hardwood bark from various tree species has also been shown to have suppressive effects on Phytopthora sp. and Rhizoctonia solani. Hoitink and coworkers (42,43,44) have conducted several studies using composted hardwood barks of varying degrees of maturity produced under different conditions. They found that composted hardwood bark (CHB) prepared in windrows at a nursery located near a forest consistently became suppressive as it aged. In contrast, CHB produced in a contained bin that was used before the high temperature phase of the composting process was completed became suppressive in some nurseries but remained conducive to damping off in others. Hoitink maintains that both the age of the compost and the composting environment effected the level of suppression. He concluded that the field produced compost was readily colonized by antagonists that commonly inhabit forest soils. This supports his claim that the presence of antagonists in mature composts is largely dependent on colonization of the compost material after peak heating has occurred. He points out that the microorganisms responsible for disease suppression are not the thermophilic organisms associated with the high temperature phases of composting. The high temperatures that are responsible for the destruction of fecal (human) and plant pathogens during composting can also destroy beneficial soil microorganisms.

Hoitink conducted a detailed examination of the fungal flora of the field produced and bin produced composts and found that fungal populations were much more diverse in the field produced compost. He also found that the more suppressive composts were characterized by high densities of Trichoderma sp. He speculated that the controlled addition of this species to compost might yield a predictably suppressive compost. Further tests showed that the addition of antagonistic organisms to a mixture of peat and CHB resulted in a rapid increase in the antagonist population and a high degree of suppression. Much higher levels were required to induce the same degree of suppression in a media that contained only peat. The antagonist fortified compost not only controlled damping off but also killed the pathogen (R. solani) and therefore had a protective as well as eradicative potential. Hoitink notes that very few soil fungicides have both qualities.

Chen et al. (12) studied various aspects of two other composted waste products; those produced from separated cattle manure (manure from which the liquid has been physically removed) and grape marc (grape processing residues consisting of stems, skins, and stalks). They demonstrated that both materials, when composted, have the ability to suppress soil borne plant pathogens when used in container media. Both materials were tested for suppressiveness to Rhizoctonia solani and Sclerotium rolfsii. Media were inoculated with the pathogens at several concentrations and planted with beans. Severe disease was observed when peat was inoculated. At inoculum levels 100 times higher, plants grown in the composted materials were still healthy. Reduction of damping-off in the composts was also observed with radish as test plants.

In another experiment, Pathos transplants were grown in peat, composted grape marc, and composted separated manure. Each material was infested with Rhizoctonia solani. Root rot was first observed two weeks after planting in the peat mix. At the end of the experiment 90 percent of the plants were dead. Only 10 percent of the plants in the composted grape marc were dead at the end of the experiment. Similar positive results were obtained when a mixture of composted grape marc and peat (1:1 volume) was used. Chen and Hadar attribute the suppression to biological mechanisms and, like Hoitink, they concluded the the ability to supress plant pathogens is developed during the final stages of composting.

While the majority of research in this area has not focused specifically on composted solid wastes, there is a limited amount of work which supports the theory that refuse type composts may also exhibit some suppressive tendencies.

Lumsden, Lewis, and Millner (55) added 10 percent by volume of municipal waste compost to soil infested with Sclerotinia minor (which causes lettuce and peanut rot), Rhizoctonia solani (which causes damping-off and root rot of many vegetables), and A. euteiches (which causes pea root rot). The diseases caused by the pathogens were significantly decreased compared to the controls. Compost added to soil with other types of pathogens either did not affect disease or in some cases increased it. For example, damping-off of peas and beans caused by Pythium sp. was initially increased. When enough time was allowed after the compost was added for resident microbial flora to be affected, disease enhancement was reversed and the soil suppressed Pythium caused disease.

Van Assch and Uyttebroeck (102) showed that the introduction of increasing quantities of domestic waste compost had a suppressive effect on the action of Rhizoctonia solani and Pythium ultimum on beans and oats. In both cases the health index of plants in an artificially contaminated mixture of solid waste compost and sandy loam soil 25:75 (volume:volume) was comparable to those in a non contaminated control. No explanation was offered for the effect other than to point out that decreased pathogenesis could be due to many single or interactive factors including antagonism, antibiosis, microbial competition, toxicity of heavy metals or several other mechanisms.

Although only minimal work has been done in this area relating specifically to solid waste composts, with the growing interest in organic farming and non chemical methods of pest control, it is likely that the subject will gain wider attention in the future.

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ATTACHMENT C

AGRICULTURAL USE OF SOLID WASTE COMPOST PRODUCTS IN MINNESOTA

A SURVEY OF POTENTIAL CONSUMERS

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Introduction

As Minnesota's most predominate method of solid waste disposal, landfilling, has become less environmentally acceptable and more highly regulated, alternative solid waste disposal methods are receiving more attention. Those alternative methods include reuse/recycle, incineration and composting. Several solid waste incinerators and refuse-derived fuel (RDF) plants are currently being planned around the State and some are already in operation. Many communities have initiated curbside recycling and yard waste composting programs to lessen the volume of solid waste which ultimately must be disposed of. There is also considerable interest in solid waste composting and several county projects are currently in the planning stages.

Probably the most important factor in planning a solid waste composting facility will be in accurately assessing the ultimate use or uses of the product generated. Many potential compost markets exist in Minnesota including horticulture (e.g., landscaping, nurseries, sod production), groundskeeping (e.g., golf courses, athletic fields, parks, etc.), reclamation (e.g., mineland, highway construction, reforestation), and finally, agriculture. A University of Minnesota report, entitled "The Utilization of Solid Waste Composts, Co-Composts, and Shredded Refuse on Agricultural Land" is available from the Soil Science Department. This report summarizes compost research studies and demonstration projects from the United States and other countries. The report includes a section on the chemical characteristics of compost quality, a section on yield effects on crops such as corn, small grains, forages, and various vegetables and a third section on changes in soil physical properties produced from compost application. Information is also provided on studies where sorted and shredded refuse was applied directly to soil without composting.

Many of the research results summarized in the aforementioned report were favorable. Crop yields were increased, nutrient status of soils were enhanced, and soil physical conditions were improved. A logical second step seemed to be to share this information with the agricultural community and survey their interest in compost use. Consequently. four meetings were conducted during January through March of 1987 in Farmington, Anoka, Corcoran, and Hugo, Minnesota. At these meetings, farmers were presented with information on the compost process, compost quality, yield effects, and soil effects. Various types of composts were circulated for visual examinations. A compost fact sheet (Appendix A) was distributed. And finally, a compost-use questionaire (Appendix B) was completed by each attendee. The following paragraphs summarize the results of the submitted questionaires.

Farmers Surveyed

Completed surveys were submitted by 37 farmers who represented management control of over 13,000 acres. Approximately one half of the completed surveys were from Dakota County residents. These people controlled 59 percent of the total acreage represented in the survey.

Most of the farmers (81%) owned the land they farmed. In addition to farming their own land, 8 of these farmers leased or rented additional acreage. Five of the farmers surveyed did not own any land, but leased or rented it from others.

The majority of the acreage (66%) represented in the survey was used for growing field crops, presumably corn, soybeans and small grains. Acreage used for forage crop production was the second largest category represented, followed by set-aside acreage.

The farmers surveyed were asked to rank solid waste management practices from the one they preferred the most, to the least. The most preferred option was reuse/recycling. The second most preferred was composting. Composting was followed very closely by incineration. Landfilling and open burning were the least preferred by quite a margin. Of the 37 farmers surveyed, six had indicated that their farm or a very near farm had at one time been proposed as a candidate landfill site. These farmers appeared to look favorably on composting slightly more than the average.

TABLE 1 -- Cross-section of farmers surveyed.

County	Attendees	Field Crops	Forage Crops	Pasture	Set-Aside	Non-Tillable	Other	Total
		(acres)						
Anoka	8	1395	780	260	280	585	130	3430
Hennepin	5	855	170		130	40		1195
Dakota	19	6205	935		618	130	5	7893
Washington	4	315	215		99	121	50	800
Chisago	1	60	20	20		10		110
TOTAL	37	8830	8120	280	1127	886	185	13428

Compost Quality

Tables 2 and 3 summarize the importance of various compost characteristics to the farmers surveyed. From these results, it would appear that contaminant level (e.g., heavy metal, toxic organic compounds, etc.), the presence of glass and plastic, and cost are of major concern to potential agricultural users of compost. Of secondary importance are nutrient, organic matter and salt contents, and ease of handling. Of lower importance are particle size, product consistency, product availability, the necessity for large application rates and odor.

Most of these compost characteristics can be controlled by proper upfront planning, selecting raw material inputs, process monitoring, and product monitoring. Based on the results of this survey, the focus of compost planners and managers should be in the area of quality control. That is to say, producing a product that has a low contaminant level and minimal amounts of visible plastic and glass. This can probably best be accomplished by proper sorting, shredding, and screening, as well as selecting high quality raw material inputs which are inherently low in contaminants (e.g., residential solid wastes, yard wastes, animal manures, etc.) versus inputs with higher contaminant levels (e.g., industrial wastes, sewage sludges, etc.).

TABLE 2 -- Importance of various compost characteristics.

Characteristic	Important 1	2	3	Unimportant 4	5
			%*		
Nutrient content	49	17	23	6	6
Organic matter content	46	40	9	3	3
Salt content	42	30	15	6	6
Contaminants	82	9	3	3	3
Particle size	25	13	18	26	18
Presence of glass or plastic	83	9	6	0	3
Product consistency	29	35	29	6	0
Product availability	26	24	26	9	12
Product odor	21	21	12	36	9
East of handling	50	21	18	3	9
Cost	86	10	0	0	3

*Percent of responses selecting the indicated importance value (1 to 5)

TABLE 3 -- Importance of the potential limitations to compost use.

Characteristic	Important 1	2	3	Unimportant 4	5
			%*		
Contaminant level	76	15	3	0	6
Presence of glass or plastic	85	9	6	0	0
Product odors	20	29	23	20	9
Large application rates	18	32	32	12	6

*Percent of responses selecting the indicated importance value (1 to 5)

Related to contaminant level, the farmers were questioned as to what they felt the level of environmental risk was in using compost. They were asked:

> "Do you feel the use of compost or agricultural land has less, more or equivalent risks to the environment as compared to other agricultural practices such as from chemical use?"

Their responses were:

40% Compost has less risk
31% Compost has same risk
20% Compost has greater risk
6% Not comparable
3% Other

Even though contaminant level rated high in importance with the majority of respondents, most felt the use of compost represented the same or less environmental risk compared to other farming practices.

Of the agricultural benefits of compost use, the ability of compost to increase both nutrient and water-holding capacities of soils was most important (Table 4). Since both of these soil properties are of more benefit in coarser-textured soils, compost planners should possibly direct their attention to areas of the state with these soil characteristics. The other beneficial properties were still important but to a lesser degree.

TABLE 4 -- Importance of the potential benefits to compost use.

Characteristic	Important 1	2	3	Unimportant 4	5
			%*		
Increased water-holding capacity of sandy soils	49	20	11	9	11
Improved aeration/drainage of clayey soils	29	23	26	9	14
Reduced runoff and erosion	35	21	32	6	6
Replace lost topsoil	21	24	36	9	9
Increased nutrient-holding capacity	31	34	9	20	6

*Percent of responses selecting the indicated importance value (1 to 5)

Interest in Compost Use

A portion of the survey dealt with the interest the farmers themselves had in actually using solid waste compost on their farms. Prior to answering several questions regarding their interest, two compost definitions were provided as follows:

"Good" Quality Compost - A solid waste compost that has a higher nutrient content, lower contaminant level, lower odor potential, little, if any, discernible particles of glass and plastic, uniform granular texture, and consistently small particle size.

"Poor" Quality Compost - A solid waste compost that has a lower nutrient content, higher contaminant level, higher odor potential, particles of broken glass and long, shredded pieces of plastic, non-uniform, coarse texture, and inconsistent particle size. It is assumed that a poor quality compost can still be used safely and provide soil and crop benefits, but extra precaution may be necessary in its use. Also, a poor quality compost may not have one or two of these unfavorable characteristics.

After reading these definitions, the farmers were asked to answer several multiple choice questions. The first question asked which of several statements best described their feelings regarding compost use. The following was their response:

47% I may be interested in using compost, but I feel more research is necessary.

33% I would be willing to try a <u>good</u> quality compost only on my farm.

11% I would be willing to try a <u>good</u> or <u>poor</u> quality compost on my farm.

8% I am not at all interested in using compost.

Two important findings were obtained from the responses to the questions. First, the overall majority of respondents (91%) indicated a favorable response to compost use. And secondly, there is a perceived need for additional research into compost use.

When asked what best described their feelings if tomorrow a <u>good</u> quality compost was offered to them at what that individual felt was a reasonable price, the following responses were attained:

42% I may be interested in the future, but I feel more research is necessary.

36% I would use it on a trial basis only and if results were satisfactory, have it applied on more acreage.

17% I would have it applied on as much acreage as possible.

6% Not interested.

As with the previous question, a majority of farmers were interested in using a good quality compost, but about one-half felt more research is necessary.

The same question as the previous one was asked, except this time regarding the use of a <u>poor</u> quality compost. The following responses were obtained:

61% Not interested.

22% I would use it on a trial basis only and if results were satisfactory, have it applied on more acreage.

14% I may be interested in the future, but I feel more research is necessary.

3% I would have it applied on as much acreage as possible.

When asked about their interest if offered a poor quality compost at a reasonable price, results were overall negative. About 48%, however, indicated they still might be interested dependent upon research on trial basis results.

In an attempt to summarize and quantify the farmers' interest in compost use the following question was asked:

"Assuming (a) researchers and pollution control officials felt that compost utilization was environmentally acceptable, and (b) you or a neighboring landowner used compost on a trial basis on a few acres and also found it to be acceptable, and (c) an agreeable cost for the compost and its application was arrived at, how many acres would you have compost applied to?"

Seventy percent of the farmers surveyed indicated acreages ranging from 5 to 450 acres. The combined acreage totalled 1995 acres or 18% of the total cropped acres controlled by the farmers responding to the survey. Assuming a compost application rate of 100 tons per acre the findings from just this small survey (37 farmers) would indicate a potential market for 200,000 tons of solid waste compost. If the farmers in this survey were representative of all farmers in the State of Minnesota, a market for many million tons of compost is available. A larger survey of farmers having reviewed the results of experimental field trials would be necessary to bear this out.

Compost Revenues

Solid waste planners are often faced with the question of how much revenue can be expected from a proposed solid waste composting program. To deal with this issue, farmers were asked what they felt was a reasonable charge for a compost product, its delivery, and its application. The responses are summarized in Table 5 below:

TABLE 5 -- Potential revenues from compost sales.

Compost Quality		
Good	Poor	Response
- - - %* - - -		
0	0	Greater than $50 per acre
16	0	$10 to $50 per acre
29	17	Less than $10 per acre
37	20	It would have to be free
9	11	I would have to be paid to use it
9	51	I would not be interested in using this compost no matter if it was free or if I was paid to use it.

*Numbers in each row represent the percentage of farmers selecting indicated response.

As previous questions indicate, Table 5 shows more farmers are interested in using a good quality compost (91%) over a poor quality one (47%). More farmers are willing to pay for a good quality compost (35%) versus a poor quality one (17%). Even though farmers might be willing to pay for a good quality compost, the amount paid would not begin to cover the costs of production, delivery, and application. Assuming an application rate of 100 tons per acre, 16% of the farmers surveyed would be willing to pay somewhere in the vicinity of only 10 to 50 cents a ton, and 29% less than 10 cents a ton. From these results, it would appear that solid waste planners should not rely on any monetary return from the agricultural compost market.

Summary Questions

In conclusion, several questions were asked in order to summarize the farmer's feelings and interest and to provide for future discretion in compost related activities. For the most part, the responses to these questions were overwhelming one way or the other. The following are the responses to the summary questions:

Agree	Disagree	
--- %	-----	
91	9	Solid waste compost should be allowed on agricultural land if certain precautions are followed.
82	18	I would be willing to use compost.
97	3	The state should develop rules regulating the quality of solid waste compost.
78	22	The state should develop rules regulating the use of solid waste compost.
100	0	The University of Minnesota should continue its research into the agricultural use of solid waste compost.
90	10	My county extension agent should set up demonstration plots so I can see the effects of utilizing solid waste compost.
90	10	I would like to learn more about the use of solid waste compost on agricultural land.
7	93	I am totally opposed to the use of solid waste compost on agricultural land.

Survey Conclusions

1. Reuse/recycling, composting and incineration are the most favored solid waste management practices.

2. The most important compost characteristics are contaminant levels, presence of glass and plastic, and cost.

3. The most important benefits from compost use are increased nutrient- and water-holding capacities of soils.

4. Farmers are definitely interested in using compost, especially good quality composts.

5. Many feel more research is necessary in the area of agricultural compost use.

6. Great potential exists for the agricultural use of vast quantities of solid waste compost ranging into the millions of tons per year.

7. Little, if any, income should be expected from compost sales to the agricultural market.

8. The State should develop rules regulating the quality and use of solid waste compost.

APPENDIX A

COMPOST FACT SHEET

COMPOST INFORMATION SHEET

University of Minnesota

THE PROBLEM

Minnesota is faced with a severe solid waste management problem. Several years ago the open burning of garbage was prohibited to protect our air quality. This action caused a major shift to the development of landfills throughout the State. However, due to reasons such as improper siting, poor management, and/or ground water contamination many landfills have been closed or will be closed in the near future. Because of the tremendous quantities of garbage produced in the seven county Twin Cities area, many of its landfills will soon run out of space. This solid waste dilemma prompted the Minnesota State Legislature to require that all counties develop long-term solid waste management plans. Hopefully, this planning effort will head off a potentially severe solid waste problem.

THE SOLUTIONS

Several options exist to mitigate the solid waste problem. Probably the most desirable and cheapest options are to recycle and/or reduce the amount of garbage generated. Homeowners can compost yard wastes and utilize it on their gardens and lawns. People can recycle paper, cans, glass and used oil. The consumer products and food service industries can limit overpackaging of their products. Consumers can also purchase many grocery and other items from bulk supplies, such as at coops and many supermarkets.

Possibly the least desirable of all solid waste management options is the siting of new landfills. Generally, this option stimulates a great degree of public resistance due to the fears of ground water contamination, lowered property values, odors, and the destruction of prime farmland. Landfills of the future, however, should have less problems due to the safeguards that will go into their construction and management. These safeguards include double liners, leachate collection, and ground water monitoring and, will greatly increase the costs of solid waste disposal.

What appears to be currently a very popular solid waste management option is incineration. Depending on facility design, the system may remove recyclables, generate electricity or heat energy, and/or produce a solid fuel. Disadvantages of this option may include reduced air quality, high construction costs, and an ash disposal problem.

The last option which usually isn't given much consideration in the United States is solid waste composting. Composting is the microbial breakdown of organic materials, such as garbage, into a dark colored, highly organic friable material which typically has an "earthy" odor. Composting is a significant solid waste management practice in Europe, the Soviet Union, India, and the Far East. In this country, the majority of materials currently being composted are yard wastes, feedlot manures, crop residues, forestry product wastes, and sewage sludges. These materials are composted to reduce volume, increase ease of handling, eliminate odor potential, destroy disease-causing pathogens, and produce an acceptable soil conditioner or and plant nutrient source.

COMPOSTING

Many people feel that composting is recycling at its best. Most solid waste is generated from products which are originated from the land including paper, food, and fiber. These materials, once disposed of, can be composted and returned back to the land. Unlike landfilling, large tracts of land are not taken out of production and permanently converted. In fact, just the opposite is true. Land can be enriched and improved by compost application. Only the area where the compost is being produced will temporarily be affected. This land can always be converted back to its original status.

Unlike incineration, emissions of potentially harmful chemicals are not a concern in the composting process. However, if improperly managed odors can be a problem at composting facilities. Both landfills and incinerators are designed with a certain design life expectancy, such as 20 years. At the end of this design life, a new landfill location must be found or the incineration facility may likely need a complete overhaul or rebuild. A composting facility relies primarily on biological activity and therefore is constantly renewable. Depending on the design, there are certain mechanical components which must be periodically replaced, but there is no reason why the facility cannot be used for an extremely long period of time.

What makes solid waste composting appear to be so attractive in Minnesota is the vast number of users available which could benefit from such a compost product. This list would include:

* turf establishment and maintenance - golf courses, cemeteries, athletic fields, airports, sod farms, parks, private lawns

* nursery crops and ornamentals

* land reclamation - mine spoils, tailings basins, gravel pits

* landscaping - parks, highway construction, flower gardens, arboretums

* horticultural production - nursery crops, ornamentals, potting media

* agricultural production - field crops, vegetable crops, forage grasses

It would appear that the largest potential user of compost in Minnesota would be the agricultural sector. This supposition is especially true if the material could be obtained at a low or at no cost. Depending on the initial materials used in the compost and the degree of processing (shredding, screening, and separation), solid waste compost would have some or all of the following benefits and limitations to the agricultural user:

Benefits:

* increased water-holding capacity of sandy soils

* improved aeration and drainage of heavy clay soils

* reduced runoff and erosion on sloped land due to increased water infiltration and storage, and improved aggregate stability

* increased nutrient-holding capability which can result in more efficient use of fertilizers

* antibiotic effects on certain plant diseases

* source of macro- and micro-nutrients

Limitations:

* large application rates (20 to 100 tons/acre) are needed to condition soil and/or provide plant nutrients

* contains residual levels of contaminants such as heavy metals

* may contain small fragments of non-biodegradable materials such as glass and plastic

THE FUTURE

The University of Minnesota is currently involved in compost research funded by the State Legislature and Metropolitan Council. Solid waste compost samples have been collected from around the world and are being analyzed for plant growth and soil conditioning properties. Future plans include small demonstration plot studies investigating the beneficial use of compost on agricultural soils and also a survey of farmers regarding their desire to use such a product. A literature review is available from the Soil Science Department which summarizes research results by various research organizations on crop yield effects and soil conditioning properties of solid waste compost application. Several Minnesota communities are already planning solid waste composting facilities which are scheduled for construction within the next few years.

APPENDIX B

COMPOST USE QUESTIONNAIRE

UNIVERSITY OF MINNESOTA COMPOST RESEARCH
AGRICULTURAL USE SURVEY

Preliminary Information

1. Are you currently involved in farming? _________ (yes or no)

2. In what county is your farm? ___________________

3. How many acres are you farming? (approximate)

   _____ acres in field crops
   _____ acres in forages
   _____ acres in set aside program
   _____ acres non-tillable
   _____ acres, other: ______________________________ (please specify)

4. Of the farm described in questions 2 and 3 above, are you: (check most appropriate)

   _____ Landowner
   _____ Leaser or renter
   _____ Relative of landowner (e.g. son)
   _____ Other, describe: ____

5. Has your farm or a farm very near to you ever been proposed as a candidate landfill site? ____________ (yes or no)

6. Rank the following solid waste management practices assigning the number 1 to the most preferred, number 2 to the second most preferred and so on, to number 5 for the least preferred practice in your opinion.

   _____ Incineration
   _____ Composting
   _____ Landfilling
   _____ Open burning
   _____ Reuse/recycling

Compost Use

7. Of the following compost characteristics, what do you believe would be your major concerns regarding compost quality. Rate each of the following on a 1 to 5 basis where 1 is important and 5 is unimportant. Circle only one number for each.

	Important				Unimportant
Nutrient content	1	2	3	4	5
Organic matter content	1	2	3	4	5
Salt content	1	2	3	4	5
Contaminants	1	2	3	4	5
Particle size	1	2	3	4	5

	Important				Unimportant
Presence of glass or plastic	1	2	3	4	5
Product consistency	1	2	3	4	5
Product availability	1	2	3	4	5
Product odor	1	2	3	4	5
Ease of handling	1	2	3	4	5
Cost	1	2	3	4	5
Other, specify ________________________	1	2	3	4	5

Additional Comments: ____

____

____

8. Of the potential benefits of compost use, what do you believe would be your major reasons for using compost, assuming you were to use it. Rate each of the following on a 1 to 5 basis where 1 is important and 5 is unimportant. Circle only one number for each.

	Important				Unimportant
Increased water-holding capacity of sandy soils	1	2	3	4	5
Improved aeration/drainage of clay soils	1	2	3	4	5
Reduced runoff and erosion	1	2	3	4	5
Replace lost topsoil	1	2	3	4	5
Increased nutrient-holding capacity	1	2	3	4	5
Nutrient source	1	2	3	4	5
Other, specify ________________________	1	2	3	4	5

9. Of the potential limitations of compost use, what do you believe would be your major reasons for not using compost, assuming you are not interested in using it. Rate each of the following on a 1 to 5 basis where 1 is important and 5 is unimportant. Circle only one number for each.

	Important				Unimportant
Contaminant level	1	2	3	4	5
Presence of glass or plastic	1	2	3	4	5
Product odors	1	2	3	4	5
Large application rates	1	2	3	4	5
Other, specify ________________________	1	2	3	4	5

The definitions below will be used in the following questions:

"Good" Quality Compost - A solid waste compost that has a higher nutrient content, lower contaminant level, lower odor potential, little, if any, discernible particles of glass and plastic, uniform granular texture, and consistently small particle size.

"Poor" Quality Compost - A solid waste compost that has a lower nutrient content, higher contaminant level, higher odor potential, particles of broken glass and long shredded pieces of plastic, non-uniform, coarse texture, and inconsistent particle size. It is assumed that a poor quality compost can still be used safely and provide soil and crop benefits, but extra precaution may be necessary in its use. Also, a poor quality compost may not have one or two of these unfavorable characteristics.

10. Which of the following statements best describes your feelings. Circle only one.

    a. I would be willing to try a good quality compost only on my farm.
    b. I would be willing to try either a good or poor quality compost on my farm.
    c. I may be interested in using compost, but I feel more research is necessary.
    d. I am not at all interested in using compost.
    e. Other, specify ______________________________

11. Which of the following statements best describes your feelings if tomorrow you were offered a <u>good</u> quality compost at what you felt was a reasonable cost. Circle only one.

    a. I would have it applied on as much acreage as possible.
    b. I would use it on a trial basis only and if results were satisfactory have it applied on more acreage.
    c. I may be interested in the future, but I feel more research is necessary.
    d. Not interested.
    e. Other, specify ______________________________

12. Which of the following statements best describes your feelings if tomorrow you were offered a <u>poor</u> quality compost at what you felt was a reasonable cost. Circle only one.

    a. I would have it applied on as much acreage as possible.
    b. I would use it on a trial basis only and if results were satisfactory have it applied on more acreage.
    c. I may be interested in the future, but I feel more research is necessary.
    d. Not interested.
    e. Other, specify ______________________________

13. Assuming the charge for a good quality compost included the compost, its delivery, and its application, what do you feel would be a reasonable price for the material and service. Circle only one.

    a. Greater than $50 per acre.
    b. $10 to $50 per acre.
    c. Less than $10 per acre.
    d. It would have to be free.
    e. I would have to be paid to use it.
    f. I would not be interested in using a good quality compost no matter if it was free or if I was paid to use it.
    g. Other, specify ______________________________

14. Assuming the charge for a poor quality compost included the compost, its delivery, and its application, how much do you feel would be a reasonable price for the material and service. Circle only one.

    a. Greater than $50 per acre.
    b. $10 to $50 per acre.
    c. Less than to $10 per acre.
    d. It would have to be free.
    e. I would have to be paid before I would use it.
    f. I would not be interested in using a poor quality compost no matter if it was free or if I was paid to use it.
    g. Other, specify ______________________________

15. Do you feel the use of compost on agricultural land has less, more, or equivalent risks to the environment as compared to other agricultural practices such as farm chemical use?

    _____ Compost has less risk.
    _____ Compost has greater risk.
    _____ Compost has the same risk.
    _____ Not comparable.
    _____ Other, specify ______________________________

16. Assuming (a) researchers and pollution control officials felt that compost utilization was environmentally acceptable, and (b) you or a neighboring landowner used compost on a trial basis on a few acres and also found it to be acceptable, and (c) an agreeable cost for the compost and its application was arrived at, how many acres would you have compost applied to? __________ acres

17. I feel an agreeable cost for compost and its application is one where (circle one):

    a. I pay for the compost and its application.
    b. The compost and its application are free.
    c. I am paid for compost application to my land.
    d. Other, specify ______________________________

18. Please indicate whether you agree or disagree with the following statements:

Agree/Disagree	Solid waste compost should be allowed on agricultural land if certain precautions are followed.
Agree/Disagree	I would be willing to use compost.
Agree/Disagree	The state should develop rules regulating the quality of solid waste compost.
Agree/Disagree	The state should develop rules regulating the use of solid waste compost.
Agree/Disagree	The University of Minnesota should continue its research into the agricultural use of solid waste compost.
Agree/Disagree	My county extension agent should set up demonstration plots so I can see the effects of utilizing solid waste compost.
Agree/Disagree	I would like to learn more about the use of solid waste compost on agricultural land.
Agree/Disagree	I am totally opposed to the use of solid waste compost on agricultural land.

ATTACHMENT D

COMPOSITION OF YARD WASTE COMPOSTS PRODUCED AT TWIN CITIES METROPOLITAN AREA CENTRALIZED COMPOSTING SITES

This project was supported by the Legislative Commission on Minnesota Resources and the Metropolitan Council of the Twin Cities Area

INTRODUCTION

Yard wastes such as leaves and grass clippings represent a significant portion of wastes currently disposed of in landfills. A waste characterization study conducted by Hennepin County in 1984 and 1985 showed that of 8.7% of the total solid waste being landfilled was yard waste (11).

The Metropolitan Council of the Twin Cities Area, in its 1986 Solid Waste Management Guide/Policy Plan (8) has identified composting as the preferred management option for yard wastes. That plan calls for a 16% reduction in the amount of Metro area wastes landfilled through recycling, waste reduction and composting activities. Composting of yard wastes alone could achieve half of that goal.

Yard wastes are particularly suited for composting for a number of reasons:

(1) Yard wastes are highly organic and therefore good feedstock for the composting process.

(2) Yard wastes are plant materials as opposed to manufactured materials and thus are less likely to contain significant amounts of contaminants such as trace metals.

(3) Yard wastes are often handled and disposed of separately by homeowners, thus it is relatively easy to segregate them from the rest of the waste stream. Extensive processing to remove materials such as glass, plastics, and metals is not necessary.

Participation at the Twin Cities Metro Area centralized composting sites has steadily increased in recent years; both in the amount of materials being deposited and the amount of finished compost being picked up for use. All of these factors lend support to efforts to increase yard waste composting as a landfill abatement practice for the Metropolitan Area.

Recognizing the importance of yard waste composting and given the fact that it represents the only significant solid waste composting currently practiced in the seven county area, yard waste composts have been included in several studies carried out as a part of the University of Minnesota Compost/Cocompost Research Project.

The most extensive work on this project involving yard waste composts has been chemical characterization. This particular aspect was emphasized because of concerns over lead (Pb) contamination in the environment and the potential for yard waste composts to contain unsafe levels of this element. Possible modes of yard waste compost contamination are either direct exposure of leaves and grass to automobile exhaust or the inclusion of street sweepings (which might contain high levels of lead from automobile exhaust) in the compost pile.

OBJECTIVES

A review of the literature showed very little information on the chemical compostition of yard waste composts. Essentially no data was available on lead levels of yard waste composts or similar materials. This monitoring study was undertaken to provide such information and to assess potential problems with the use of yard waste composts produced at the centralized facilities.

MATERIALS AND METHODS

Eleven different sites in the Twin Cities Metropolitan Area were sampled in 1985 and 1986 (Figure 1). The locations were selected to include sites from both highly urbanized areas where one might expect higher atmospheric lead levels and from more remote areas with less traffic and therefore less exposure to automoblile exhaust.

The sites also represent some differences in pile management. At the majority of sites, materials are deposited over the summer and fall months and allowed to compost for a period of approximately eighteen months. For example, compost available for pick-up or distribution in the spring of 1986 was produced from materials deposited in the summer and fall of 1984. At the Hennepin County facilities (sites E, J, and K) more intensive management practices such as shredding of materials and more frequent turning and watering of piles has enabled a shorter composting period. Compost available at these sites in the spring of 1986 was produced from materials deposited in the summer and fall of 1985.

All of the facilities now accept both leaves and other yard wastes such as grass clippings, and the materials are composted together in large windrows. However, during the summer and fall of 1984, grass clippings and leaves were collected and composted separately at site E. The two types of composts were individually sampled during the first round of sampling.

The first sets of compost samples were collected in the late fall of 1985. Sites J and K were not included in this initial sampling as all finished compost produced from 1984 materials had been distributed in the spring of 1985. The second sets of samples from sites E, J, and K were collected in May of 1986. The remainder of the sites were sampled for the second time in December of 1986. The schedule for the second set of sampling enabled collection of finished compost produced from 1985 materials prior to public distribution and pick-up.

Fourteen individual grab samples were collected from each site or from different windrows at a given site. The samples were taken along a transect along the ridgetop of the windrow. A 30-cm deep hole was made using a tiling spade and a grab sample of approximately one kilogram was taken from the bottom of the hole. A single composite sample of recently deposited leaves was also taken from each site in the fall of 1985 so that lead levels in finished compost could be compared with those in the starting materials.

Samples were air-dried, ground in a soil pulverizer and passed through a 5 mm screen. Stones, plastic, and other materials that could not be pulverized were discarded. The less than 5 mm fraction was ball-milled and then subsampled for analysis.

Chemical characterization of the composts included: total nitrogen by semi-micro Kjeldahl; total carbon by Leco CR-12 C determinator; pH and electrical conductivity (1:1 compost:water suspension); and elemental analyses by inductively coupled plasma (ICP) spectrometry for phosphorus, potassium, calcium, magnesium, aluminum, iron, sodium, manganese, zinc, copper, boron, lead, nickel, chromium, and cadmium.

RESULTS AND DISCUSSION

Lead data from the two sampling sets are summarized in Table 1. The year shown on the table indicates the year that fresh materials were deposited at the site. For example, 1984 samples consist of composts that were produced from 1984 leaves and/or grass. The sample of composted grass clippings collected at site E during the initial round of sampling is indicated by an asterisk. All other composts were produced from leaves or from a combination of leaves, grass clippings, and other yard wastes.

As might be expected, the highest lead concentrations were found in composts produced at sites in the most urban areas. In the 1984 batch the single sample with the highest lead concentration (329 mg/kg) was from location D. This site also had the highest average lead concentration (92 mg/kg) for 1984. In the 1985 samples the single sample with the highest lead concentration (380 mg/kg) was collected from location C. Location J had the highest average lead concentration (128 mg/kg) of the 1985 samples.

Data for two years is available for nine sites. At seven of those sites the average lead concentration was less in the second set of samples. These lower values might suggest that, as the consumption of leaded gasoline decreases, we can expect to see a corresponding decrease in the amount of lead in yard waste composts.

Lead concentrations in soils commonly range from 2 to 200 mg/kg (2). Recent studies have shown that levels in urban soils often exceed the upper end of this range (10). Thus it is not unlikely that the lead concentrations of yard waste composts may actually be less than those of some urban soils. Lead is quite insoluble in soil and tends to be excluded by plants (7). This fact has been demonstrated by considerable research - much of which has focused on the fate of trace metals when added to soils from the application of sewage sludges (4).

Generally, it has been considered safe to use garden produce grown in soils with total lead levels less than 500 mg/kg. The Food and Drug Administration, along with the Environmental Protection Agency, has suggested that sewage sludges containing less than 1000 mg/kg of lead can be used for the production of fruit and vegetable crops (14). The Minnesota Pollution Control Agency (MPCA), in its proposed Solid Waste Rules, has also established a level of 1000 mg/kg as the maximum allowable concentration of lead that may be contained in solid waste composts that are distributed in an unrestricted manner (9). It should be noted that the lead levels in the yard waste composts are considerably less than these limits.

Nitrogen and carbon contents, along with carbon:nitrogen (C:N) ratios are shown in Tables 2 and 3. Nitrogen contents range from 0.57 to 2.14%. The average for all sample sites is approximately 1.25%. There was considerable variation in carbon content with levels ranging from 4.4 to 39.3%. Some of the variation is likely due to differences in the degree of decompostion of the composts. It was also suspected that the high sand content of some of the samples resulted in relatively low carbon levels.

The C:N ratio is a commonly used indicator of compost maturity (the extent of decomposition). As decompostion occurs during the composting process, carbon is oxidized and released to the atmosphere as carbon dioxide. Thus there is a net reduction in the amount of carbon and a corresponding decrease in the C:N ratio. If inadequately decomposed yard wastes are added to soil, the materials will continue to break down in the soil. Soil nitrogen may be tied up (immobilized) by the decompostion process and plants growing in the soil may suffer from nitrogen deficiency.

Ratios of C:N ranging from less than 15:1 to less than 30:1 have been cited as limits below which nitrogen mineralization will occur; nitrogen is released from rather than immobilized by the organic matter. Studies carried as a part of the University of Minnesota Compost Research Project have shown that nitrogen mineralization from composted waste materials occurs when the C:N ratio is below 15:1 to 20:1. The majority of samples collected for the yard waste compost study have C:N ratios less than 20:1; several of these were less than 15:1. Thus it does not appear that nitrogen immobilization should be a major concern with most yard waste composts.

Other plant macronutrients such as phosphorus, potassium, calcium, and magnesium are also present in yard waste composts. Data on these elements are summarized in Tables 4 through 7. There is considerable variation in concentrations of these elements both with a given pile and from site to site. Differences are probably due to several factors including age of the compost, amount of water added, plant species, and the amount of soil that is inadvertently mixed into the pile during turning.

Average concentrations of phosphorus, potassium, calcium, and magnesium for all sites are 0.20, 0.30, 3.0, and 0.50 % respectively. Ranges of these elements that might ordinarily be expected in mineral soils are: phosphorus, 0.01 - 0.20 %; potassium, 0.17 - 3.30 %; calcium, 0.07 - 3.60 %; and magnesium, 0.12 to 1.50 %.

The concentrations of these elements in yard waste composts are more similar to those of a rich topsoil than commercial fertilizer materials. Yard waste compost is most appropriately used as an amendment which, when worked into soil, will improve physical and biological properties and provide small amounts of nutrients over a period of time. Compost is also an excellent mulch material for the home lawn and garden. Applied around the base of plants it can help to control weeds and conserve soil moisture.

Concentrations of trace elements other than lead, are shown in Tables 8 through 16. Of these iron, sodium, manganese, zinc, copper, and boron are essential plant nutrients and their presence in composts may provide some benefit. However, all of the trace elements, at too high concentrations, can be toxic to plants or cause other problems due to nutrient imbalances. Of particular concern, in addition to lead, are the elements cadmium, chromium, copper, nickel, and zinc. The Minnesota Pollution Control Agency, in its proposed Solid Waste Rules has established maximum concentrations of these elements for composts that are distributed in an unrestricted manner. The allowable levels in milligrams per kilogram (parts per million) on a dry weight basis are:

Cadmium	10
Nickel	100
Copper	500
Chromium	1000
Zinc	1000

A quick survey of the data shows that yard waste composts easily meet these requirements. Typical concentrations of most of these elements found in the yard waste composts are many fold less than the allowable levels.

Values of pH and electrical conductivity (EC) are important parameters in assessing the suitability of a material for plant growth. The acidity or alkalinity of a material is indicated by pH. The pH scale ranges from 0 to 14 with 7 being neutral. The greater the pH above 7, the more alkaline a material and the lower the pH below 7, the more acidic a material. A soil pH range of 5.5 to 7.0 is optimum for the growth of most plants. As is shown in Table 18, pH values for yard waste composts tended to be in the 7.0 to 8.0 range. Although slightly alkaline, the use of compost should not pose problems when diluted by mixing into soil. In fact, many Minnesota soils tend to be slightly acidic and benefit from practices that increase soil pH (6). Yard waste composts are not well suited for use on acid loving plants such azaleas, strawberries, and blueberries.

Soluble salts refer to the inorganic constituents that are soluble in water. Elements contributing to salinity include calcium, magnesium, and sodium in combination with chlorides, sulfates, and nitrates. A high soluble salt content increases osmotic pressure in the soil solution. The result is a decrease in availability of water to plants. Both seed germination and plant growth are adversely affected by a high soluble salt content.

The ability of a solution to conduct electricity is approximately proportional to its soluble salt content. Thus, the EC of an extract is a commonly used indicator of soluble salt concentration. The conductance is often expressed as millimhos per centimeter (mmho/cm). At soil EC values less than 2 mmho/cm salinity effects are largely negligible, between 2 and 4 mmho/cm yields of sensitive crops may be affected, and at EC values greater than 4 mmho/cm yields of many crops are restricted (15).

The EC values of all compost samples ranged from 0.3 to 10.6 mmho/cm. Site averages ranged from 0.4 to 3.4 mmho/cm. The soluble salt contents of yard waste composts are satisfactory for plant growth. As with pH, dilution of the compost by mixing into soil will prevent adverse effects. It is not recommended that undiluted compost be used as a growing meduim for potted plants or germinating seeds. Research in this area has shown that media used for these purposes should not contain more than 25% by volume of compost materials (13).

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FIGURE 1. SAMPLING LOCATIONS

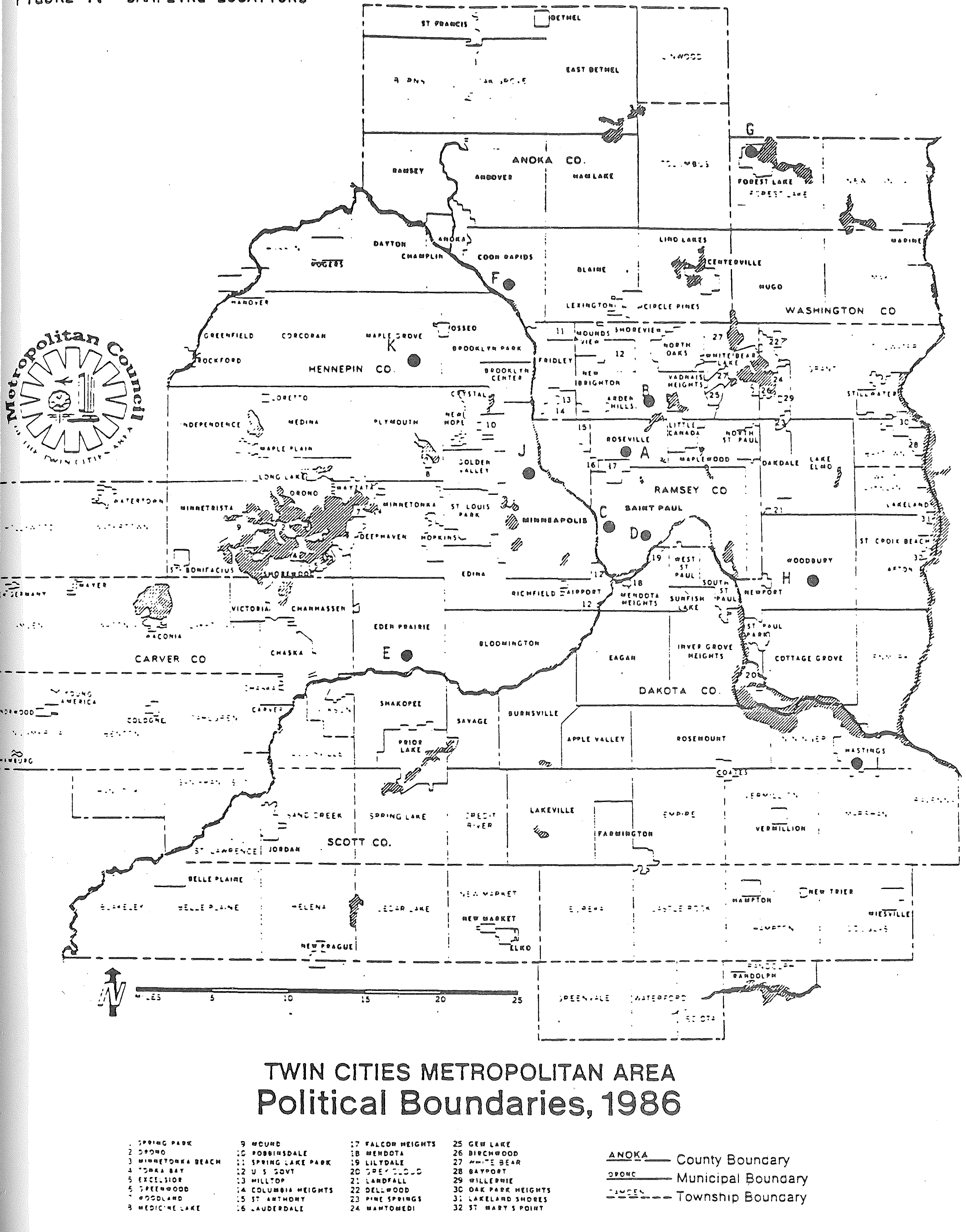

Table 1. Lead content of yard waste compost and leaves.

Site	Year	Compost Range	Compost Mean	Compost Standard Deviation	Leaves
		mg/kg			
A	1984	13-74	34	16	
	1985	10-20	14	3	5
B	1984	18-58	33	12	
	1985	11-27	18	5	<2
C	1984	54-121	83	22	
	1985	43-380	98	84	9
D	1984	32-329	92	74	
	1985	19-123	69	34	7
E	1984	40-60	51	7	
	1984*	35-46	42	3	
	1985	24-97	43	18	13
F	1984	27-75	48	13	
	1985	1-30	10	7	3
G	1984	23-45	34	6	
	1985	15-43	25	6	<2
H	1984	23-59	33	12	
	1985	6-17	10	3	<2
I	1984	26-70	53	14	
	1985	22-253	60	60	4
J	1984	--	--	--	
	1985	64-218	127	35	26
K	1984	--	--	--	
	1985	34-70	48	10	10

Table 2. Nitrogen content of yard waste composts.

Site	Year	Nitrogen Range	Nitrogen Mean	Nitrogen Standard Deviation
		%	%	%
A	1984	0.54-1.74	1.30	0.38
	1985	0.65-1.93	1.39	0.28
B	1984	0.70-1.65	1.26	0.36
	1985	0.74-1.82	1.38	0.31
C	1984	0.74-1.63	1.24	0.24
	1985	0.75-1.68	1.39	0.28
D	1984	0.50-4.20	1.54	0.90
	1985	1.25-3.00	1.82	0.52
E	1984	0.66-1.47	0.91	0.20
	1984*	1.29-1.70	1.44	0.11
	1985	0.42-1.19	0.93	0.18
F	1984	0.40-3.52	1.16	0.89
	1985	1.16-3.01	2.14	0.52
G	1984	0.58-1.47	0.85	0.27
	1985	0.86-1.44	1.19	0.19
H	1984	1.03-1.73	1.40	0.20
	1985	0.92-2.03	1.60	0.31
I	1984	0.38-1.88	0.92	0.54
	1985	0.52-1.56	1.07	0.32
J	1984	--	--	--
	1985	0.33-0.87	0.57	0.18
K	1984	--	--	--
	1985	0.73-1.10	0.86	0.09

Table 3. Carbon content and carbon nitrogen ratio of yard waste composts.

Site	Year	Carbon Range	Carbon Mean	Carbon Standard Deviation	Carbon:Nitrogen Ratio
		----------------------	%	----------------------	
A	1984	11.2-41.4	29.2	9.0	22.8
	1985	13.7-36.9	27.5	7.2	19.6
B	1984	9.7-28.8	21.6	6.0	17.3
	1985	13.7-26.6	19.8	4.9	14.2
C	1984	13.3-27.8	21.7	4.4	17.6
	1985	11.3-28.3	22.1	4.7	14.7
D	1984	9.7-34.5	21.5	7.1	15.4
	1985	16.2-38.2	22.7	5.9	12.7
E	1984	11.8-16.6	14.2	1.5	16.8
	1984*	13.9-19.7	16.2	1.8	11.3
	1985	15.8-23.9	18.9	3.8	20.4
F	1984	4.4-39.3	16.3	12.2	14.1
	1985	12.6-40.7	28.4	7.4	14.1
G	1984	9.8-18.5	13.2	2.4	15.9
	1985	11.8-25.1	16.8	3.2	14.2
H	1984	8.2-22.4	16.6	3.7	11.5
	1985	10.0-26.1	19.2	3.8	12.0
I	1984	5.4-25.2	11.8	5.9	13.8
	1985	11.4-24.6	18.1	4.0	17.4
J	1984	--	--	--	--
	1985	17.2-31.7	13.7	4.0	24.8
K	1984	--	--	--	--
	1985	12.9-19.7	15.6	2.2	18.3

Table 4. Phosphorus content of yard waste composts.

Site	Year	Phosphorus Range	Phosphorus Mean	Phosphorus Standard Deviation
		%		
A	1984	0.07-0.18	0.15	0.03
	1985	0.13-0.50	0.23	0.12
B	1984	0.08-0.28	0.13	0.05
	1985	0.12-0.32	0.19	0.05
C	1984	0.09-0.20	0.14	0.03
	1985	0.11-0.22	0.18	0.04
D	1984	0.13-0.27	0.17	0.05
	1985	0.22-0.56	0.31	0.10
E	1984	0.07-0.15	0.10	0.02
	1984*	0.17-0.23	0.21	0.02
	1985	0.12-0.22	0.16	0.03
F	1984	0.05-0.50	0.14	0.11
	1985	0.20-1.15	0.44	0.25
G	1984	0.09-0.21	0.12	0.04
	1985	0.14-0.29	0.18	0.04
H	1984	0.15-0.27	0.20	0.04
	1985	0.22-0.46	0.34	0.07
I	1984	0.05-0.30	0.12	0.08
	1985	0.12-0.28	0.18	0.04
J	1984	--	--	--
	1985	0.06-0.09	0.08	0.01
K	1984	--	--	--
	1985	0.10-0.16	0.12	0.02

Table 5. Potassium content of yard waste composts.

Site	Year	Potassium Range	Mean	Standard Deviation
		%		
A	1984	0.07-0.19	0.16	0.03
	1985	0.19-0.97	0.41	0.19
B	1984	0.08-0.28	0.13	0.05
	1985	0.23-0.59	0.41	0.09
C	1984	0.09-0.20	0.14	0.03
	1985	0.16-0.71	0.47	0.14
D	1984	0.13-0.27	0.17	0.05
	1985	0.35-2.71	0.88	0.66
E	1984	0.08-0.15	0.10	0.02
	1984*	0.17-0.23	0.21	0.02
	1985	0.19-0.52	0.31	0.08
F	1984	0.07-0.73	0.23	0.16
	1985	0.29-1.82	0.61	0.30
G	1984	0.09-0.21	0.12	0.04
	1985	0.39-0.69	0.52	0.08
H	1984	0.15-0.27	0.20	0.04
	1985	0.58-1.42	0.87	0.30
I	1984	0.06-0.36	0.15	0.11
	1985	0.11-0.23	0.18	0.07
J	1984	—	—	--
	1985	0.04-0.14	0.06	0.02
K	1984	—	—	--
	1985	0.17-0.31	0.21	0.04

Table 6. Calcium content of yard waste composts.

Site	Year	Calcium		
		Range	Mean	Standard Deviation
		%		
A	1984	2.71-4.08	3.26	0.49
	1985	2.46-5.55	4.09	0.96
B	1984	0.94-2.36	1.82	0.39
	1985	1.05-2.69	1.81	0.45
C	1984	2.57-6.69	4.22	0.99
	1985	2.99-5.22	4.51	0.60
D	1984	2.77-4.73	3.48	0.53
	1985	1.95-5.31	3.05	1.09
E	1984	3.62-4.44	4.07	0.21
	1984*	2.13-3.44	2.55	0.34
	1985	3.10-4.38	3.85	0.35
F	1984	0.38-3.16	1.36	0.80
	1985	0.89-5.15	3.13	1.21
G	1984	2.23-8.04	3.65	0.14
	1985	1.84-5.73	3.13	1.03
H	1984	0.70-3.05	1.67	0.52
	1985	1.84-5.73	3.13	0.61
I	1984	1.54-3.43	2.18	0.43
	1985	1.84-3.37	2.60	0.44
J	1984	—	—	—
	1985	2.44-3.32	3.02	0.25
K	1984	—	—	—
	1985	2.28-3.51	2.76	0.37

Table 7. Magnesium content of yard waste composts.

Site	Year	Magnesium Range	Mean	Standard Deviation
		%		
A	1984	0.39-0.85	0.54	0.13
	1985	0.35-0.70	0.52	0.11
B	1984	0.18-0.99	0.37	0.21
	1985	0.20-0.36	0.26	0.04
C	1984	0.55-1.23	0.85	0.25
	1985	0.61-1.01	0.80	0.12
D	1984	0.39-0.57	0.47	0.05
	1985	0.34-0.54	0.42	0.05
E	1984	0.89-1.34	1.16	0.15
	1984*	0.49-1.05	0.65	0.16
	1985	0.75-1.06	0.88	0.09
F	1984	0.09-0.46	0.20	0.09
	1985	0.21-0.65	0.44	0.11
G	1984	0.30-0.55	0.42	0.06
	1985	0.27-0.45	0.39	0.06
H	1984	0.14-0.34	0.26	0.05
	1985	0.17-0.48	0.33	0.09
I	1984	0.31-0.90	0.61	0.20
	1985	0.38-0.68	0.46	0.08
J	1984	—	—	—
	1985	0.59-1.11	0.82	0.13
K	1984	—	—	—
	1985	0.41-0.61	0.49	0.06

Table 8. Iron content of yard waste composts.

Site	Year	Iron Range	Iron Mean	Iron Standard Deviation
		mg/kg		
A	1984	1651-3071	2298	542
	1985	913-2409	1623	570
B	1984	1857-2749	2357	262
	1985	1835-2828	2042	343
C	1984	1883-5048	3332	710
	1985	2271-3178	2667	259
D	1984	2035-3921	3130	656
	1985	1112-3370	2523	724
E	1984	2744-3642	3058	245
	1984*	2928-4401	3848	345
	1985	1971-2922	2452	269
F	1984	1687-2406	2005	212
	1985	589-2484	1327	621
G	1984	2303-3089	2643	238
	1985	2659-3717	2886	283
H	1984	2275-3655	2798	364
	1985	1958-3092	2673	316
I	1984	—	—	—
	1985	1601-2096	1853	158
J	1984	—	—	—
	1985	2092-3718	3186	424
K	1984	—	—	—
	1985	2233-2601	2448	113

Table 9. Aluminum content of yard waste compost.

Site	Year	Aluminum Range	Aluminum Mean	Aluminum Standard Deviation
		mg/kg		
A	1984	88-1555	1206	224
	1985	596-1608	1188	378
B	1984	1376-1780	1542	130
	1985	1802-2717	2079	221
C	1984	1230-2427	1880	275
	1985	1775-2314	2038	179
D	1984	1464-2163	1802	249
	1985	741-2895	2225	620
E	1984	1003-1324	1179	100
	1984*	1556-3246	2788	390
	1985	1182-1778	1361	199
F	1984	1199-2135	1684	287
	1985	573-2509	1310	643
G	1984	1801-2561	2183	248
	1985	2533-3088	2820	162
H	1984	2128-3457	2574	398
	1985	2394-3889	3198	390
I	1984	818-2302	1413	517
	1985	1380-2295	1862	247
J	1984	—	—	—
	1985	948-1442	1234	145
K	1984	—	—	—
	1985	1200-1595	1448	121

Table 10. Sodium content of yard waste composts.

Site	Year	Sodium Range	Sodium Mean	Sodium Standard Deviation
		mg/kg		
A	1984	52-103	77	15
	1985	53-139	84	24
B	1984	57-139	84	24
	1985	70-132	91	18
C	1984	73-105	92	10
	1985	79-159	128	21
D	1984	73-153	96	26
	1985	79-164	122	26
E	1984	79-149	110	23
	1984*	65-170	139	29
	1985	133-204	159	23
F	1984	36-177	89	45
	1985	38-133	87	27
G	1984	327-721	472	110
	1985	298-921	563	196
H	1984	88-269	143	46
	1985	75-132	100	18
I	1984	48-155	82	34
	1985	47-92	61	11
J	1984	—	—	—
	1985	146-426	265	105
K	1984	—	—	—
	1985	135-253	184	33

Table 11. Manganese content of yard waste composts.

Site	Year	Manganese Range	Mean	Standard Deviation
		mg/kg		
A	1984	320–646	457	95
	1985	310–736	421	110
B	1984	311–488	410	54
	1985	273–570	376	69
C	1984	302–708	504	88
	1985	348–525	445	49
D	1984	314–568	398	66
	1985	162–477	300	84
E	1984	418–567	476	42
	1984*	385–672	461	72
	1985	384–472	430	26
F	1984	340–689	435	88
	1985	239–733	397	147
G	1984	400–1261	583	220
	1985	361–842	573	163
H	1984	300–633	433	81
	1985	329–748	435	105
I	1984	223–451	300	71
	1985	263–425	365	48
J	1984	—	—	—
	1985	225–460	289	57
K	1984	—	—	—
	1985	265–380	322	26

Table 12. Zinc content of yard waste composts.

Site	Year	Zinc Range	Zinc Mean	Zinc Standard Deviation
		mg/kg		
A	1984	51-336	117	70
	1985	39-136	71	29
B	1984	63-190	114	33
	1985	51-98	68	14
C	1984	86-141	112	16
	1985	62-585	167	139
D	1984	54-222	119	45
	1985	79-266	131	63
E	1984	41-59	53	6
	1984*	56-74	66	7
	1985	47-108	67	16
F	1984	22-203	77	61
	1985	43-148	69	29
G	1984	41-70	52	7
	1985	45-85	63	11
H	1984	66-136	101	19
	1985	50-86	58	18
I	1984	40-189	82	51
	1985	45-142	82	26
J	1984	—	—	—
	1985	88-215	132	40
K	1984	—	—	—
	1985	48-68	57	5

Table 13. Copper content of yard waste composts.

Site	Year	Copper Range	Mean	Standard Deviation
		---------------- mg/kg	----------------	----------------
A	1984	7-95	17	23
	1985	6-12	9	2
B	1984	6-25	10	5
	1985	6-14	8	2
C	1984	6-62	14	14
	1985	7-27	12	5
D	1984	10-31	15	5
	1985	11-19	14	2
E	1984	6-9	8	1
	1984*	5-11	9	1
	1985	5-21	11	4
F	1984	3-16	8	4
	1985	6-12	8	2
G	1984	5-14	9	3
	1985	7-12	9	2
H	1984	5-16	8	3
	1985	6-10	8	1
I	1984	6-18	9	3
	1985	5-11	8	2
J	1984	—	—	--
	1985	14-22	18	3
K	1984	—	--	--
	1985	7-143	18	35

Table 15. Nickel content of yard waste composts.

Site	Year	Nickel Range	Nickel Mean	Nickel Standard Deviation
		mg/kg		
A	1984	6.9-33.3	14.4	8.1
	1985	2.5-5.4	4.3	0.9
B	1984	9.2-18.9	11.4	2.5
	1985	2.9-4.4	3.5	0.5
C	1984	7.9-18.0	14.8	3.2
	1985	4.6-6.4	5.8	0.5
D	1984	4.4-19.8	13.2	4.4
	1985	2.8-5.7	4.5	0.9
E	1984	5.1-7.1	6.2	0.8
	1984*	5.3-6.5	6.9	0.8
	1985	4.8-7.5	5.9	0.7
F	1984	4.5-37.1	8.6	7.3
	1985	1.7-5.3	3.5	1.2
H	1984	4.6-7.5	6.1	0.7
	1985	4.4-6.7	5.4	0.8
I	1984	4.2-5.8	5.0	0.5
	1985	3.6-5.0	4.3	0.3
J	1984	—	—	—
	1985	6.2-12.1	8.9	1.7
K	1984	—	—	—
	1985	4.3-5.9	5.2	0.4

Table 14. Chromium content of yard waste composts.

Site	Year	Chromium Range	Chromium Mean	Chromium Standard Deviation
		mg/kg		
A	1984	5.4-32.4	12.2	8.3
	1985	1.7-3.4	2.8	0.5
B	1984	8.7-21.0	11.3	3.0
	1985	2.7-4.4	3.5	0.5
C	1984	7.2-21.1	14.1	3.6
	1985	3.8-5.8	4.9	0.7
D	1984	3.2-17.1	11.6	4.4
	1985	1.7-6.1	4.3	1.2
E	1984	3.3-5.0	4.0	0.4
	1984*	4.4-6.5	5.7	0.6
	1985	3.7-5.9	4.9	0.6
F	1984	2.2-12.0	4.9	3.3
	1985	1.2-5.0	2.5	1.1
G	1984	3.1-4.5	4.1	0.4
	1985	4.3-7.1	5.4	1.2
H	1984	3.7-9.5	4.9	1.7
	1985	3.5-5.4	4.2	0.7
I	1984	3.1-10.7	4.9	1.8
	1985	2.8-5.7	3.8	0.8
J	1984	—	—	—
	1985	4.8-12.7	8.9	2.2
K	1984	—	—	—
	1985	4.1-9.1	5.3	1.2

Table 15. Nickel content of yard waste composts.

Site	Year	Nickel Range	Nickel Mean	Nickel Standard Deviation
		mg/kg		
A	1984	6.9-33.3	14.4	8.1
	1985	2.5-5.4	4.3	0.9
B	1984	9.2-18.9	11.4	2.5
	1985	2.9-4.4	3.5	0.5
C	1984	7.9-18.0	14.8	3.2
	1985	4.6-6.4	5.8	0.5
D	1984	4.4-19.8	13.2	4.4
	1985	2.8-5.7	4.5	0.9
E	1984	5.1-7.1	6.2	0.8
	1984*	5.3-6.5	6.9	0.8
	1985	4.8-7.5	5.9	0.7
F	1984	4.5-37.1	8.6	7.3
	1985	1.7-5.3	3.5	1.2
H	1984	4.6-7.5	6.1	0.7
	1985	4.4-6.7	5.4	0.8
I	1984	4.2-5.8	5.0	0.5
	1985	3.6-5.0	4.3	0.3
J	1984	—	—	—
	1985	6.2-12.1	8.9	1.7
K	1984	—	—	—
	1985	4.3-5.9	5.2	0.4

Table 16. Boron content of yard waste composts.

Site	Year	Boron Range	Boron Mean	Boron Standard Deviation
		mg/kg		
A	1984	29-103	67	24
	1985	34-103	69	24
B	1984	14-31	25	6
	1985	21-59	39	11
C	1984	47-111	70	16
	1985	42-110	82	21
D	1984	36-141	73	28
	1985	24-111	53	29
E	1984	25-42	33	6
	1984*	14-21	18	2
	1985	27-61	44	8
F	1984	7-56	24	13
	1985	41-106	60	29
G	1984	17-37	22	6
	1985	15-38	25	6
H	1984	6-41	24	9
	1985	12-61	28	12
I	1984	13-35	19	6
	1985	22-55	32	9
J	1984	—	—	--
	1985	16-37	26	6
K	1984	—	—	--
	1985	29-47	34	5

Table 17. Cadmium content of yard waste composts.

Site	Year	Cadmium Range	Cadmium Mean	Cadmium Standard Deviation
		mg/kg		
A	1984	0.1-0.7	0.4	0.2
	1985	0.1-0.4	0.3	0.1
B	1984	0.1-0.7	0.3	0.2
	1985	0.2-0.4	0.4	0.1
C	1984	0.4-0.8	0.5	0.1
	1985	0.4-1.4	0.6	0.3
D	1984	0.2-0.8	0.4	0.2
	1985	0.2-0.8	0.5	0.2
E	1984	0.4-0.6	0.5	0.1
	1984*	0.4-0.9	0.6	0.2
	1985	0.2-0.5	0.3	0.1
F	1984	0.2-0.6	0.4	0.2
	1985	<0.1-0.4	0.2	0.1
G	1984	0.2-2.0	0.5	0.4
	1985	0.1-0.4	0.3	0.1
H	1984	0.4-0.9	0.6	0.1
	1985	0.2-0.8	0.4	0.1
I	1984	0.3-1.0	0.4	0.2
	1985	0.1-0.4	0.3	0.1
J	1984	—	—	—
	1985	0.4-0.8	0.5	0.1
K	1984	—	—	—
	1985	0.1-0.3	0.2	0.1

Table 18. pH of yard waste composts.

Site	Year	pH Range	pH Mean	pH Standard Deviation
A	1984	5.2-7.9	7.1	0.8
	1985	6.7-8.3	8.0	0.4
B	1984	6.9-7.5	7.2	0.2
	1985	7.2-8.0	7.5	0.3
C	1984	7.2-8.3	8.0	0.3
	1985	7.8-8.2	8.0	0.1
D	1984	7.8-8.1	8.0	0.1
	1985	7.7-8.5	8.0	0.2
E	1984	7.7-7.9	7.8	0.1
	1984*	7.4-7.9	7.6	0.1
	1985	8.0-8.5	8.2	0.2
F	1984	6.8-7.9	7.4	0.4
	1985	4.5-8.5	7.6	0.1
G	1984	7.6-7.9	7.7	0.1
	1985	7.5-8.2	7.9	0.2
H	1984	7.2-7.8	7.6	0.2
	1985	6.9-8.2	7.6	0.4
I	1984	6.6-7.8	7.4	0.4
	1985	7.6-8.3	8.0	0.2
J	1984	—	—	—
	1985	7.2-8.1	7.8	0.2
K	1984	—	—	—
	1985	8.0-8.6	8.3	0.1

Table 19. Electrical conductivity of yard waste composts.

Site	Year	Electrical Conductivity Range	Mean	Standard Deviation
		mmhos/cm		
A	1984	0.8-2.5	1.3	0.5
	1985	0.8-2.7	1.5	0.6
B	1984	0.6-1.2	0.8	0.2
	1985	1.1-2.6	2.1	0.6
C	1984	0.9-1.9	1.4	0.3
	1985	1.4-2.9	2.3	0.4
D	1984	1.0-2.8	1.7	0.5
	1985	1.8-5.3	3.4	1.0
E	1984	0.6-1.0	0.8	0.1
	1984*	0.7-3.1	2.3	0.7
	1985	0.9-2.3	1.4	0.3
F	1984	0.5-10.6	2.4	2.7
	1985	1.4-5.8	3.1	1.5
G	1984	1.1-2.1	1.5	0.3
	1985	1.9-3.0	2.5	0.3
H	1984	1.0-3.8	1.7	0.8
	1985	2.1-5.6	3.6	1.1
I	1984	0.4-4.1	1.3	1.3
	1985	0.5-1.2	0.8	0.2
J	1984	—	—	—
	1985	0.3-0.6	0.4	0.1
K	1984	—	—	—
	1985	0.9-1.5	1.1	0.2

ATTACHMENT E

COMPOST COMPOSITION AND NITROGEN MINERALIZATION

This project was supported by the Legislative
Commission on Minnesota Resources and the
Metropolitan Council of the Twin Cities Area

COMPOST COMPOSITION AND N-MINERALIZATION

Increased interest in the production of municipal solid waste composts and co-composts as an alternative to landfilling solid waste has led to a need for a more accurate method of evaluating quality. Compost quality evaluation will assist in defining uses, establishing values and developing potential markets.

Land spreading of composts will not only reduce the demand for landfills, but also may be beneficial for plant growth as a soil amendment and fertilizer. Application of compost to soil can affect soil physical and chemical properties, as well as greatly influencing nitrogen (N) availability or immobilization. Characterization of composts by their ability to supply N to plants is important in determining compost quality.

Nitrogen released during incubation experiments has been correlated to plant growth and yields (Deans et al., 1984). Increasing the level of N mineralization increases the ability of plants to take up N from the soil. Different composts may have different N release patterns, which can influence their use, and in turn, provide information for developing a better product.

The objectives of this study were: (1) to determine compost and co-compost quality by chemical analysis; (2) to characterize the N release patterns for several compost materials; (3) to suggest criteria for mature composts.

MATERIALS AND METHODS

Materials

Composts and co-composts (refuse, leaves, and animal manure representing a variety of materials and methods of production) included in the chemical characterization and incubation studies were collected from several Minnesota, U.S., and foreign sources. They were air-dried and stored in plastic bags. To insure uniformity, the compost materials were ground in a pulverizer to pass a 5-mm screen. Stones, plastics and other materials larger than 5 mm were rejected. A subsample of the <5-mm fraction was ballmilled for chemical analysis.

Methods

Total N and C were determined by a semi-micro Kjeldahl procedure (Bremner and Mulvaney, 1982) and Leco CR-12 carbon determinator, respectively. Compost pH and electrical conductivity (EC) were measured on a 1:5 compost:water suspension. Analyses of phosphorus, cations and trace metals were determined by inductively coupled plasma (ICP) spectrometry. Results of chemical analyses are presented in Tables 1 through 7.

Incubation Experiments

4-Week Incubation. A short-term incubation experiment modified from the technique of Hadas et al. (1986) was started as a preliminary study to evaluate compost quality as a function of the method and type of material used. Composts used were: Eden Prairie 1984, a leaf compost (Table 1); St. Cloud 1985 (Table 1), Delaware (Table 1), and Lodi 1985 (Table 3) co-composts; and Thief River Falls 1985 (Table 1) municipal refuse that was not composted.

A Hubbard sandy loam soil, after air-drying and screening through a 2-mm sieve, was mixed in the ratio of 1 part compost (5 g) to 5 parts soil (25 g) and placed in glass jars. Nitrogen was applied at the rate of 10 μg $(NH_4)_2SO_4$-N/g of mix and water was added to bring the mix to near field capacity. The jars were then covered with plastic film and put into a 35°C incubator maintained at 99% relative humidity. Four replicates of each treatment were included in the study.

Inorganic-N was measured by extracting the whole 30 g of the soil mix with 300 mL of 1M KCl and analyzing the extract on a Technicon Autoanalyzer II for NH_4-N (phenol) and $(NO_2^- + NO_3^-)$-N (Cu/Cd)

<u>20-Week Incubation</u>. A long-term incubation experiment using a static technique suggested by Clay (1987), included 11 compost materials. The composts and co-composts used were: Eden Prairie 1985, St. Cloud 1986, and Thief River Falls 1986 (Table 1); Holden horticultural grade 1984B (Table 2); Lodi July 1985, September 1985, December 1985, and March 1986 (Table 3); Delaware (Table 4); Sweden (Falkenberg) 1985 (Table 5); and Switzerland (Ndzl) (Table 6). Moist compost samples were air-dried and ground in a pulverizer to pass a 5-mm screen. Residues larger than 5 mm that could not be ground were removed. Acid-washed sand (0.5 to 0.8 mm) was mixed dry with 50 g of compost in a ratio of 1 part compost to 5 parts quartz. This mixture represented a ratio of 1:1 by volume. The compost-sand mix was poured into 15 x 45 cm (flat) plastic bags. Water was added to bring the mix to field capacity (0.1 bar). The bags were placed in an incubator and maintained at constant temperature (35°C) for 140 days. Water was added at periodic intervals to keep the moisture content near field capacity. Samples were removed from the bags at 7, 14, 35, 56, 77, 98, 119, and 140 days and analyzed for inorganic-N. Four replicates of each treatment were included in the study.

Inorganic-N was determined for the compost mixes by extraction with 1M KCl (1:10 ratio) and analyzed on a Technicon Autoanalyzer II for NH_4-N (salicylate/nitroprusside) and $(NO_2 + NO_3)$-N (Cu/Cd).

A comparison incubation study was also started at the same time involving the same compost treatments, but using the leaching method as described by Stanford and Smith (1972). Results of this study will be presented in a later report.

RESULTS AND DISCUSSION

Chemical Analysis

The composition of 35 composts from Minnesota, the U.S., Canada, and Northern Europe were analyzed and the results are shown in Tables 1 through 7. Eden Prairie 1984, a leaf compost (Table 1) showed the lowest values for C, N, P, K, S and Na of all the composts tested. This result may be due to a larger amount of sand and soil included with the compost during turning and mixing.

Holden Farms (Table 2) composts had the highest values of P and K, and the agricultural grade had the highest total N. The characteristics of the Holden samples were probably due to the turkey manure as the main component.

Lodi composts (Table 3) in general had high metal contents, particularly Zn, Cu, Pb, and Cd. Lodi (December 1985 and March 1986) composts had 5 to 18 times the Minnesota Pollution Control Agency (M.P.C.A.) solid waste maximum concentration limits for those trace metals.

Delaware compost (Table 4) had very high C contents, probably due to its short composting time and immaturity. Levels of Zn were high, and Pb and Ni were both above the limits set by the M.P.C.A. rules.

The Sweden and Denmark composts (Table 5) tended to have higher metal contents than their U.S. counterparts. Concentration of Zn was above the limit in all except the Falkenberg 1986 compost. Schaffhausen green (Table 6) was above limits for both Zn and Cu. All composts in Table 7 were above limits for Pb, however, Leeds compost was low in K. Other elements were about average for municipal solid waste co-composts

The pH ranged from 6.0 to 8.2 in all composts tested, with most in the range of 7.0 to 8.0. The EC for the composts had a range from 0.9 to 8.2 dS/m. Highest values were in the Holden Farms composts.

4-Week Incubation Experiment

The net N mineralized in this incubation experiment from 5 composts and compost-soil mixes is presented in Table 8. Highest negative net N mineralization was seen in the Delaware compost. This immobilization could be the result of its short composting time and its high C content (Table 4). Positive N mineralization did not occur during the four-week incubation time for this compost. High levels of NH_4-N were present in the extracted samples, with little N in the form of NO_3-N.

For the Thief River Falls material, other than periods of small amounts of N loss and gain, no NO_3-N release pattern could be determined. This result was probably due to the immature nature of the compost. Like Delaware, N was in the form of NH_4-N.

The St. Cloud compost showed a period of negative net N mineralization followed by a period of positive net N mineralization. This type of pattern may be explained by a reduction in available C, followed by a period of mineralization of biomass N.

Both Eden Prairie and Lodi composts showed periods of increasing positive net N mineralization. These patterns are usually associated with mature compost materials.

The results of this preliminary study suggest that positive net N mineralization occurs in composts when the C:N ratio is in the range of 20 to 25. Mature composts with lower C:N ratios are more productive in terms of supplying NO_3-N. Immature composts tend to liberate more NH_4-N and exhibit negative net N mineralization values.

20-Week Incubation Experiment

Amounts of net N mineralized (NH_4 + NO_3) during successive incubation intervals for the 20-week incubation study are given in Table 9. These data have been calculated on a per gram of compost basis, rather than on a per gram of compost + sand mix. Relatively large amounts of N were released from the co-composts when compared to the leaf and yard waste composts. These high values of mineralized N may have been the result of addition of N as sewage sludge and manure in production of the co-composts. Holden horticultural compost, at the end of 20-weeks incubation yielded about 2500 μg N/g compost, compared to about 450 μg N/g for the Eden Prairie leaf compost. These N values are quite significant when compared with the 120 μg N/g soil mineralized from a high fertility Waukegan silt loam (Deans et al., 1983). High values of N were found in the initial sampling dates for both Lodi July and September composts. These high levels were maintained for the duration of the study. Both Lodi March and December co-composts, started with low N and increased to about 2000 and 900 μg N/g compost, respectively.

From the graphs of net N mineralization (total N minus initial inorganic-N) four types of patterns of N transformations were observed that can be divided into distinct phases (Fig. 1 through 4).

Type I: pattern was characterized by a single phase of positive net N mineralization for the entire 20-week incubation period. An initial period of 5 weeks of rapid mineralization was followed by about 15 weeks of slower NO_3-N accumulation. This pattern was found with St. Cloud 1986 (Fig. 1), Lodi December 1985 (Fig. 2), Switzerland and Eden Prairie 1985 composts. The mineralization pattern observed with this type of compost was similar to those observed on soil alone (Hadas et al., 1986). Compost of this type releases inorganic-N slowly at a relatively constant rate over time. This fact is important in the consideration of the compost suitability for plant growth.

Type II: pattern was characterized by two-phase configuration. In the first phase of up to 2 weeks, there is negative net N mineralization, followed by a second phase of the balance of 20 weeks of positive net N mineralization. This pattern can be seen with Lodi March 1986 (Fig. 2), Sweden (Fig. 3), Thief River Falls, and Holden horticultural grade composts. The first phase may be the result of the presence of uncomposted material, which may be caused by mechanical disturbance and/or differential drying. Uncomposted material may contain readily-available C, which in turn may have caused an increase in microbial biomass, resulting in a negative net N mineralization. As the C source is depleted, the microbial biomass is decreased, with an increased net N mineralization.

Type III: pattern was characterized by a three-phase configuration. In the first phase there is a 1- to 2-week period of positive net N mineralization, followed by a second 1-week phase of negative net N mineralization. The final phase is a long period of positive net N mineralization for the balance of the experiment. This pattern was found in the Lodi July 1985 and September 1985 composts (Fig. 2). This pattern of positive, followed by negative net N mineralization, may be the result of different C sources being made available to the microbes during this period.

Type IV: pattern was characterized by a three-phase configuration. In the first phase, lasting up to 5 weeks, there is negative net N mineralization, followed by a long phase of 6 weeks where net N mineralization was near zero. In the final phase of 9 weeks, there is an increase in positive net N mineralization. This pattern, similar to but more extreme than Type II, was observed for the Delaware compost (Fig. 4). This type of pattern is indicative of an immature compost. The initial negative net N mineralization probably is the result of high a C:N ratio mix at compost initiation. The intermediate phase of low inorganic-N may be the result of lowering the C:N ratio of the substrate close to the 20/30 break-even point. Positive net N mineralization starts when the C:N ratio drops further to allow NO_3-N to accumulate.

The results of the 20-week incubation study suggest that mature composts can reduce the N fertilizer needs of a crop. For example, Holden horticultural compost could supply up to 50 kg N/ha if applied at a rate of 20 Mg/ha. The lowest N producing composts were Thief River Falls and Eden Prairie which, if applied at the same rate, could contribute only from 6 to 10 kg N/ha, respectively. Four N release patterns were observed: type I, indicates a stable, mature compost in which N is slowly and continuously mineralized; types II and III, represent N release patterns indicating somewhat immature composts with initial rapid immobilization or mineralization, respectively; and type IV, initially shows strong immobilization associated with an immature compost. The N that is immobilized during incubation of this compost, however, could be released at a later date.

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Table 1. Composition of municipal compost and co-composts from Minnesota.

Characteristic	EP†		STC‡		TRF§	
	1984	1985	1985	1986	1985	1986
	%					
C	11.0	24.4	30.1	18.9	13.7	15.4
N	0.66	1.09	1.14	1.36	0.90	0.90
C/N¶	16.7	22.4	26.4	13.9	15.2	17.1
P	0.10	0.18	0.30	0.39	0.29	0.26
K	0.14	0.40	0.82	0.98	0.26	0.18
S	0.09	0.20	0.63	0.67	1.05	0.46
Ca	3.70	4.77	6.77	6.33	3.45	4.58
Mg	0.99	1.29	0.23	0.39	0.39	1.02
Na	0.01	0.02	0.49	0.56	0.59	0.16
Fe	0.34	0.41	0.74	1.13	0.53	0.63
Al	0.13	0.17	1.08	1.44	0.49	0.56
	mg/kg					
Zn	55	101	436	699	364	796
Cu	12	27	106	341	280	386
Pb	44	47	130	310	138	642
Mn	471	696	222	466	261	548
Cr	35	6	60	56	19	24
Ni	35	9	27	34	11	30
B	30	62	46	79	43	32
Cd	<1	<1	2	4	3	4
pH	7.7	7.2	6.0	7.4	7.7	7.5
EC(dS/m)	0.9	1.5	5.5	3.7	6.7	6.2

† Yardwaste (leaves from Eden Prairie).

‡ Municipal solid waste and septage and/or chicken manure from St. Cloud.

§ Municipal solid waste with refuse derived fuel removed, from Thief River Falls.

¶ Ratio calculated by dividing total-C by total-N.

Table 2. Composition of composts[†] from Holden Farms, MN.

Characteristic	Agricultural		Horticultural[‡]		
	1985	1986	1984-A	1984-B	1984-C
	%				
C	28.7	23.0	19.1	20.3	11.7
N	3.65	2.62	1.93	1.88	0.94
C/N[§]	7.86	8.78	9.90	10.8	12.4
P	3.52	2.70	2.46	2.33	1.28
K	3.32	3.46	2.41	1.41	1.18
S	0.91	0.63	0.58	0.44	0.26
Ca	5.23	3.95	5.42	5.04	5.31
Mg	1.01	0.96	1.12	1.13	1.47
Na	0.65	0.36	0.39	0.28	0.22
Fe	0.15	0.42	0.34	0.31	0.27
Al	0.13	0.35	0.29	0.21	0.25
	mg/kg				
Zn	495	765	358	436	765
Cu	115	224	104	87	224
Pb	<9	17	<9	11	17
Mn	587	802	641	756	463
Cr	8	11	23	8	11
Ni	9	19	24	13	19
B	55	75	47	39	75
Cd	<1	<1	1	<1	<1
pH	6.9	7.0	7.9	6.4	6.1
EC(dS/m)	9.2	15.4	6.7	10.0	11.0

† Turkey manure and bedding.

‡ Different batches of compost.

§ Ratio calculated by dividing total-C by total-N.

Table 3. Composition of municipal co-composts from Lodi, WI.

Characteristic	Composite† 1985	July‡ 1985	September† 1985	December† 1985	March† 1986
			%		
C	23.0	20.8	20.4	18.9	18.3
N	1.62	1.63	1.60	1.38	1.41
C/N§	14.2	12.8	12.8	13.7	13.0
P	0.45	0.41	0.45	0.49	0.42
K	0.56	0.54	0.69	0.84	0.65
S	0.61	0.56	0.68	0.60	0.44
Ca	3.82	3.35	3.39	4.43	4.45
Mg	0.50	0.45	0.49	0.43	0.66
Na	0.52	0.58	0.55	0.66	0.46
Fe	0.71	1.03	1.05	1.36	1.48
Al	1.83	2.05	1.70	2.08	1.72
			mg/kg		
Zn	989	1100	953	5370	18200
Cu	267	419	242	213	536
Pb	660	548	492	1080	299
Mn	623	836	753	967	1020
Cr	74	55	50	59	39
Ni	28	29	34	28	24
B	66	60	79	64	62
Cd	8	6	6	6	7
pH	7.4	7.4	7.6	8.1	7.9
EC (dS/m)	4.6	8.3	8.6	7.2	5.9

† Municipal solid waste and sewage sludge.

‡ Municipal solid waste and urea.

§ Ratio calculated by dividing total-C by total-N.

Table 4.[illegible] Composition of municipal co-composts from the U.S.

Characteristic	Delaware[†]	Texas[‡]	Oregon[§]
	%		
C	34.9	12.3	31.7
N	1.55	0.84	2.07
C/N[¶]	21.8	15.4	15.1
P	0.54	0.71	0.41
K	0.22	0.20	1.48
S	0.71	0.26	0.27
Ca	1.73	1.20	2.62
Mg	0.24	0.11	0.29
Na	0.27	0.12	0.26
Fe	0.47	1.09	0.53
Al	0.98	0.73	0.44
	mg/kg		
Zn	802	502	152
Cu	208	104	31
Pb	573	185	91
Mn	369	218	228
Cr	185	69	14
Ni	197	15	7
B	40	12	37
Cd	5	6	1
pH	7.4	7.1	9.0
EC(dS/m)	6.7	1.9	1.3

† Municipal solid waste with refuse derived fuel removed and sewage sludge from Wilmington.

‡ Municipal solid waste and sewage sludge from Gladewater.

§ Household and yard waste from Portland.

¶ Ratio calculated by dividing total-C by total-N.

Table 5. Composition of municipal co-composts from Sweden and Denmark.

Characteristic	Falkenberg 1985†	Falkenberg 1986‡	Borlange§	Frederikssund¶ 2 mo.	Frederikssund¶ 6 mo.	Frederikssund¶ 12 mo.
	%					
C	31.1	23.6	21.1	29.6	21.2	20.9
N	2.06	2.31	1.74	1.43	1.60	1.75
C/N#	14.8	10.3	12.4	21.1	13.2	11.6
P	0.48	0.27	0.70	0.45	0.48	0.53
K	0.94	0.74	0.44	0.32	0.38	0.73
S	0.55	0.31	0.52	0.38	0.45	0.63
Ca	3.63	2.13	2.81	2.44	3.08	3.49
Mg	0.29	0.20	0.22	0.19	0.27	0.33
Na	0.64	0.33	0.38	0.30	0.47	0.74
Fe	0.65	0.48	1.61	0.70	0.69	0.86
Al	1.05	0.53	1.51	0.88	0.96	1.37
	mg/kg					
Zn	1370	317	2420	1140	1250	1410
Cu	293	54	985	202	288	394
Pb	554	109	1620	1250	578	423
Mn	550	286	1370	440	638	980
Cr	93	28	56	57	53	139
Ni	51	16	68	42	51	80
B	43	26	47	30	38	59
Cd	3	1	8	2	4	3
pH	7.3	7.6	7.2	6.2	7.2	6.8
EC (dS/m)	8.1	6.3	5.8	8.5	9.9	8.0

† Municipal solid waste with refuse derived fuel removed and sewage sludge.

‡ Whet/dry separation process. Same as 1985, but wet material only.

§ Solid waste and sewage sludge.

¶ Composted at different lengths of time.

\# Ratio calculated by dividing total-C by total-N.

Table 6. Composition of municipal co-composts from Switzerland.

Characteristic	Ndzl†	Muri‡	Kruchtal		Schaffhausen	
			rough§	fine¶	green§	rough¶
	%					
C	20.5	18.4	20.4	20.7	19.3	21.3
N	2.53	1.73	1.62	1.60	1.38	1.60
C/N=	8.10	10.6	12.8	12.8	14.0	13.3
P	0.34	0.26	0.25	0.32	0.69	0.56
K	1.08	0.91	0.65	0.66	0.49	0.62
S	0.18	0.29	0.27	0.27	0.39	0.34
Ca	4.20	5.87	3.53	3.53	5.81	5.16
Mg	0.41	0.91	0.51	0.46	0.42	0.37
Na	0.08	0.07	0.19	0.25	0.28	0.23
Fe	0.52	0.59	0.68	0.49	1.16	0.99
Al	0.52	0.49	1.12	0.91	1.12	0.52
	mg/kg					
Zn	170	330	646	747	1430	522
Cu	30	66	90	115	1090	126
Pb	55	180	286	377	395	237
Mn	355	465	662	502	523	420
Cr	14	33	36	37	58	46
Ni	10	32	24	23	20	18
B	23	36	32	30	50	42
Cd	1	1	2	3	2	2
pH	7.8	8.2	8.1	7.7	7.8	7.3
EC(dS/m)	4.9	3.5	3.2	4.8	5.2	5.0

† Source separated organic garden and household waste. From Niederuzwil.

‡ Household and yard waste.

§ Municipal solid waste.

¶ Yard waste.

= Ratio calculated by dividing total-C by total-N.

Table 7. Composition of municipal co-composts from Europe and Canada.

Characteristic	Leeds†	Dusslingen‡	Toronto§
	%		
C	18.8	32.1	24.5
N	1.24	2.00	1.20
C/N¶	15.7	16.0	0.4
P	0.62	0.34	0.46
K	0.15	0.90	0.28
S	0.46	0.70	0.54
Ca	3.72	4.57	4.31
Mg	0.26	0.42	0.47
Na	0.89	0.48	0.57
Fe	1.10	0.59	0.58
Al	1.12	1.14	1.77
	mg/kg		
Zn	972	708	1060
Cu	174	134	514
Pb	588	682	770
Mn	666	543	490
Cr	83	39	98
Ni	43	21	53
B	43	58	60
Cd	4	1	8
pH	7.3	7.5	7.8
EC(dS/m)	1.7	7.9	3.7

† Municipal solid waste and sewage sludge from England.

‡ Municipal solid waste with recyclables removed and sewage sludge from Germany

§ Municipal solid waste with refuse-derived fuel removed and sewage sludge from Canada.

¶ Ratio calculated by dividing total-C by total-N.

Table 8. Total net nitrogen mineralized during four weeks of incubation.

Compost	Days			
	7	14	21	28
	µg N/g			
Lodi	449	829	768	1063
+ Soil	122	200	239	291
Delaware	5	-1607	-1245	-622
+ Soil	-275	-288	-290	-290
Eden Prairie	86	25	118	141
+ Soil	-1	-7	-3	11
Thief River Falls	-319	30	-66	-146
+ Soil	-7	31	-6	-12
St. Cloud	-141	-120	1	29
+ Soil	-29	-32	-28	-38
Soil only	1	-4	12	26

Table 9. Total net nitrogen mineralized during 20 weeks of incubation.

Compost	Days							
	7	14	35	56	77	98	119	140
	µg N/g							
Eden Prairie	-15	-23	106	471	365	457	482	367
St. Cloud	128	223	561	625	607	686	739	677
Thief River Falls	-134	-138	-50	144	260	298	287	368
Holden Farms	-164	606	2310	2360	2500	2140	2610	2460
Lodi March	-393	697	797	1000	1150	1070	1490	2130
Lodi July	911	694	824	1219	613	817	886	461
Lodi Sept	1670	749	996	1160	958	1210	1330	975
Lodi Dec	88	237	323	596	768	813	887	922
Delaware	-560	-674	-1470	-1530	-1460	-803	172	-253
Sweden	-734	-753	-470	-67	203	345	269	810
Switzerland	-4	31	173	320	513	668	649	635

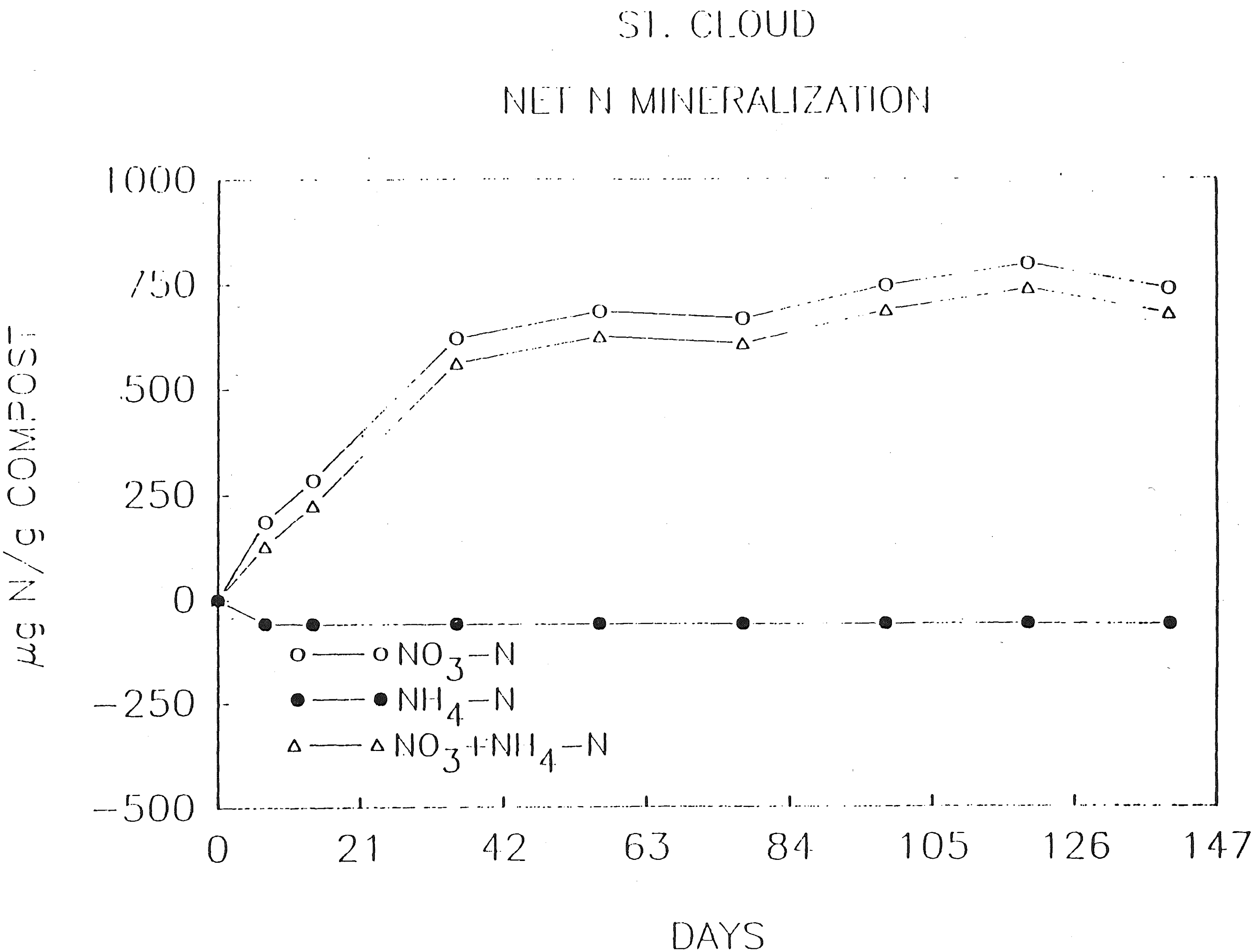


Figure 1. Net N mineralization release pattern obtained from a 20-week incubation study using compost from St. Cloud, MN.

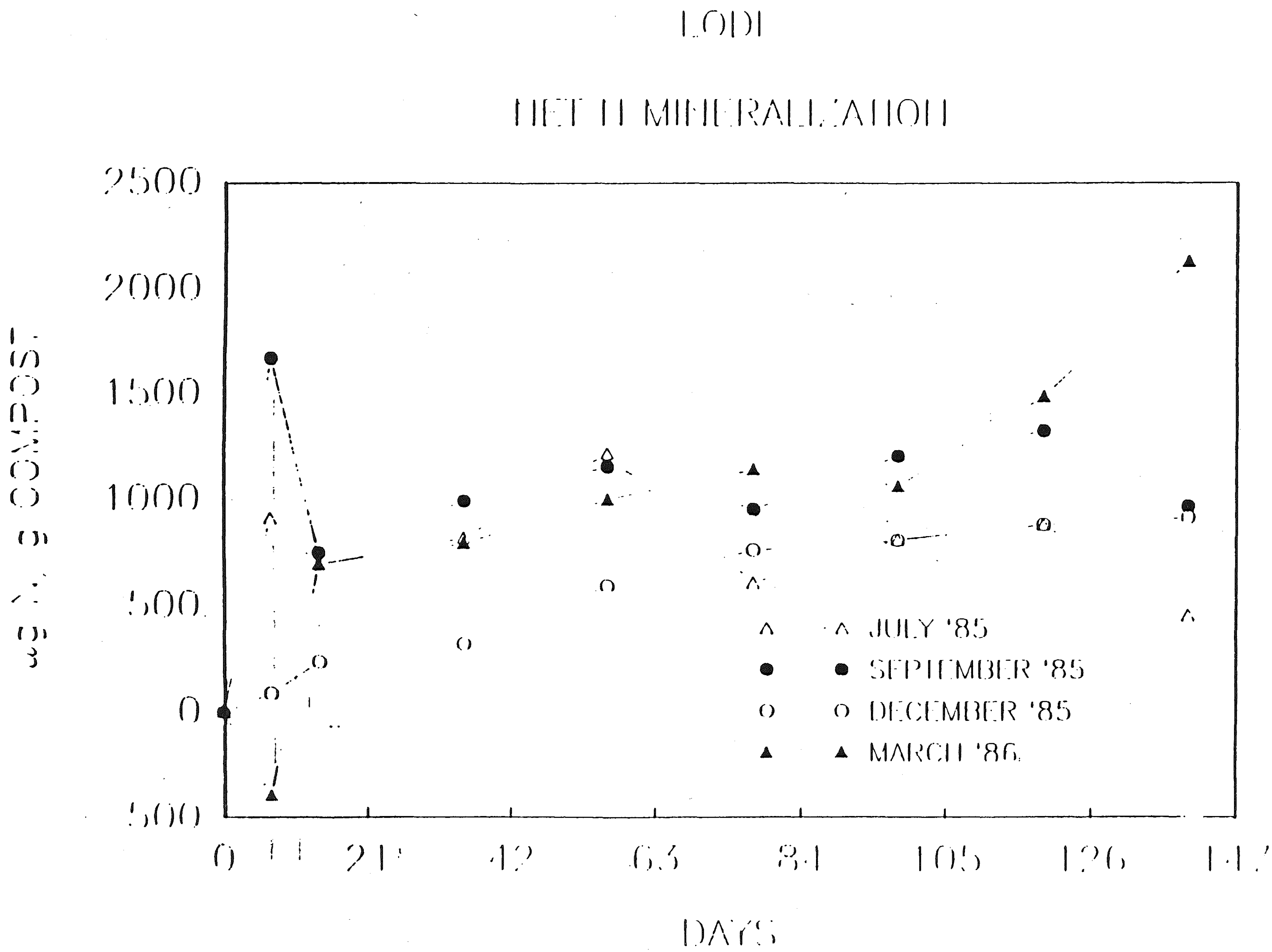


Figure 2. Net N mineralization release patterns obtained from a 20-week incubation study using four composts collected at different dates from Lodi, WI.

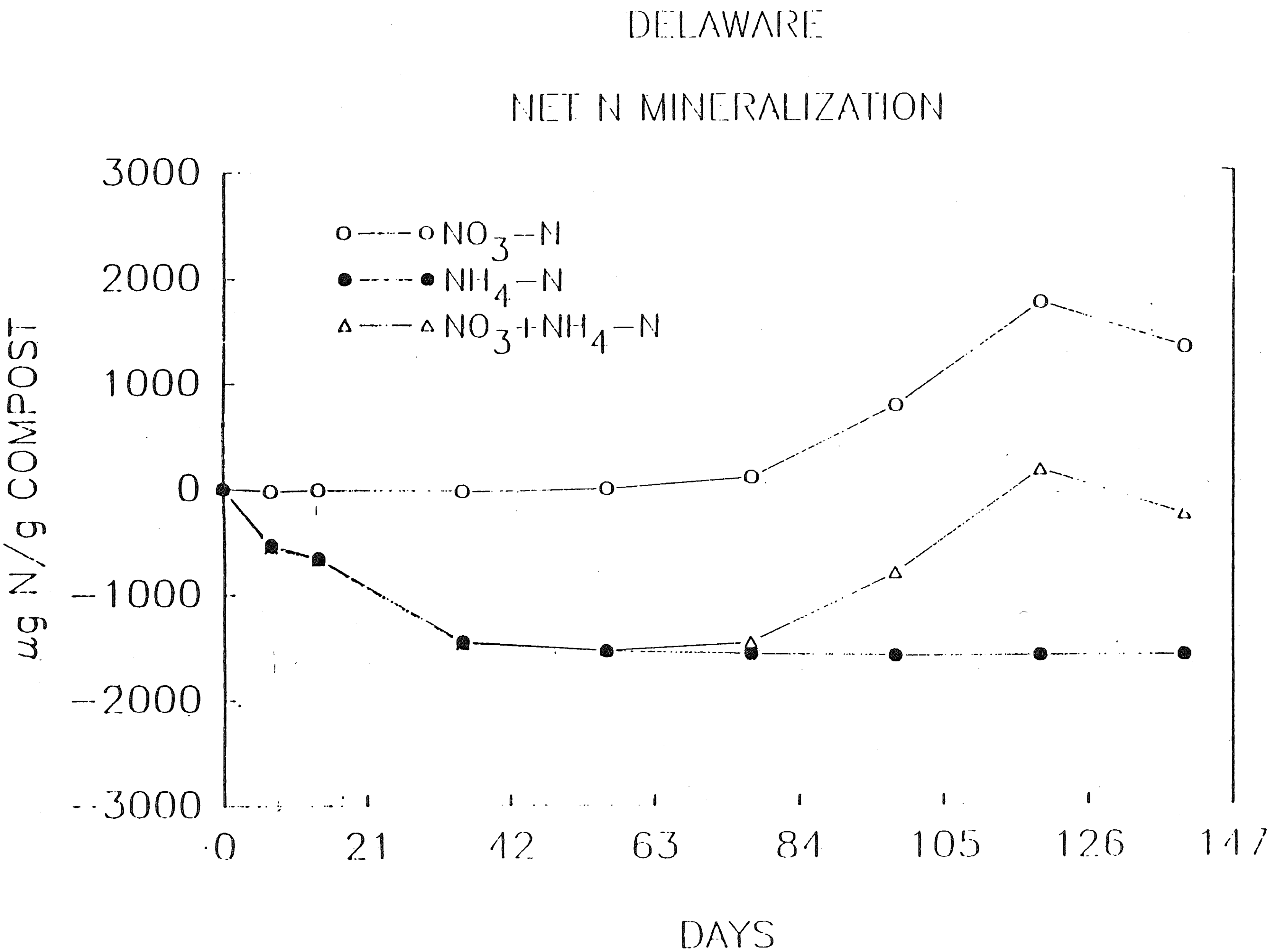


Figure 4. Net N mineralization release pattern obtained from a 20-week incubation study using compost from Wilmington, DE.

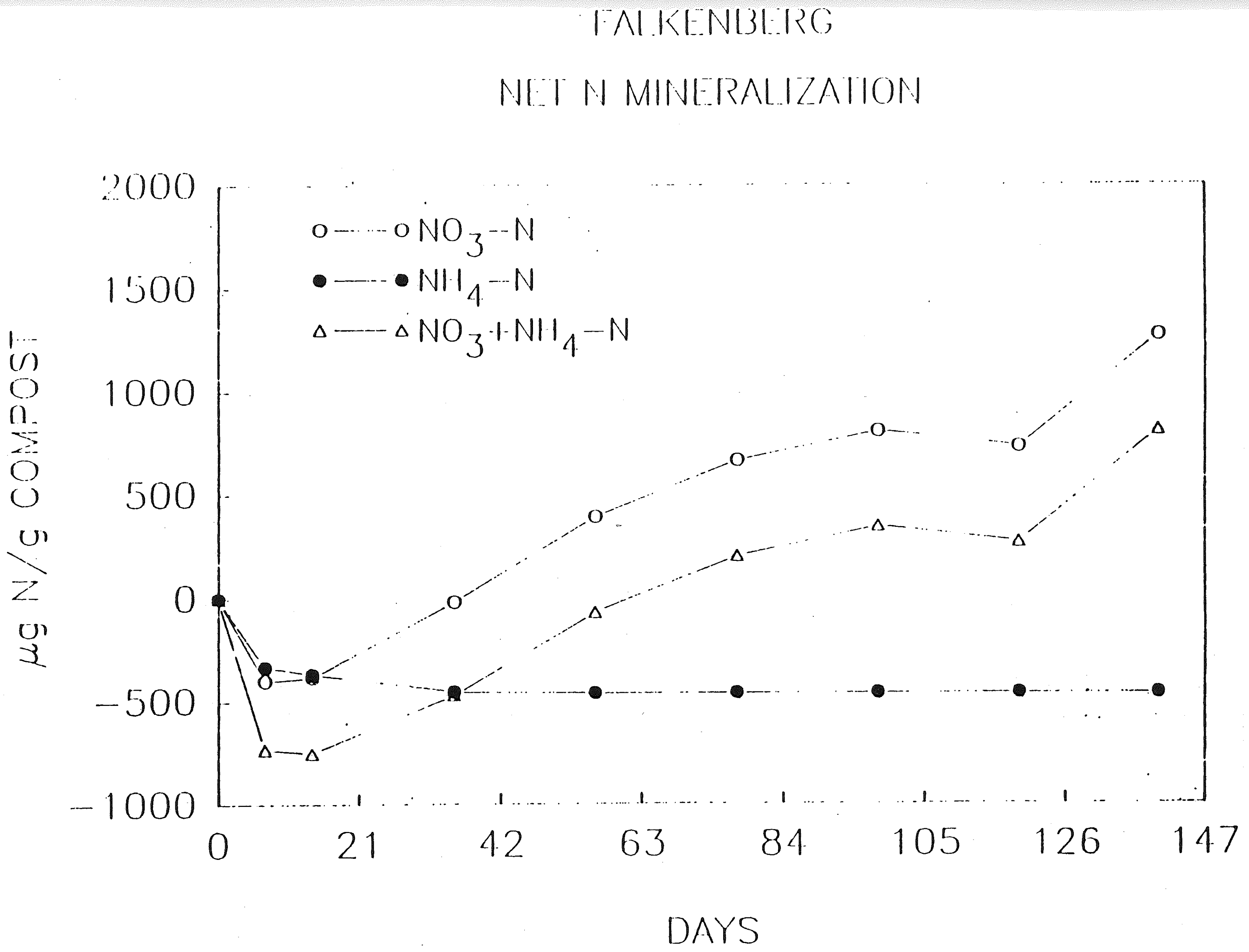


Figure 3. Net N mineralization release pattern obtained from a 20-week incubation study using compost from Falkenberg, Sweden.

ATTACHMENT F

PHYSICAL PROPERTIES OF SOIL - COMPOST MIXTURES

This project was supported by the Legislative
Commission on Minnesota Resources and t'.:
Metropolitan Council of the Twin Citie Area

Physical Properties of Soil-Compost Mixtures

Introduction

About 16 million hectares of cropland in the United States could benefit measurably from greater depth of soil (USDA, 1967). Included in this 16 million hectares are capability classes II, III, and IV with limiting factors such as shallowness, stoniness, low fertility that is difficult to correct, low water holding capacity, and salinity or sodium problems. Potentially, some of these soils could benefit from the addition of soil material rich in organic matter such as compost.

Objectives

1. To determine the physical aspects of soil-compost mixtures which include:

   a) mechanical properties i.e., bulk density

   b) thermal properties i.e., thermal conductivity

   c) hydraulic properties i.e., hydraulic conductivity and water retention characteristics

2. To evaluate the effect of compost in alleviating limitation on productive and marginal soils.

3. To define soil-compost mixtures which provide the optimum soil physical environment for plant growth.

4. To relate physical properties of mixtures to organic matter content in order to predict the behavior of other soil-compost mixtures.

Soils

- Rozetta silt loam: a soil prone to crusting which leads to reduced in filtration thereby creating more runoff and erosion; reduced seedling emergence is also a problem.

- Webster clay loam: a wet soil that has perched water tables in the spring and therefore problems of aeration to plant roots.

- Hubbard sand: is a droughty soil.

Composts

- Lodi compost: a municipal garbage compost from Lodi, WI.

- Eden Prairie compost: a leaf compost from Eden Prairie, MN.

Treatments

The treatments used in this study were 100% soil, 2/3 soil plus 1/3 compost (by weight), 1/3 soil plus 2/3 compost (by weight), and 100% compost.

Materials

Table 1 shows the particle size distributions and organic carbon contents of the soils and the composts used in this study.

Methodology

The specific physical properties studied include bulk density, particle density, water retention, saturated hydraulic conductivity, unsaturated hydraulic conductivity, thermal conductivity, and wetting angle.

The methodology used for measuring these properties is as follows:

Water retention: pressure plate extractors

Saturated hydraulic conductivity: constant head method

Unsaturated hydraulic conductivity: one-step outflow and slope of the water retention curve

Thermal conductivity: cylindrical thermal conductivity probe

Wetting angle: rise in the heights of water and ethyl alcohol (ethanol) in soil columns

Results and Discussion

Figure 1 shows a decrease in the bulk density of the soil with the addition of compost. The lowest bulk density of the treatments corresponded to the bulk density of the composts. The decrease in the bulk density was greater for the Lodi compost as compared to the Eden Prairie compost. This was due to the composition of the two composts; the Lodi consisting of a lighter or less dense municipal waste material and the Eden Prairie having a large proportion of stones and material which was picked up along with the leaves. Trends in the particle density of soil on addition of compost are similar to that of bulk density (Figure 2).

The water release curves for the Lodi treatments are shown both by weight and by volume in Figures 3 to 8. The curves on a volume basis for the Rozetta and Webster treatments show very little difference in the amount of water retained at a given suction between the treatments, while the curves on a weight basis show a distinct difference between treatments. In other words, as the amount of compost in the soil increases the weight of water that the soil can hold at a given suction also increases, but the amount of water held per unit volume of soil doesn't change significantly.

The difference in the water retention curves when expressed on a weight or on a volume basis reflects the differences in the density of soil, compost and its mixtures. Since plants extract water from a given volume of soil, Figures 3 and 5 show very little advantage on the availability of water to plants when compost is mixed in the Webster and Rozetta soils.

The addition of Lodi compost to Hubbard sand showed a more pronounced effect on the water retention curves. Water retention curves, both on a volume and a weight basis show that as the amount of Lodi compost increases, the amount of water held in Hubbard sand also increases. This reflects a decrease in the pore size distribution of the soil due to the addition of smaller compost particles in a sandy soil. Although the data is incomplete for the Hubbard-Eden Prairie mixtures (Figures 9-12), similar trends can be seen in the Eden Prairie treatments.

The water retention curves of these treatments also give information on the amount of water available to plants (Tables 2 and 3). Water in the soil is available to plants between field capacity (-0.1 bar potential) and wilting point (-15 bar potential). As expected from previous discussions, the Lodi and Eden Prairie treatments of the Rozetta and Webster soils do not show a significant change in the amount of water available to plants. The Hubbard soil, however, does show some improvement in water availability. The Eden Prairie compost, on the other hand, seems to slightly decrease the amount of available water. This is due to the sandy nature of the Eden Prairie compost.

Figure 13 shows the saturated hydraulic conductivities (Ksat) for the various treatments. For the Lodi compost, Webster soil showed an increased Ksat for increasing amounts of compost, while the Rozetta and Hubbard soils showed very little change. For the Eden Prairie compost, the soils showed an increase in Ksat for increasing amounts of compost. It should be noted that there are some unexplainable dips in some of these curves, but even with the decrease shown, the Ksat shown is still high enough to handle the heavier rain intensities that Minnesota receives.

The unsaturated hydraulic conductivities of the treatments were also studied (Figures 14-18). The figures, a plot of unsaturated hydraulic conductivity vs. volumetric water content, show that for a given water content, unsaturated hydraulic conductivity decreased with an increase in the amount of compost. Because of the differences in the particle and bulk densities between different treatments, a comparison of unsaturated conductivity vs. normalized water content will be a better representation of the differences in unsaturated water flow due to an addition of compost. Work is currently underway to convert the volumetric water contents in figures 14-18 to normalized water contents.

Measurements of unsaturated hydraulic conductivity are important because it determines the rate at which water will be available to plants, and the rate of soil drying. We have shown in this study that the amount of water retained in a sand increases with an addition of compost. If the unsaturated hydraulic conductivity for a given soil or treatment is low, the water will be transmitted slowly to the plant roots, even though the water in the soil is available for the plant to absorb. The drying of the soil is important in Minnesota in the spring. In spring the farmers have to wait for the fields to become dry enough for them to use heavy equipment to plant. The soil goes through the drying process by evaporation in which the soil water is pulled upwards towards the soil surface. The higher the unsaturated hydraulic conductivity, the faster the rate at which a soil can dry. Low unsaturated hydraulic conductivity soils will tend to remain wet.

Thermal conductivity measurements have been completed on two soils with the Lodi compost. In both the Rozetta and Webster soils the thermal conductivity decreases with increasing amounts of compost (Table 4). This is expected because composts, which have a high organic matter content, are poor conductors of heat. Also, a decrease in bulk density and the subsequent increase in pore space with compost addition makes it more difficult for the heat to be transferred through the soil system. Reduced thermal conductivity of soil plus compost mixtures suggests that soil mixed with compost will not warm as fast as 100% soil during the early spring and thus a reduction or delay in plant emergence may occur.

The wetting angle was studied in order to determine the hydrophobic characteristics of the soils and the treatments with the composts. It was found that the Lodi compost was much more hydrophobic than the Eden Prairie compost and this difference was reflected in the wetting angles of the mixtures of the two composts (Table 5). The hydrophobic property of the Lodi compost was also noticeable when water was added to the compost. Water beaded up on the surface of the compost and did not immediately penetrate (Photo 1). Photos 2-4 show that the beading effect decreases as the amount of compost in the soil decreases. The Eden Prairie compost was found to be non-hydrophobic due to an increased number of sand particles. The treatments with this compost exhibited minimal hydrophobic characteristics. Hydrophobicity could be a problem in sloping areas where the water repellency would mean increased runoff at least over the short term. Increased runoff could lead to movement of compost material with runoff water on steep slopes. On flatter areas the water would sit on the surface and take time to penetrate.

Conclusions

Compost addition influences the physical properties of the soil. However, the beneficial effects of compost addition greatly depend upon the type and amount of compost and the type of soil used.

Lodi, being a high organic matter compost, had a greater influence on soil physical properties than the Eden Prairie compost. However, the beneficial effects such as increased available water and increased drainage were minimal for the Rozetta and Webster soils. The Hubbard sand showed definite improvements in the amount of available water, but a considerable amount of compost had to be added in order to bring about this change. In general, unsaturated hydraulic conductivity decreased with an addition of compost. Low unsaturated hydraulic conductivities can lead to slower drying of soils in the spring and could also decrease the rate at which water is available to the plant roots. Compost, being a poor heat conducting material, reduced the thermal conductivity of soil when mixed with compost. Decreased thermal conductivity of the compost mixtures can lead to slower warming of soils in the spring and reduced crop emergence. Compost high in organic matter showed hydrophobic characteristics over the short term. Increased hydrophobicity of soil-compost mixtures can result in less infiltration and thus increased runoff on steep slopes.

Table 1. Particle size analysis and organic carbon contents of soils and composts used.

Soil/Compost	%			
	Sand	Silt	Clay	OC
Rozetta (silt loam)	5.8	71.6	22.6	1.3
Webster (clay loam)	31.0	34.6	34.4	3.7
Hubbard (sand)	88.1	6.9	5.0	2.0
Lodi (compost)	--	--	--	23.0
Eden Prairie (compost)	--	--	--	11.0

Table 2. Available water content of Lodi compost mixtures.

	Water Content By Volume		
Treatment	0.1 bar	15 bar	Available Water Content
	---------------Rozetta silt loam---------------		
Soil	0.348	0.137	0.211
2/3 R, 1/3 L	0.378	0.182	0.196
1/3 R, 2/3 L	0.418	0.202	0.216
Compost	0.385	0.179	0.206
	---------------Webster clay loam---------------		
Soil	0.451	0.231	0.220
2/3 W, 1/3 L	0.420	0.211	0.209
1/3 W, 2/3 L	0.409	0.209	0.200
Compost	0.385	0.179	0.206
	---------------Hubbard sand---------------		
Soil	0.199	0.073	0.126
2/3 H, 1/3 L	0.300	0.109	0.191
1/3 H, 2/3 L	0.429	0.208	0.221
Compost	0.385	0.179	0.206

Table 3. Available water content of Eden Prairie compost mixtures.

Treatment	0.1 bar	15 bar	Available Water Content
	Water Content By Volume		
	Rozetta silt loam		
Soil	0.348	0.137	0.211
2/3 R, 1/3 EP	0.381	0.174	0.207
1/3 R, 2/3 EP	0.386	0.190	0.196
Compost	0.368	0.248	0.120
	Webster clay loam		
Soil	0.451	0.231	0.220
2/3 W, 1/3 EP	0.418	0.230	0.188
1/3 W, 2/3 EP	0.371	0.208	0.163
Compost	0.368	0.248	0.120
	Hubbard sand		
Soil	0.199	0.073	0.126
2/3 H, 1/3 EP	experiment still in progress		
1/3 H, 2/3 EP			
Compost	0.368	0.248	0.120

Table 4. Thermal conductivity as affected by the addition of Lodi compost to Rozetta and Webster soils.

Treatment	Thermal Conductivity (10^{-3} cal cm^{-1} sec^{-1} $°C^{-1}$)
	---------- Rozetta silt loam ----------
Soil	3.37
2/3 R, 1/3 L	1.90
1/3 R, 2/3 L	1.36
Compost	1.06
	---------- Webster clay loam ----------
Soil	4.28
2/3 W, 1/3 L	1.75
1/3 W, 2/3 L	1.48
Compost	1.06

Table 5. Wetting angles of soil-compost mixtures studied.

	Wetting Angle (degrees)		
	Soils		
	Rozetta	Webster	Hubbard
	Lodi Compost		
Soil	71.47	76.20	57.78
2/3 soil, 1/3 compost	75.40	77.24	78.61
1/3 soil, 2/3 compost	85.82	85.29	82.50
Compost	81.67	81.67	81.67
	Eden Prairie Compost		
Soil	71.74	76.20	57.78
2/3 soil, 1/3 compost	75.95	76.19	68.12
1/3 soil, 2/3 compost	73.87	74.05	69.10
Compost	63.15	63.15	63.15

Wetting angle of glass beads (control) = 66.95.

Figure 1. Bulk density versus percent compost by weight.

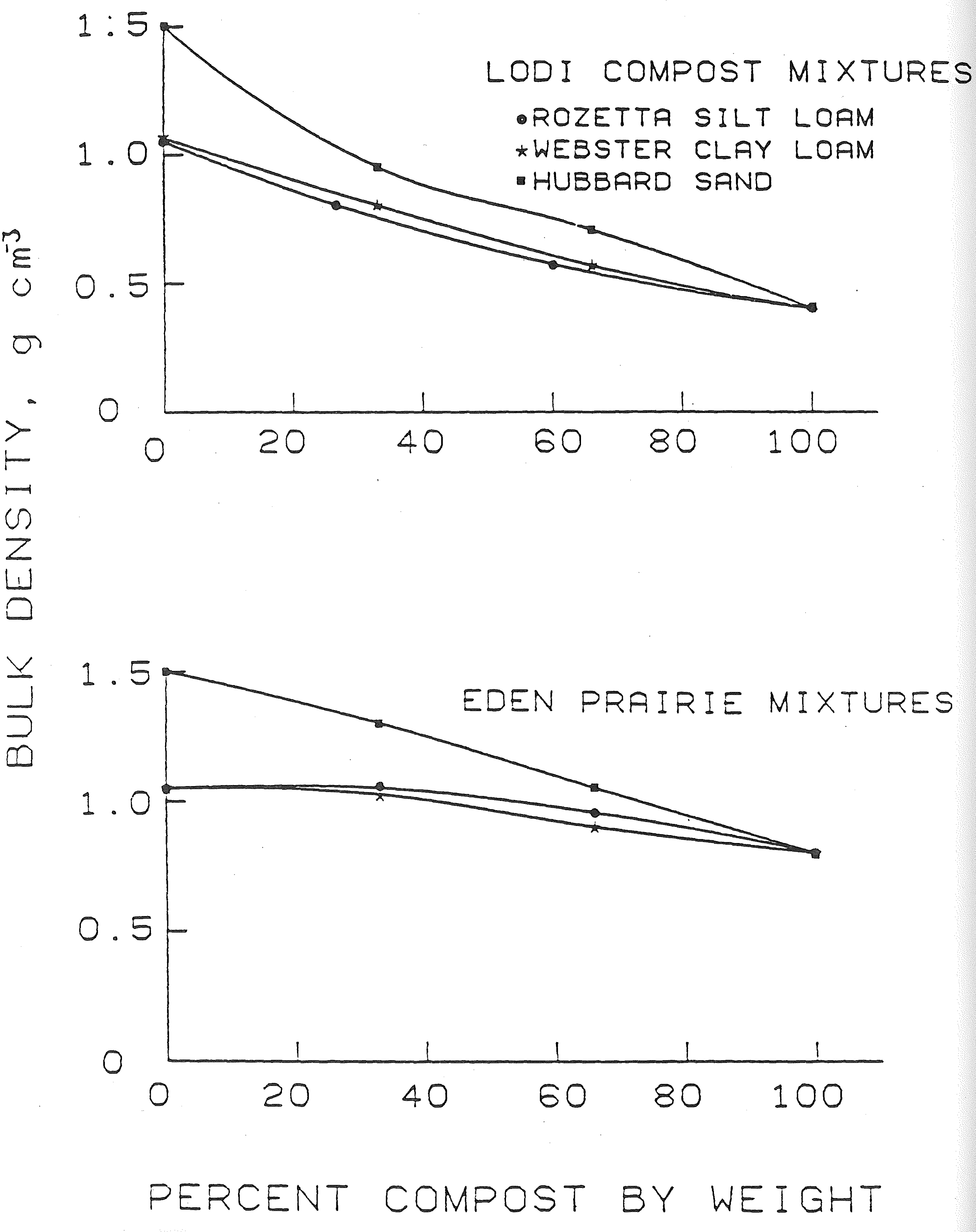
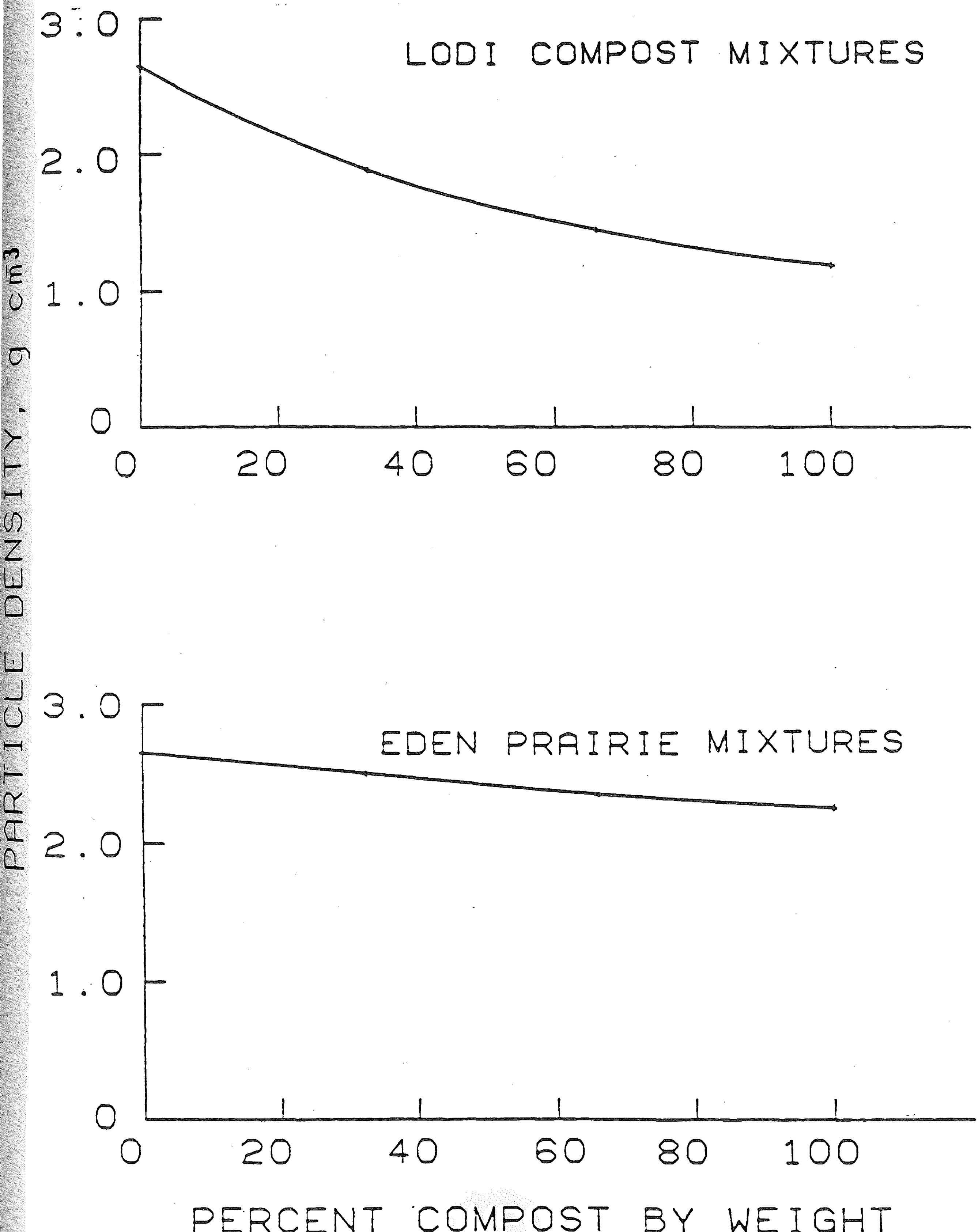


Figure 2. Particle density versus percent compost by weight



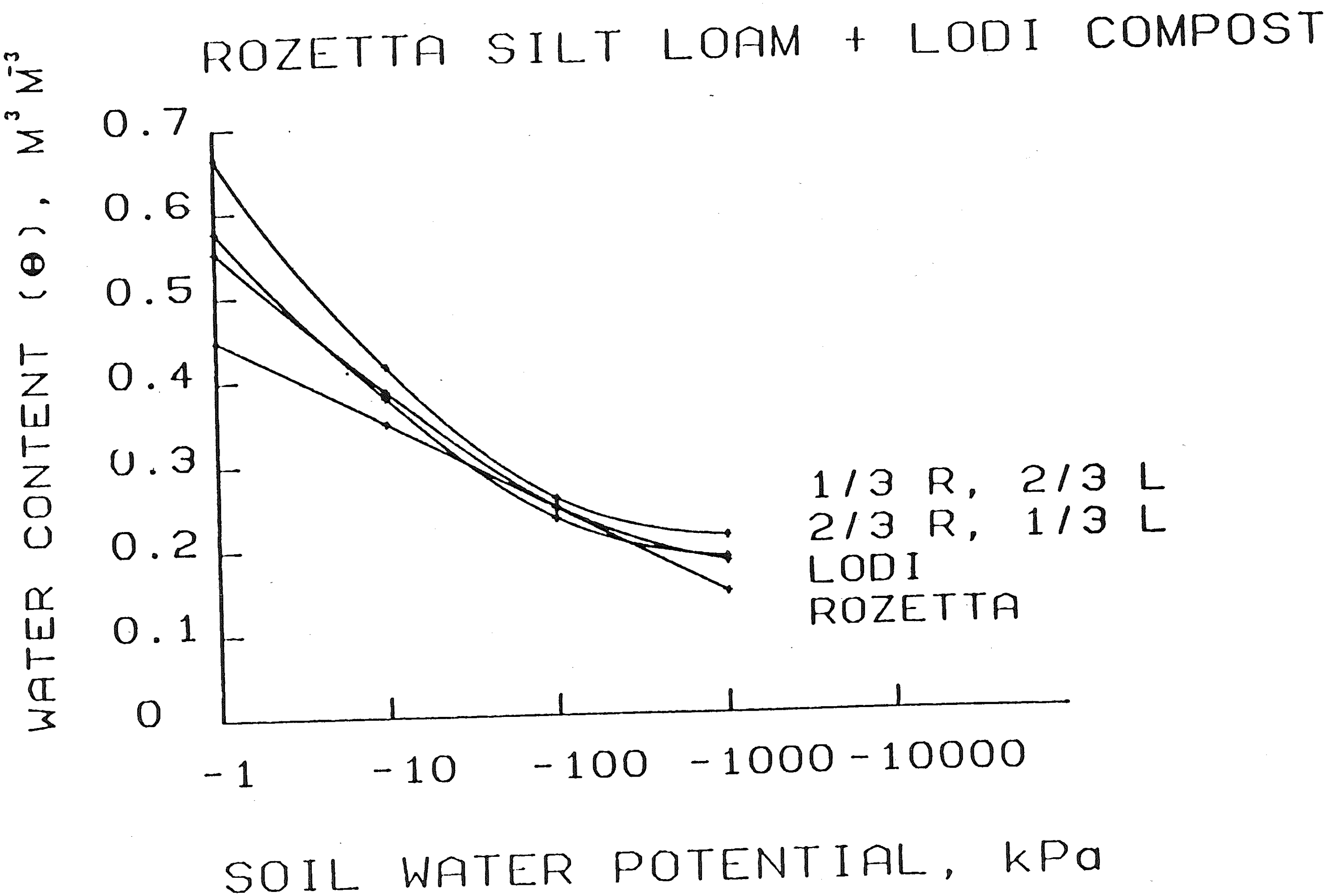


Figure 3. Soil water retention curve for Rozetta soil as affected by addition of Lodi compost, water content by volume.

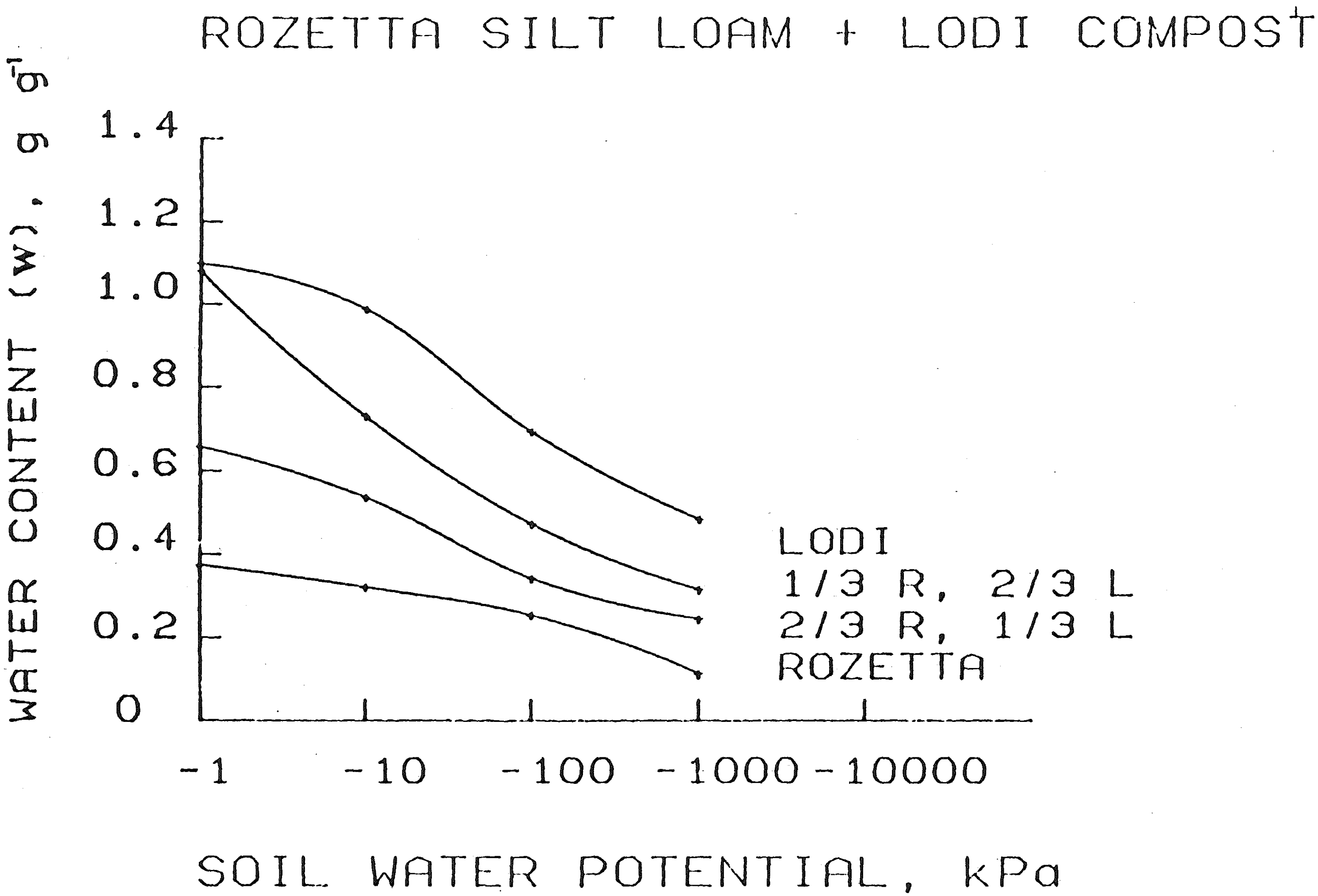


Figure 4. Soil water retention curve for Rozetta soil as affected by addition of Lodi compost, water content by weight

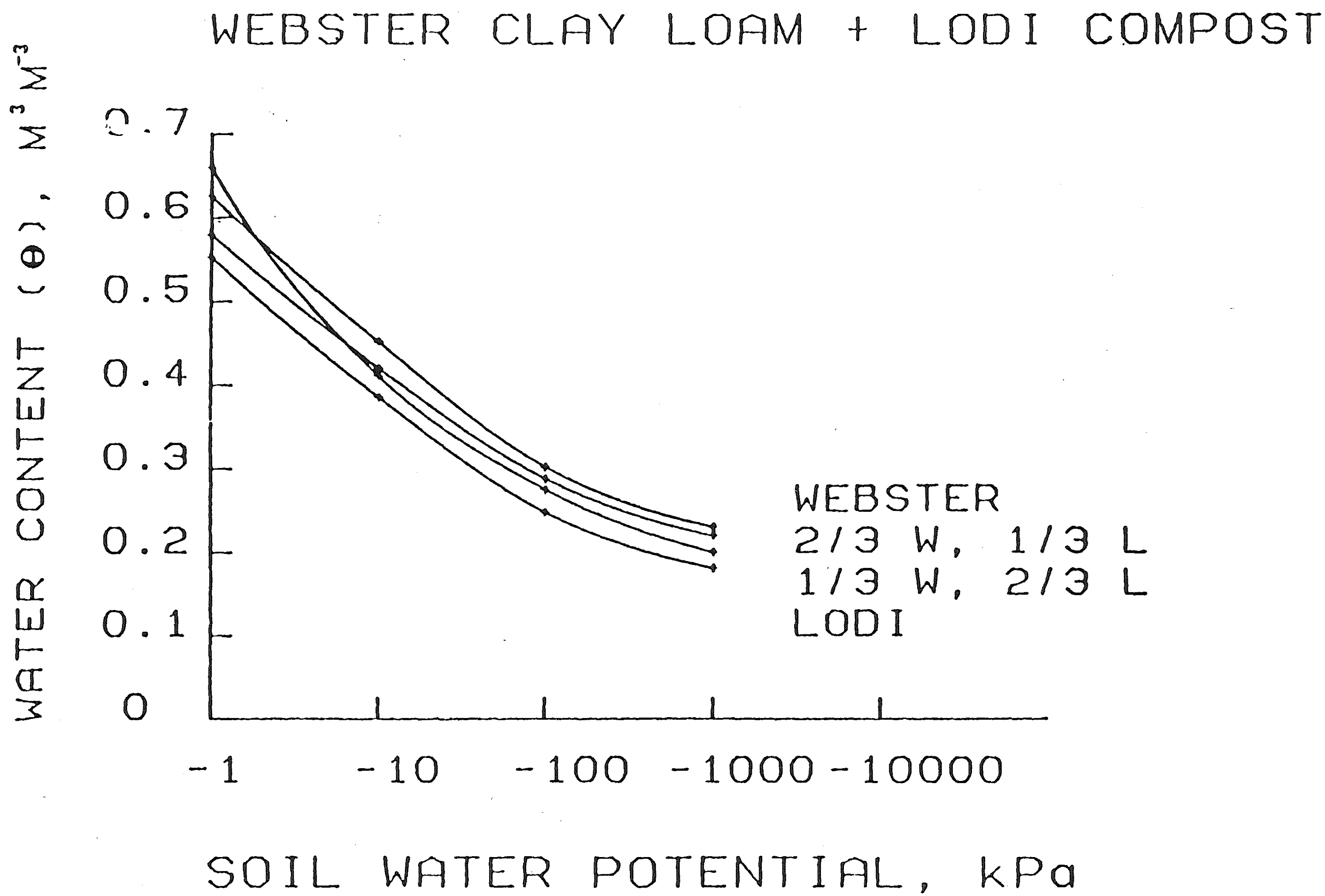


Figure 5. Soil water retention curve for Webster soil as affected by addition of Lodi compost, water content by volume

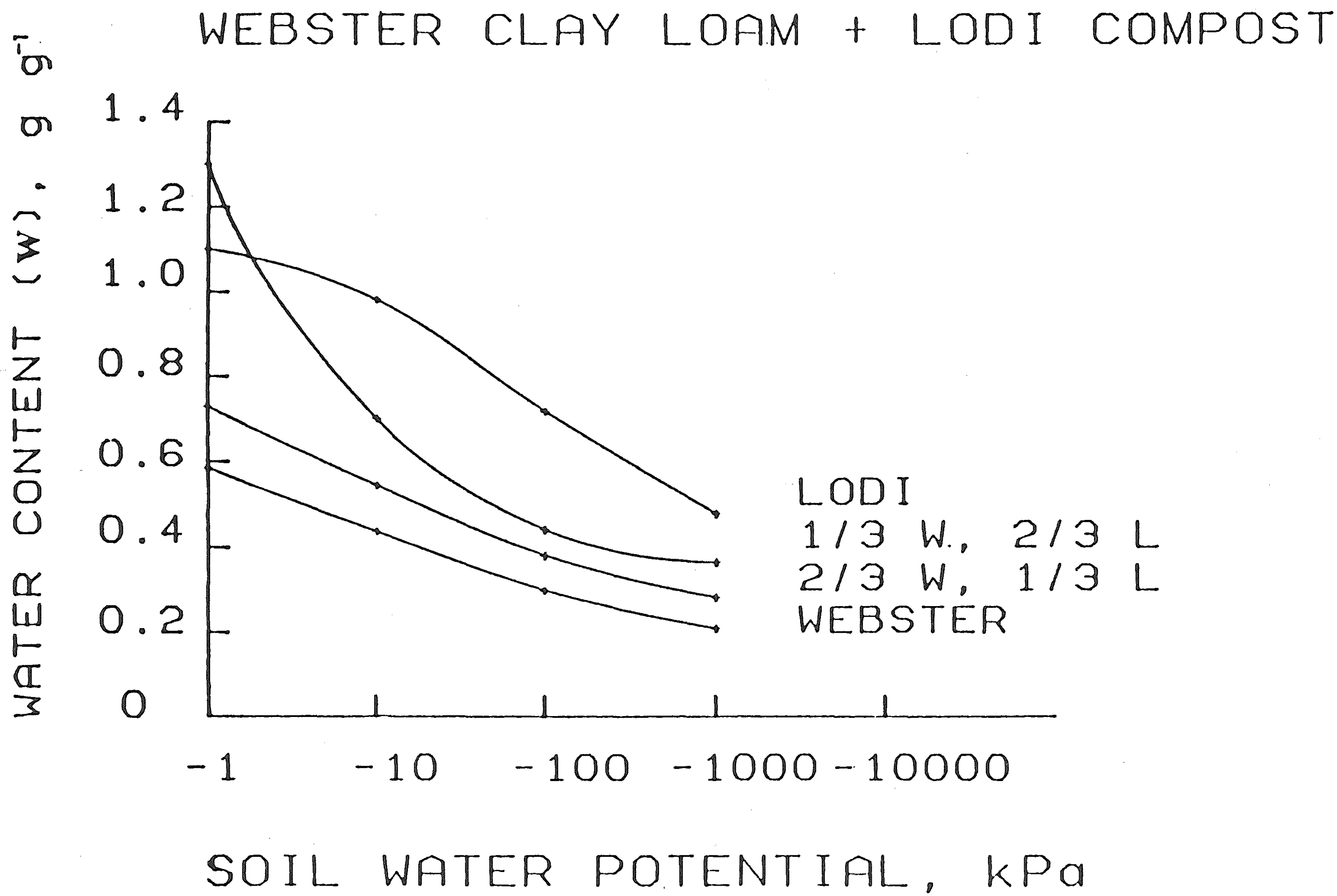


Figure 6. Soil water retention curve for Webster soil as affected by addition of Lodi compost, water content by weight.

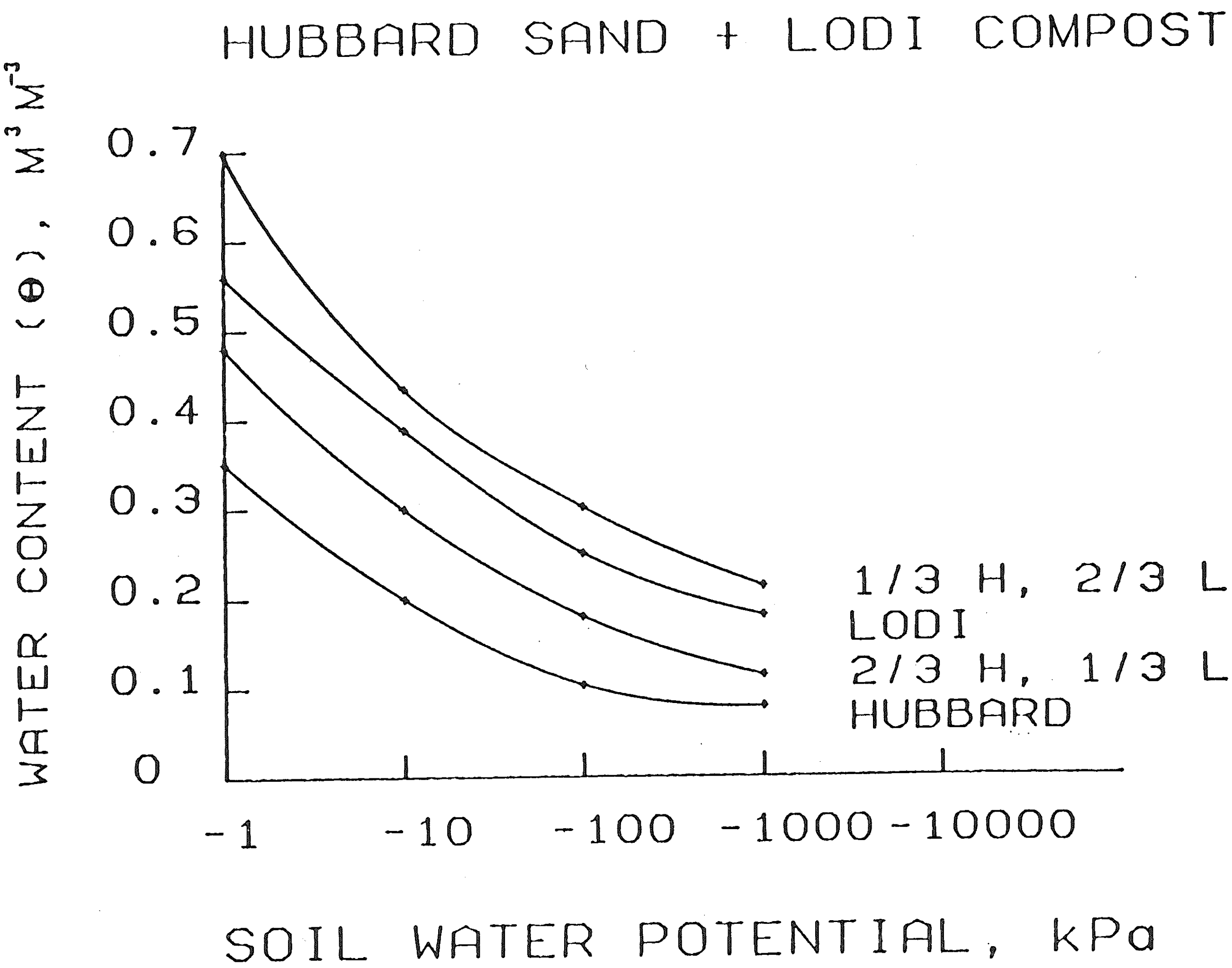


Figure 7. Soil water retention curve for Hubbard soil as affected by addition of Lodi compost, water content by volume.

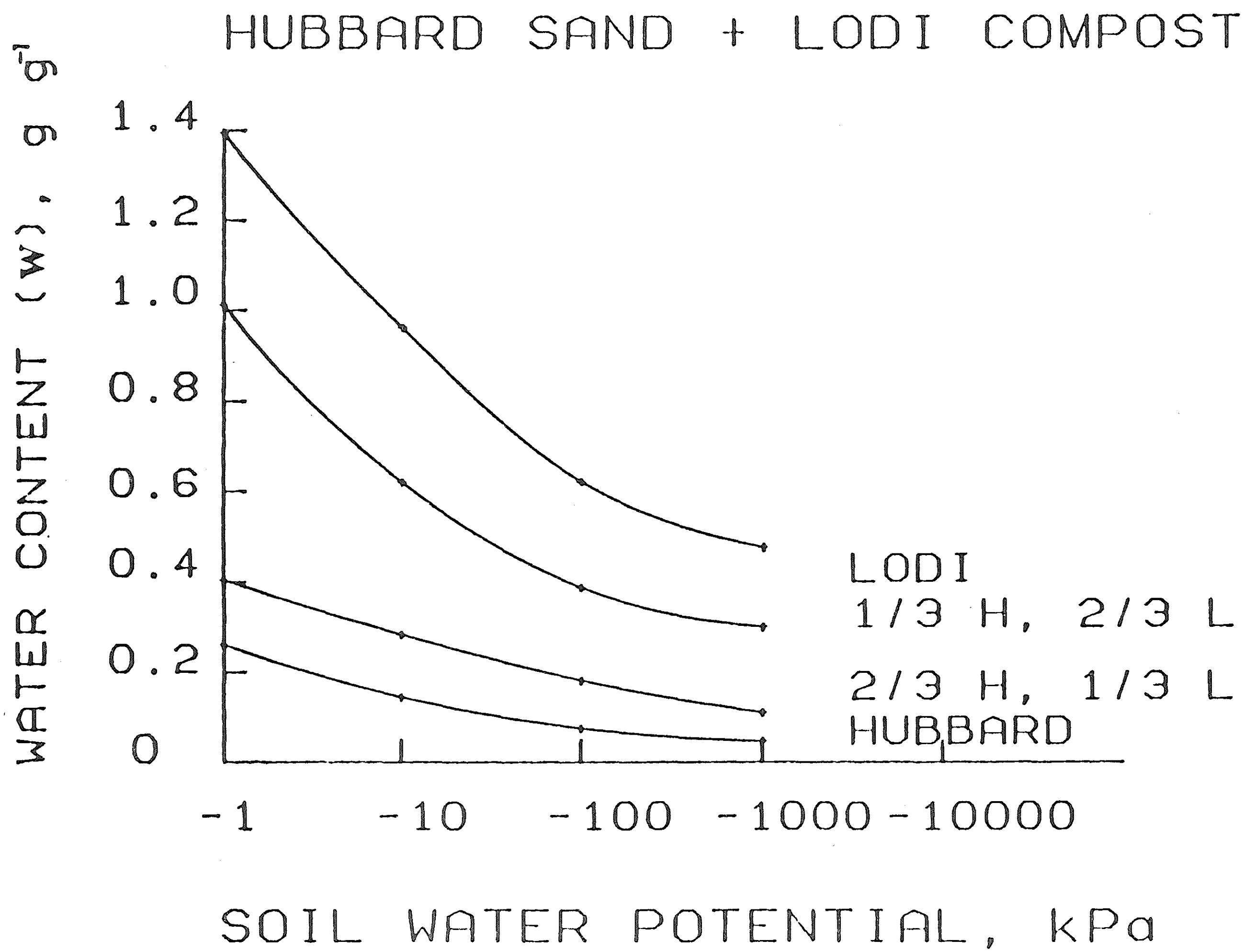


Figure 8. Soil water retention curve for Hubbard soil as affected by addition of Lodi compost, water content by weight.

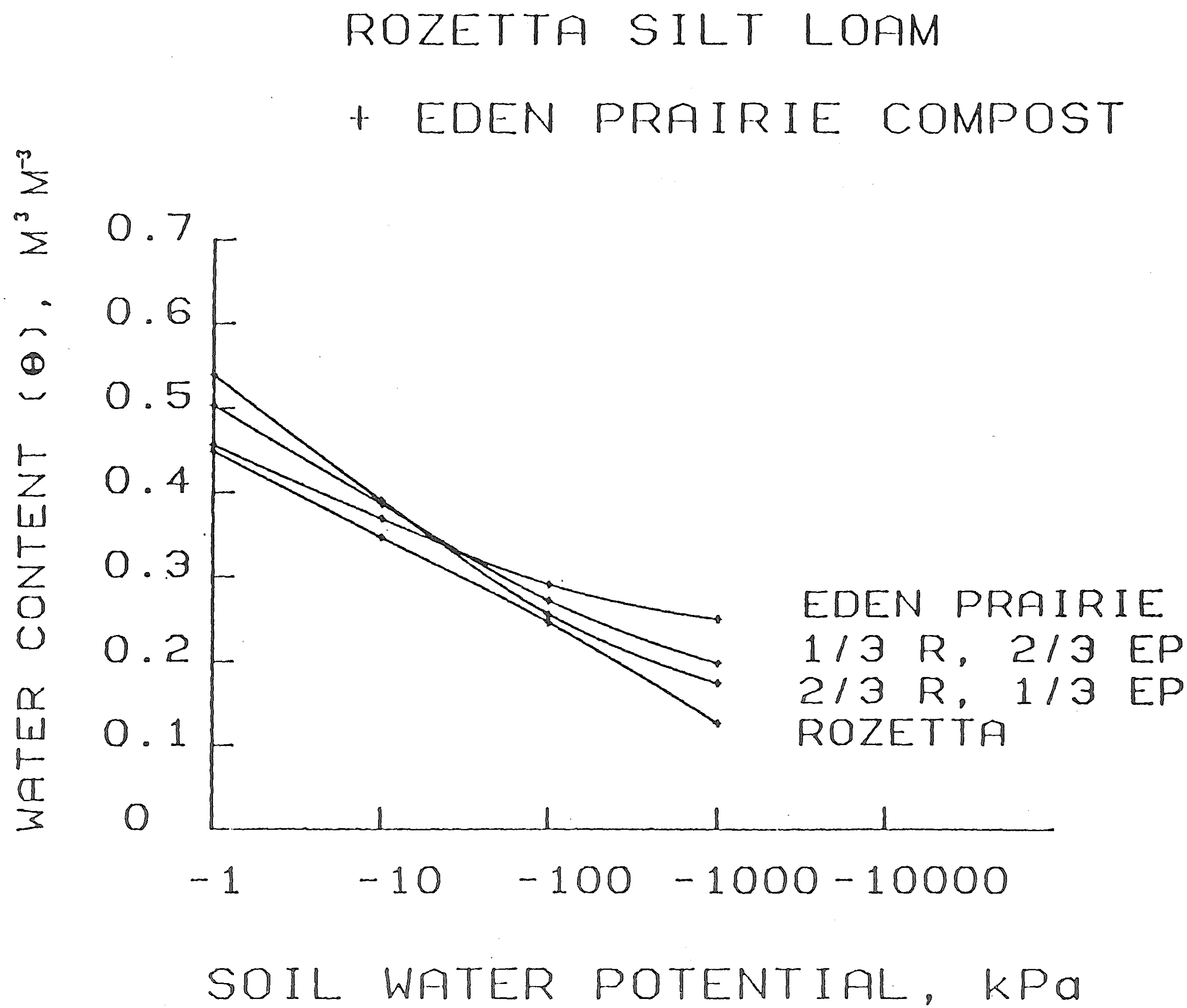


Figure 9. Soil water retention curve for Rozetta soil as affected by the addition of Eden Prairie compost, water content by volume.

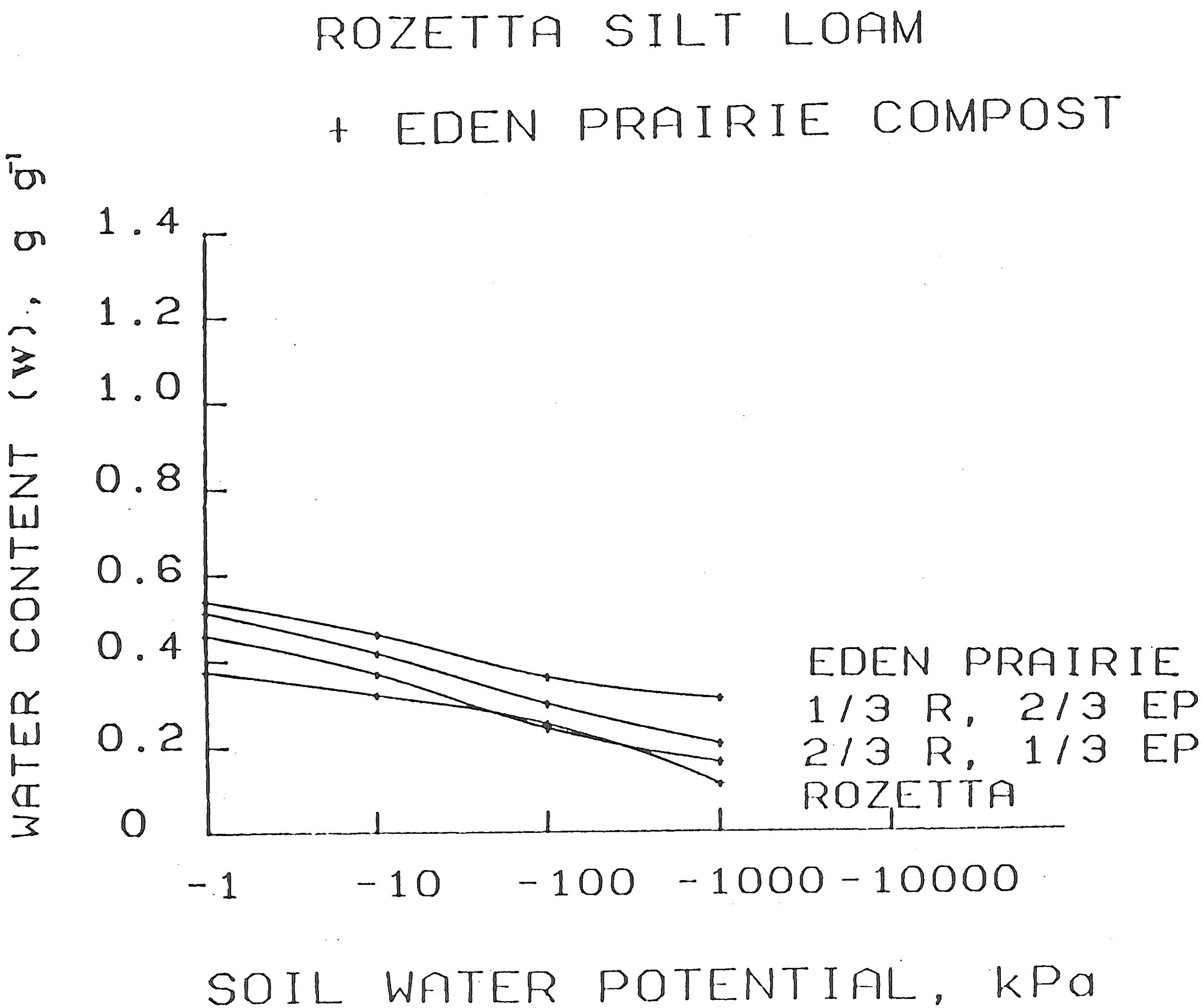


Figure 10. Soil water retention curve for Rozetta soil as affected by the addition of Eden Prairie compost, water content by weight.

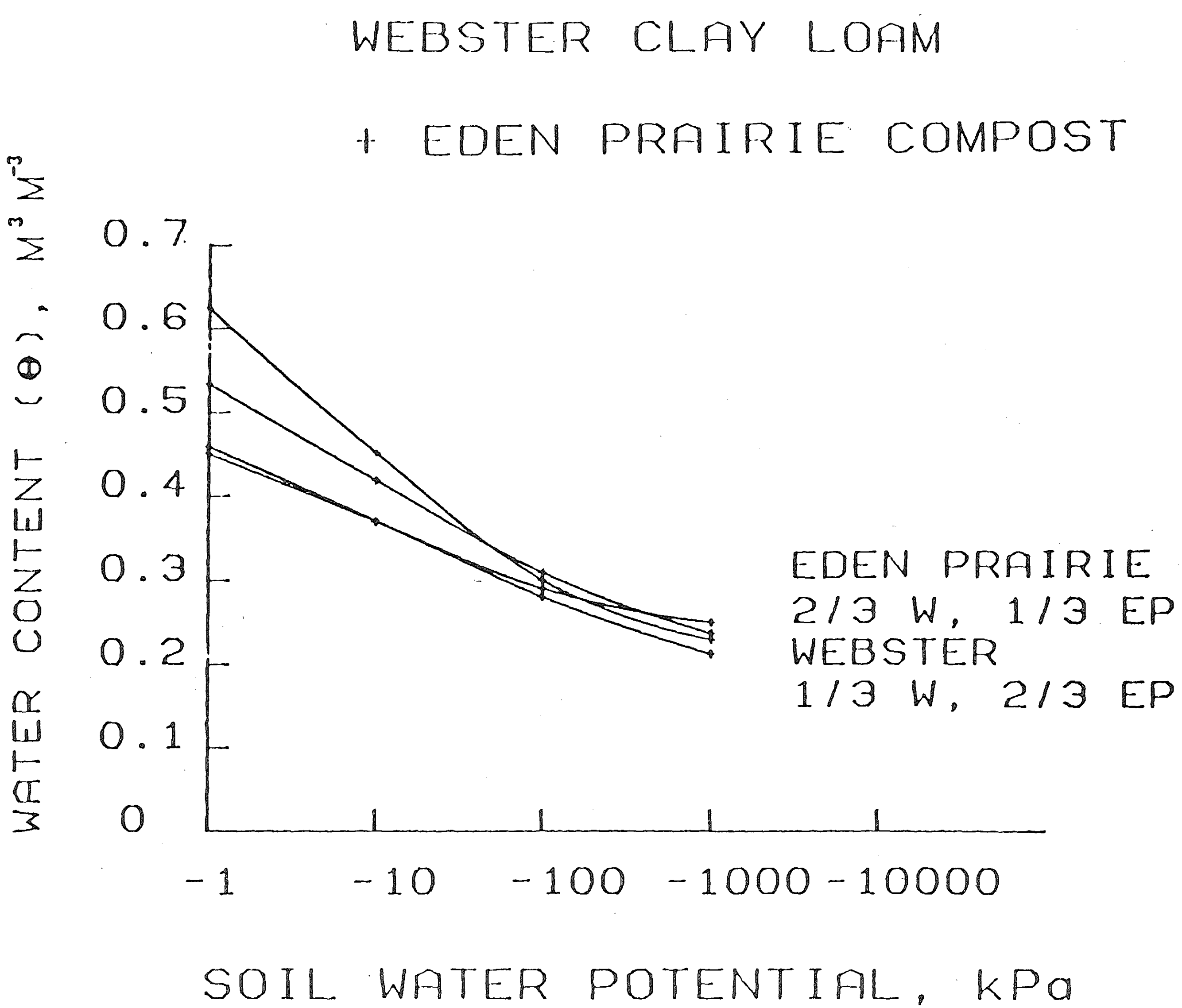


Figure 11. Soil water retention curve for Webster soil as affected by the addition of Eden Prairie compost, water content by volume.

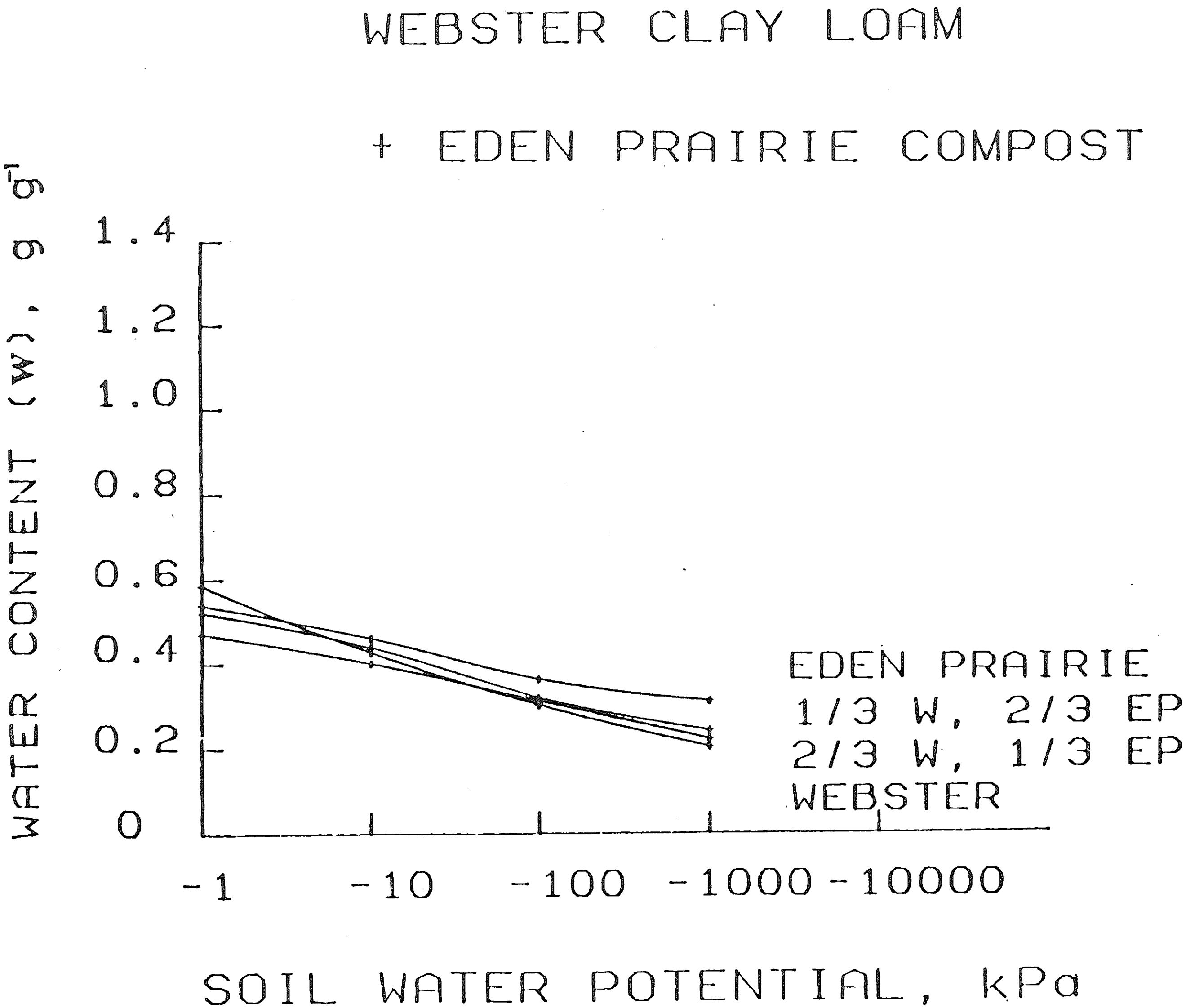


Figure 12. Soil water retention curve for Webster soil as affected by the addition of Eden Prairie compost, water content by weight.

Figure 13. Saturated hydraulic conductivity of Rozetta Webster, and Hubbard soil as affected by compost addition

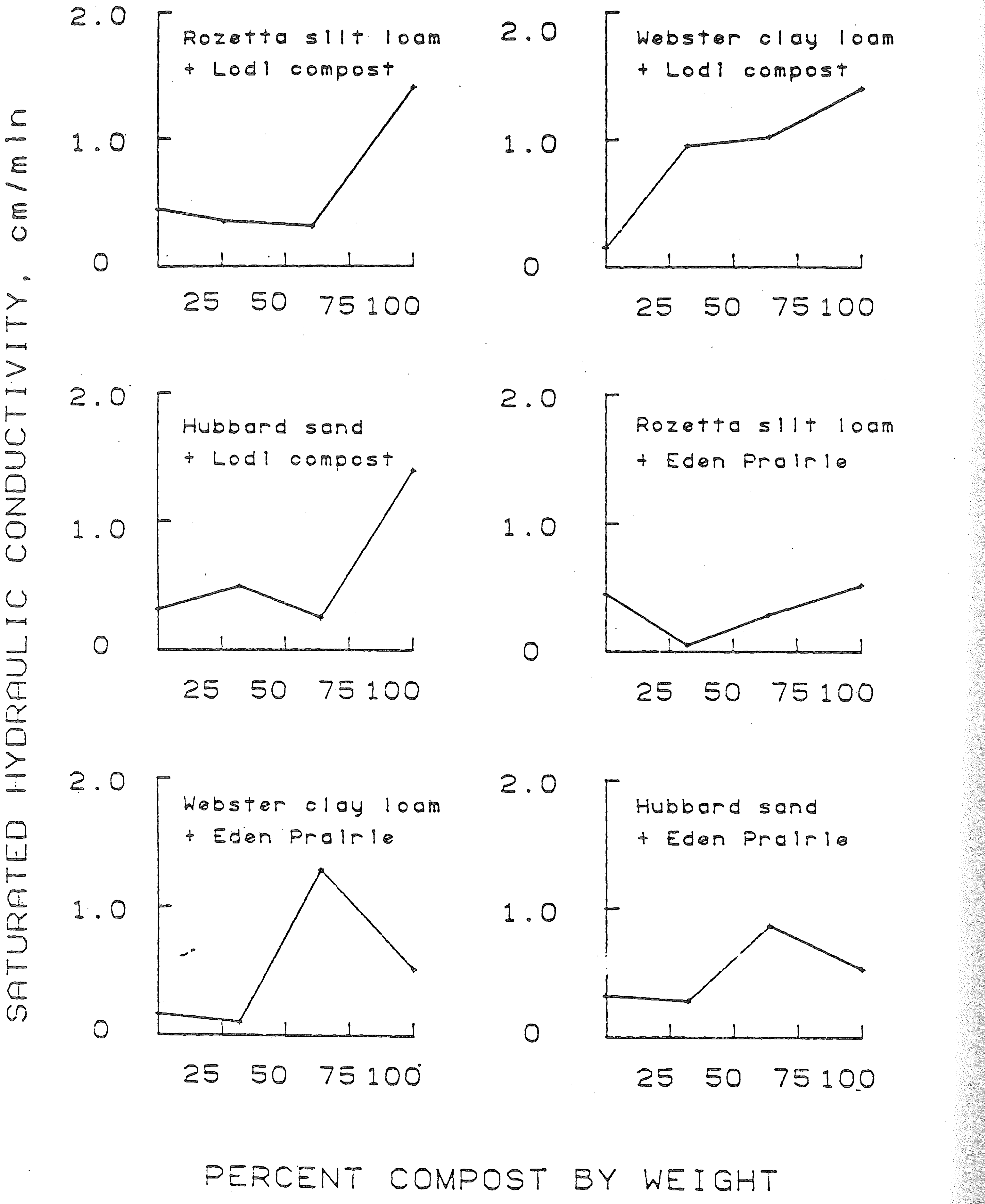
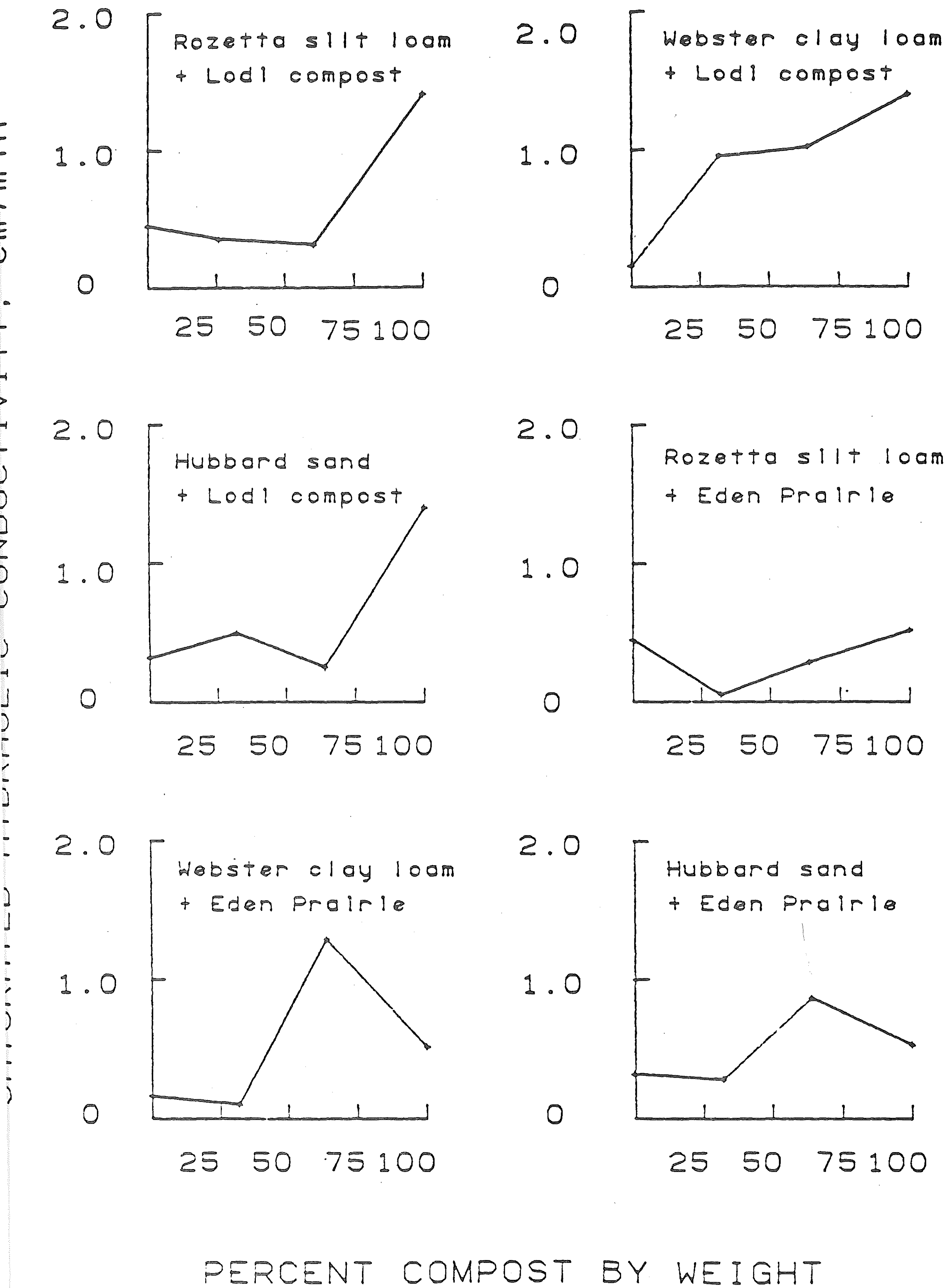


Figure 13. Saturated hydraulic conductivity of Rozetta Webster, and Hubbard soil as affected by compost addition



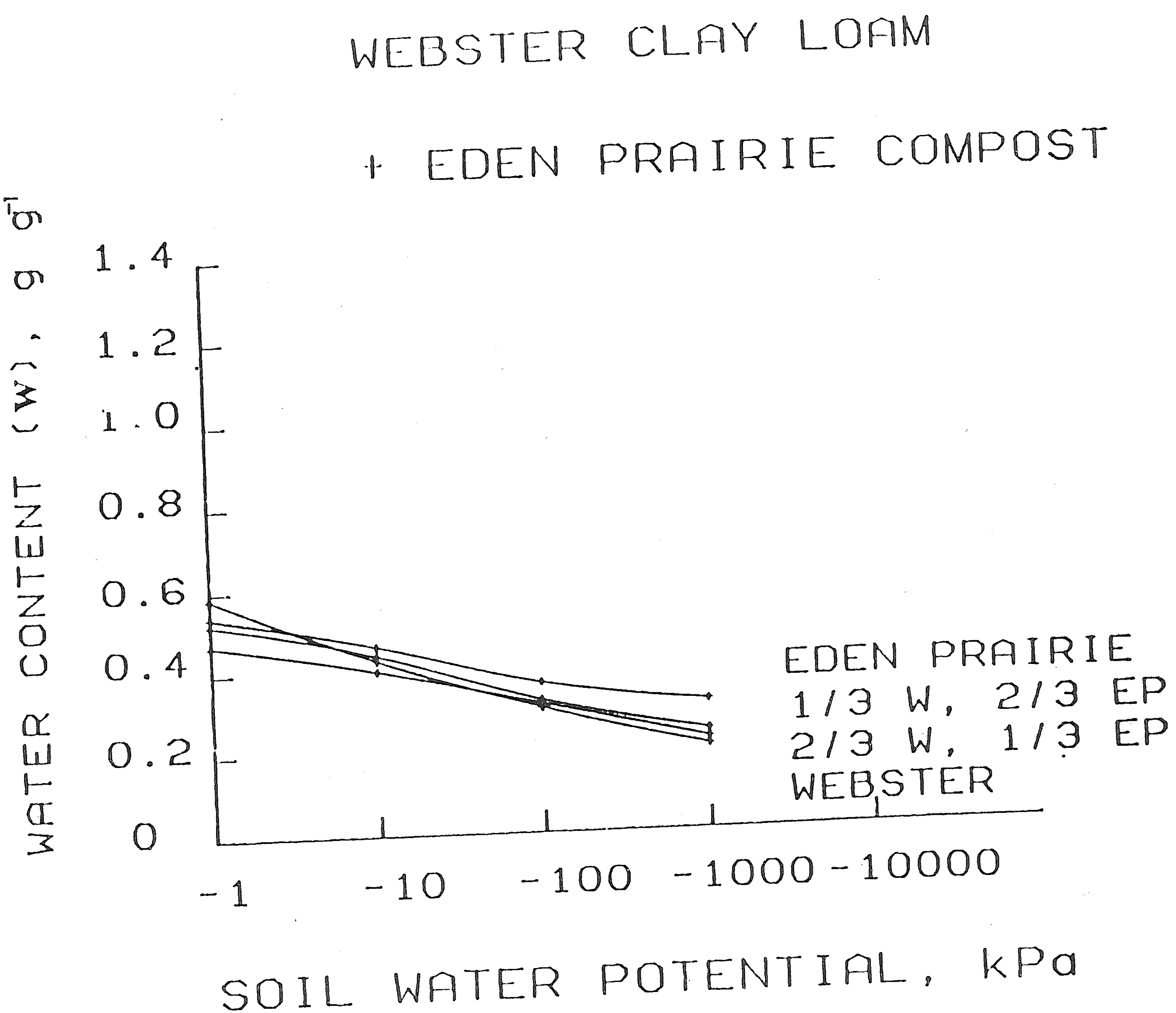


Figure 12. Soil water retention curve for Webster soil as affected by the addition of Eden Prairie compost, water content by weight.

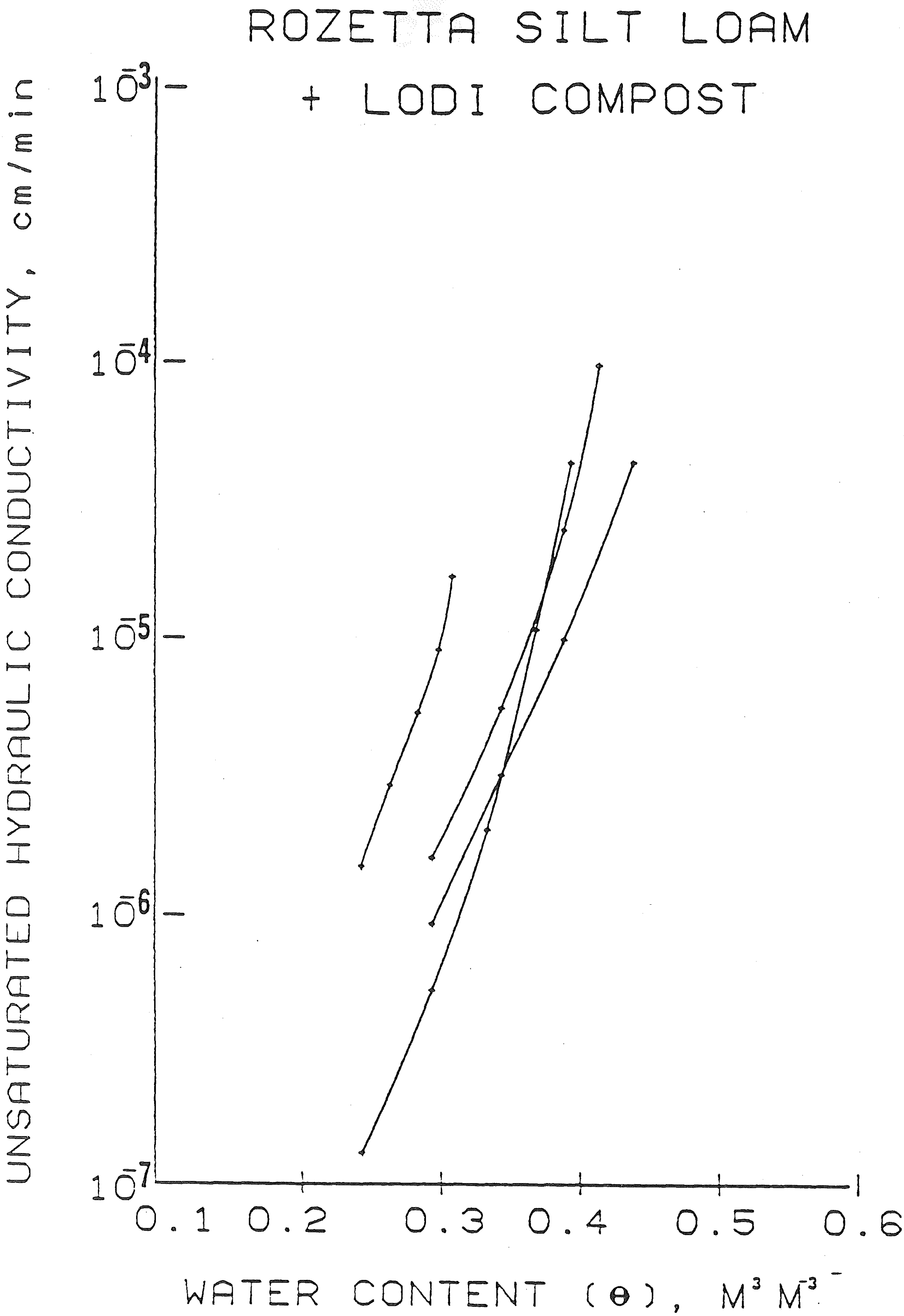


Figure 14. Soil water content versus unsaturated hydraulic conductivity of Rozetta soil as affected by compost addition.

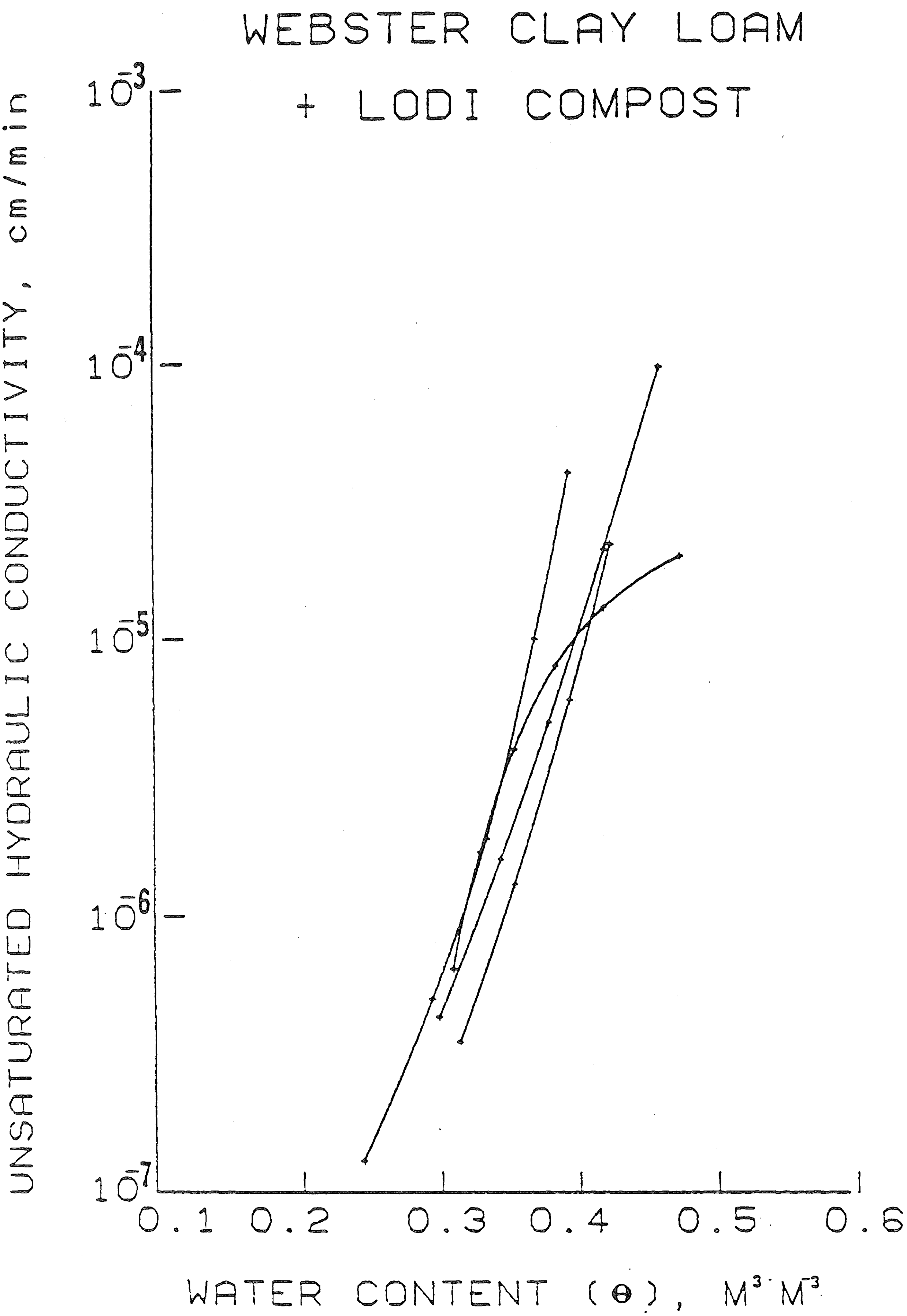


Figure 15. Soil water content versus unsaturated hydraulic conductivity of Webster soil as affected by compost addition

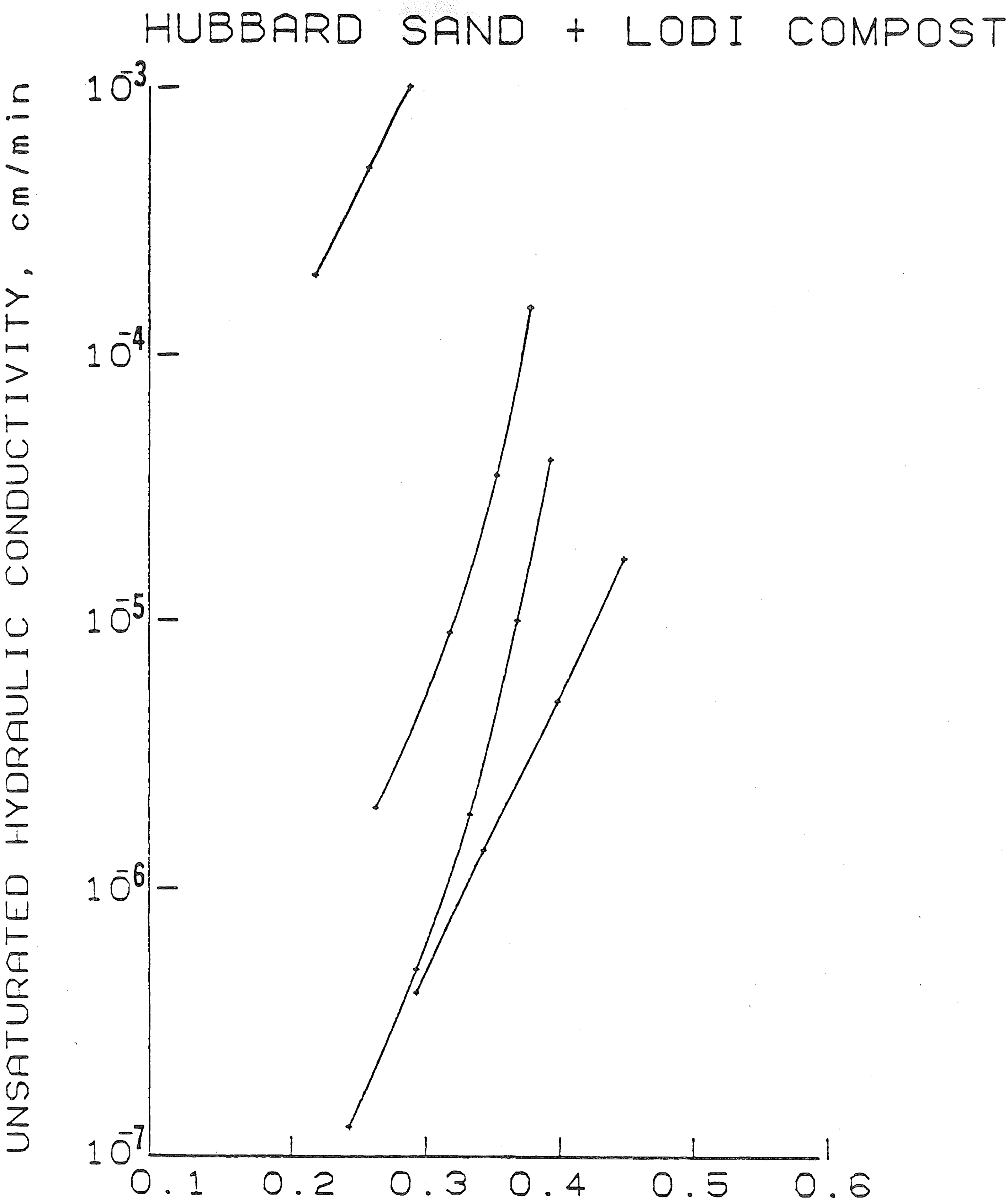


Figure 16. Soil water content versus unsaturated hydraulic conductivity of Hubbard soil as affected by compost addition.

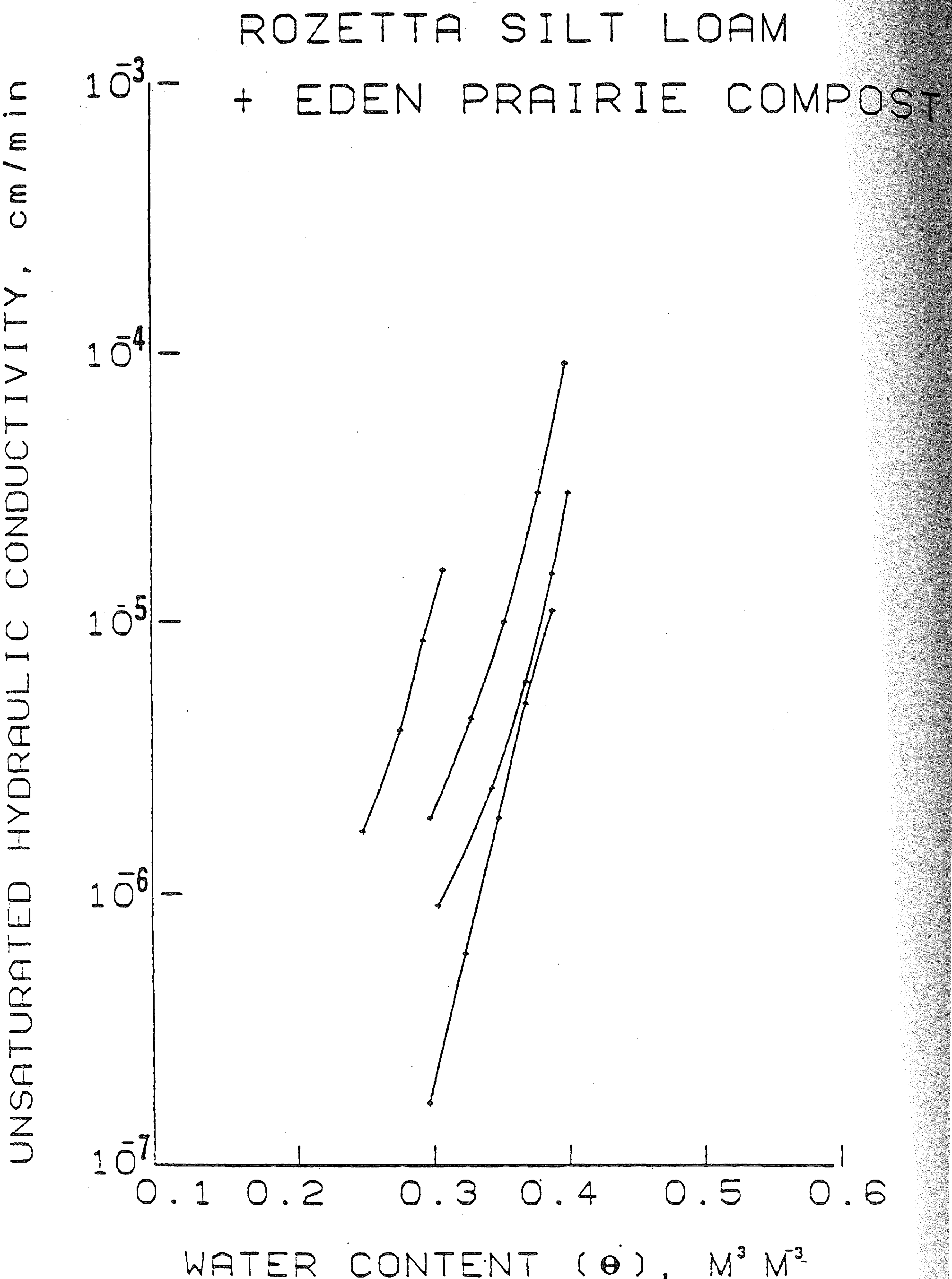


Figure 17. Soil water content versus unsaturated hydraulic conductivity of Rozetta soil as affected by compost additi

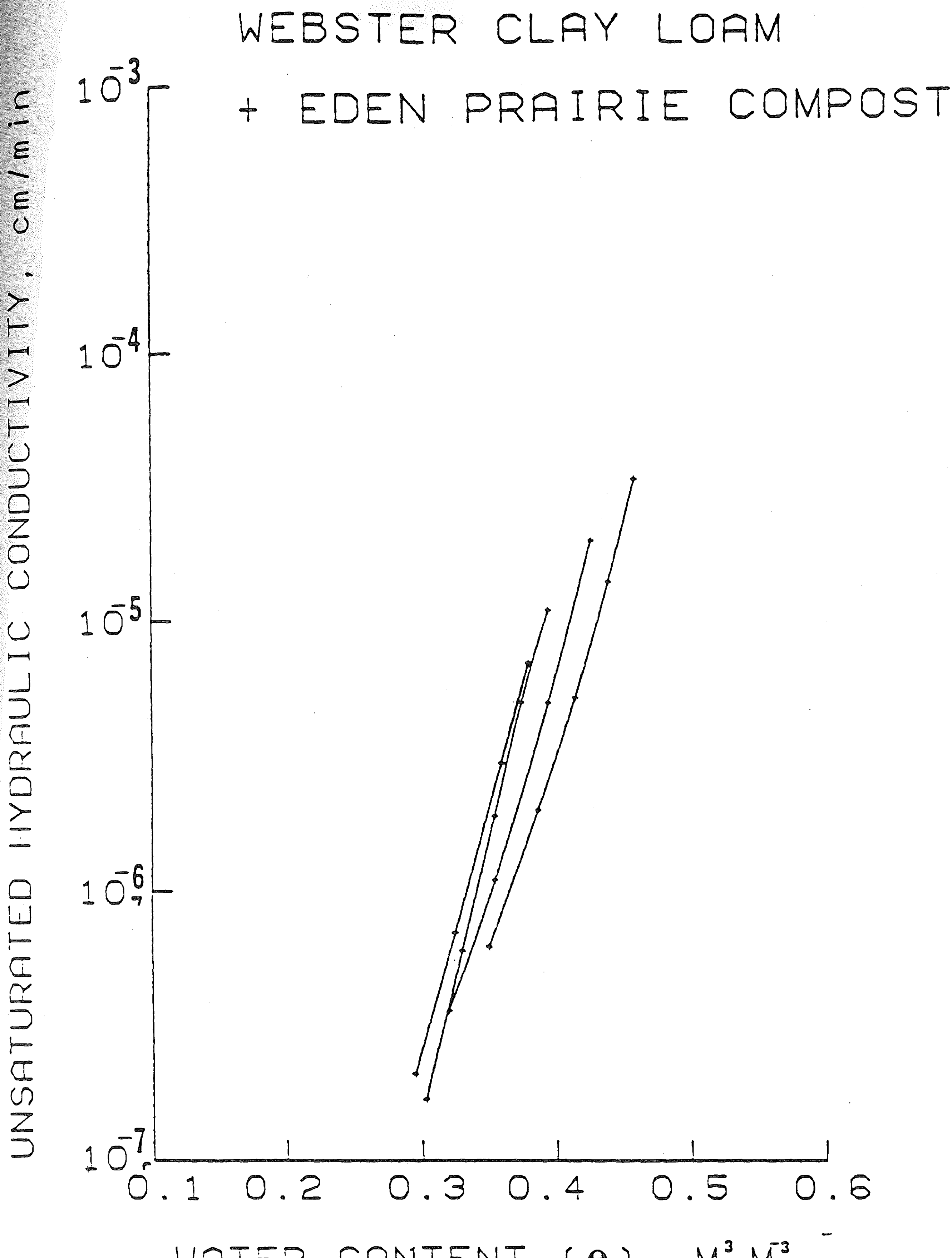


Figure 18. Soil water content versus unsaturated hydraulic conductivity of Webster soil as affected by compost addition.

Figure 1. Bulk density versus percent compost by weight.

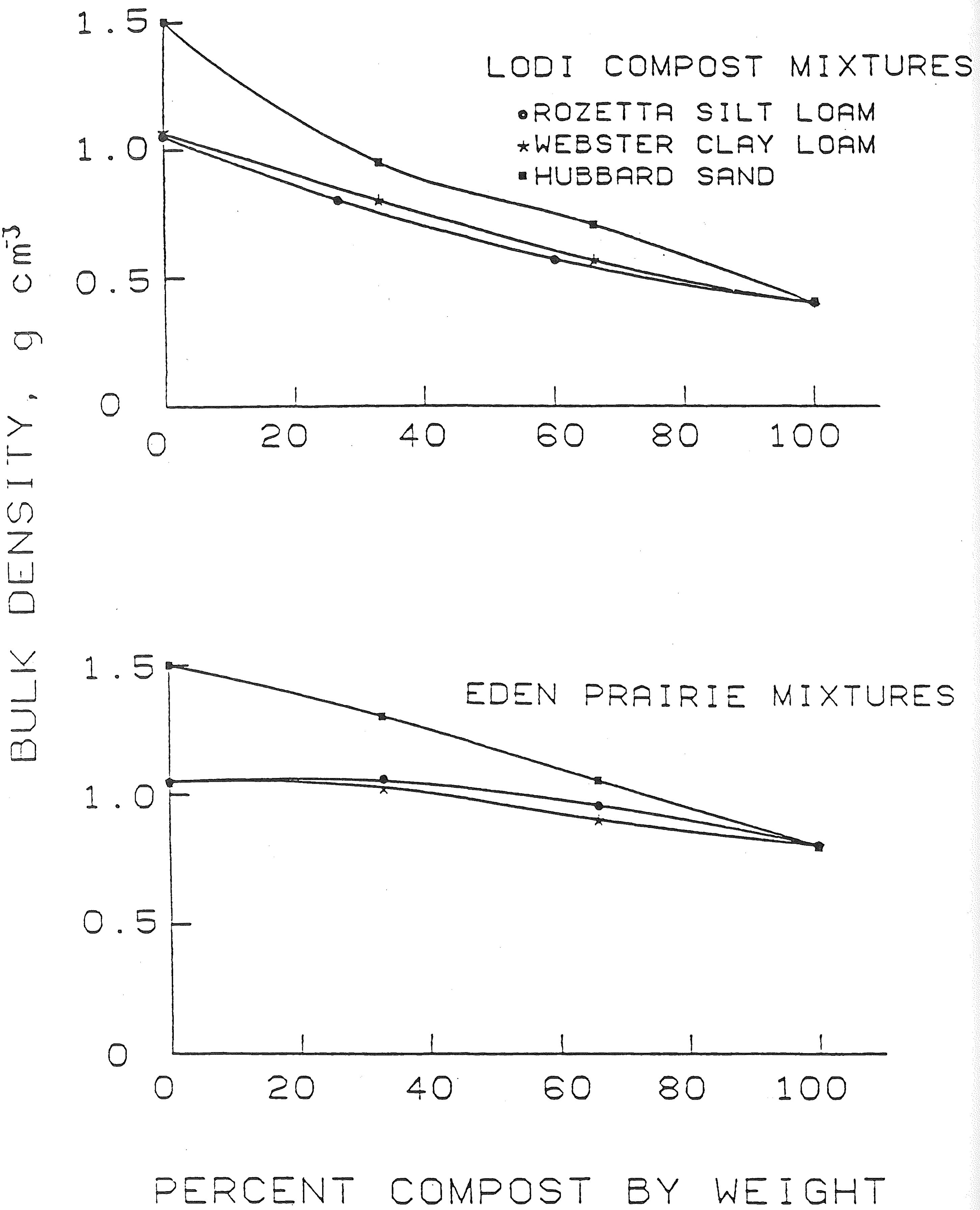
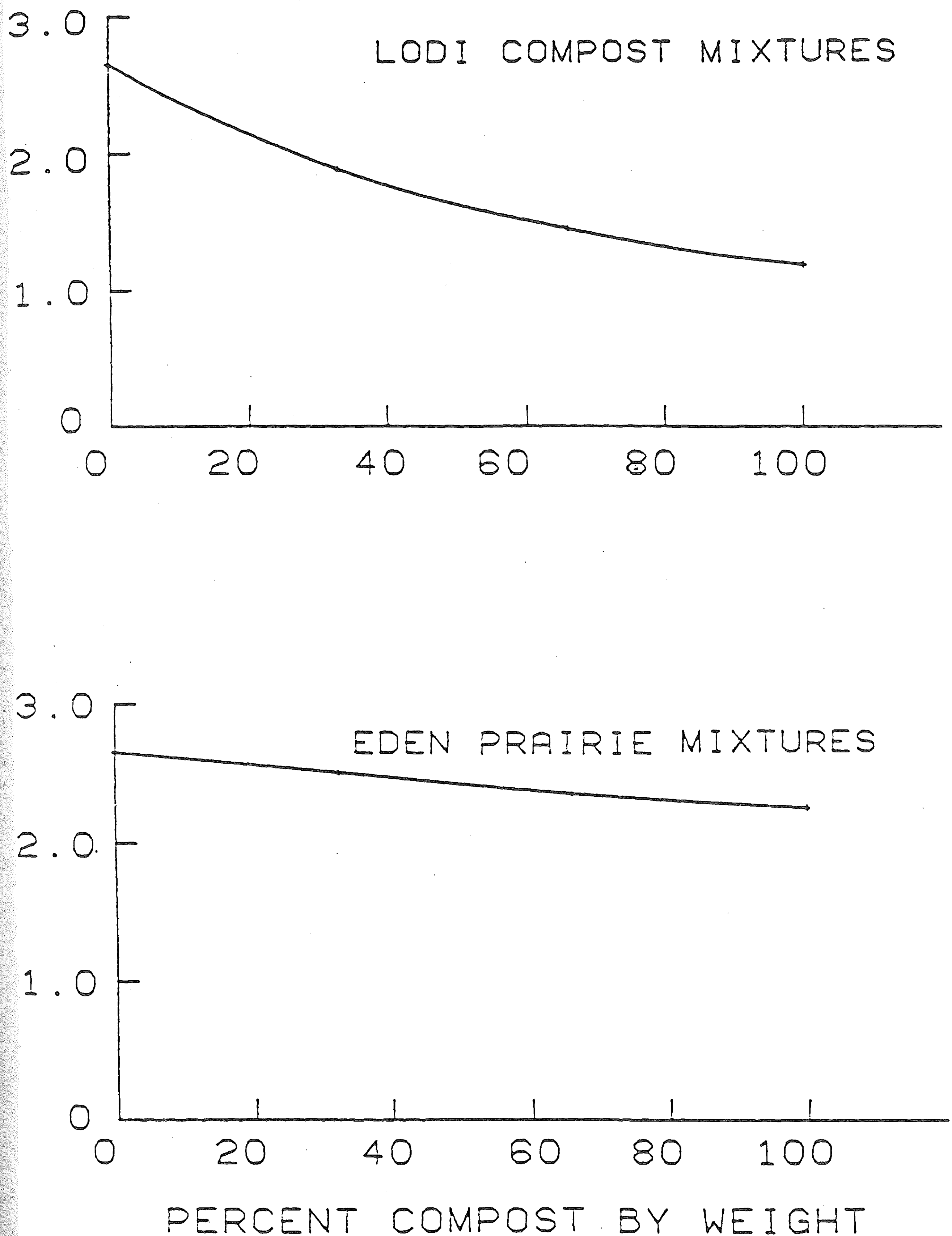


Figure 2. Particle density versus percent compost by weight



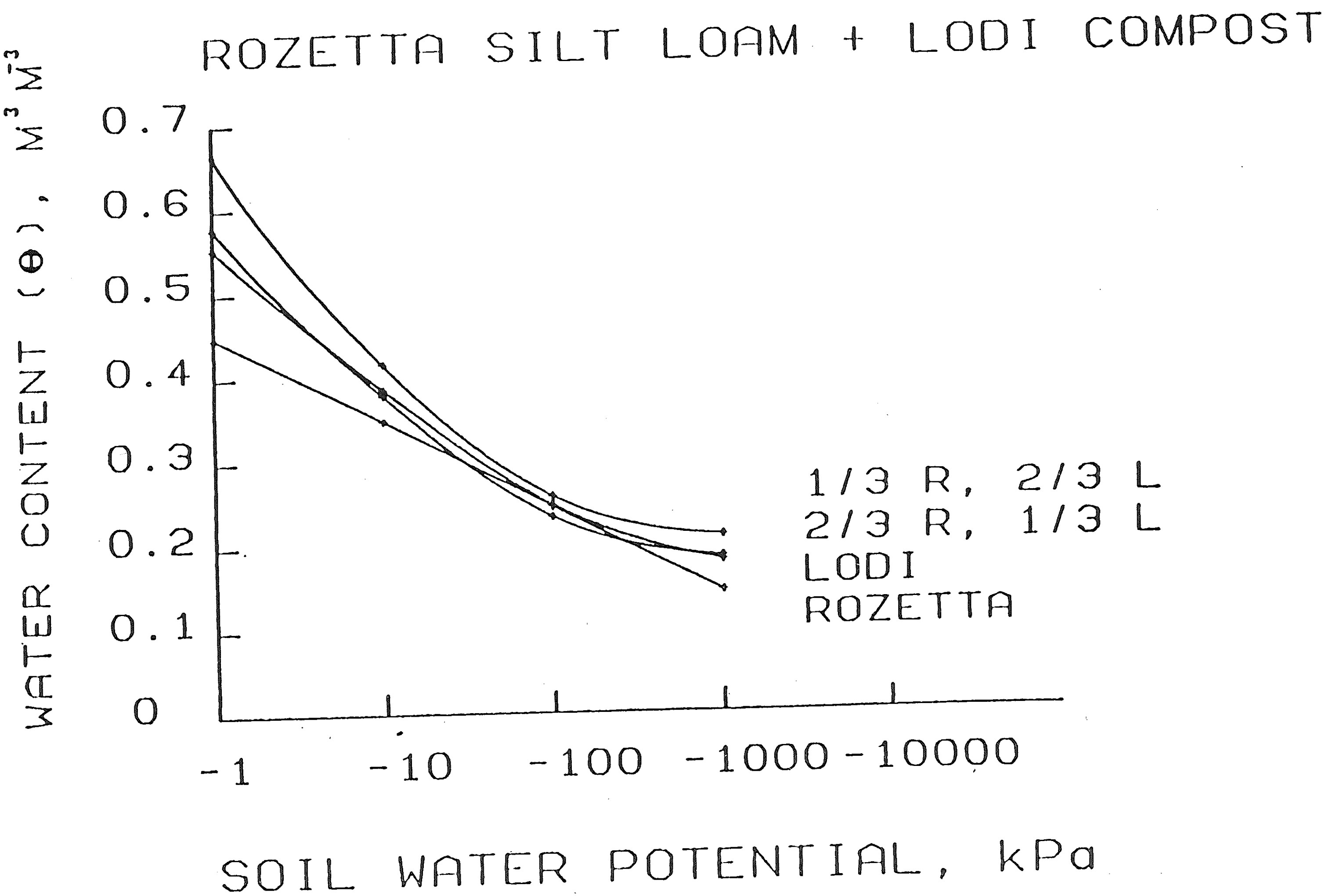


Figure 3. Soil water retention curve for Rozetta soil as affected by addition of Lodi compost, water content by volume.

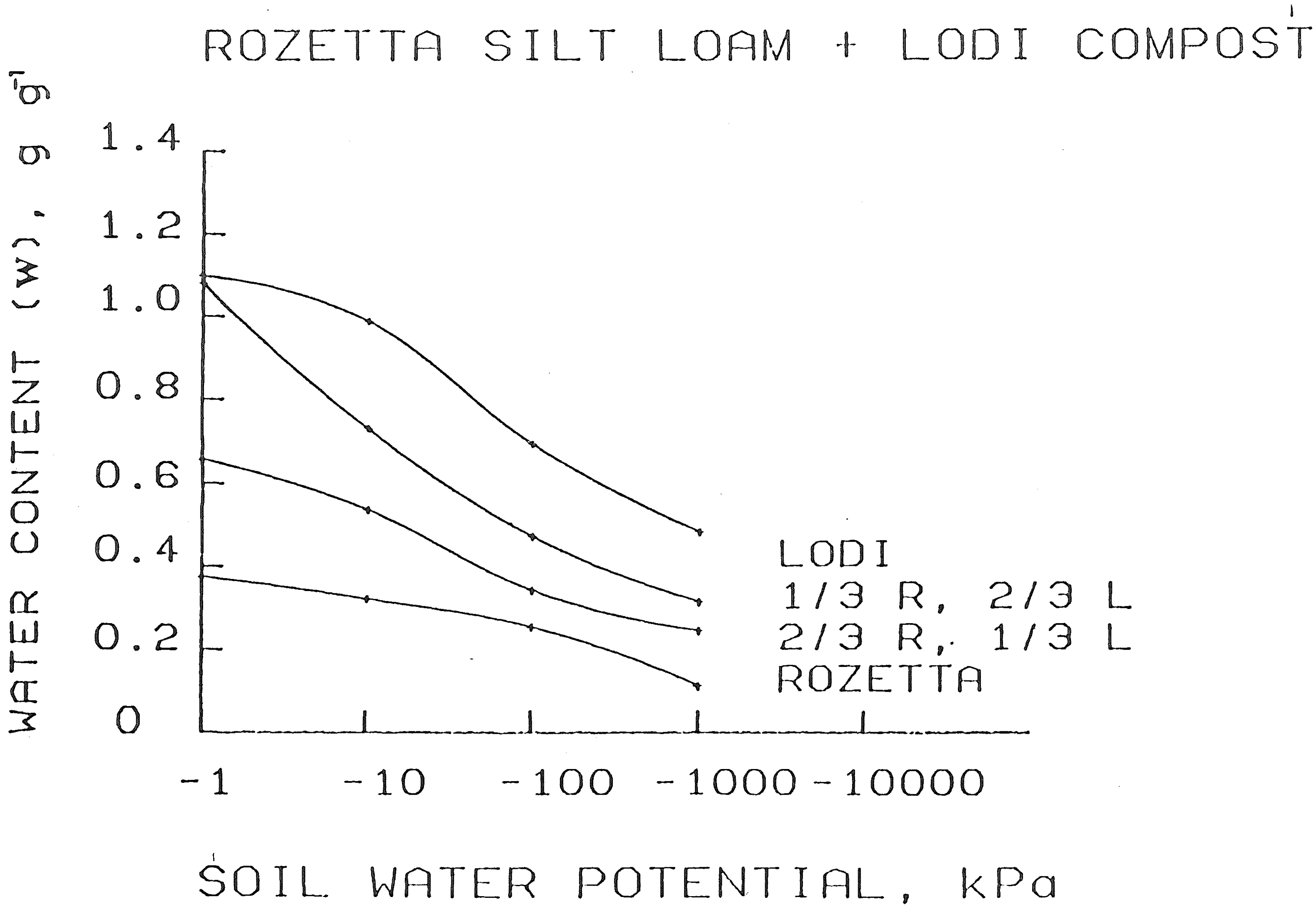


Figure 4. Soil water retention curve for Rozetta soil as affected by addition of Lodi compost, water content by weight

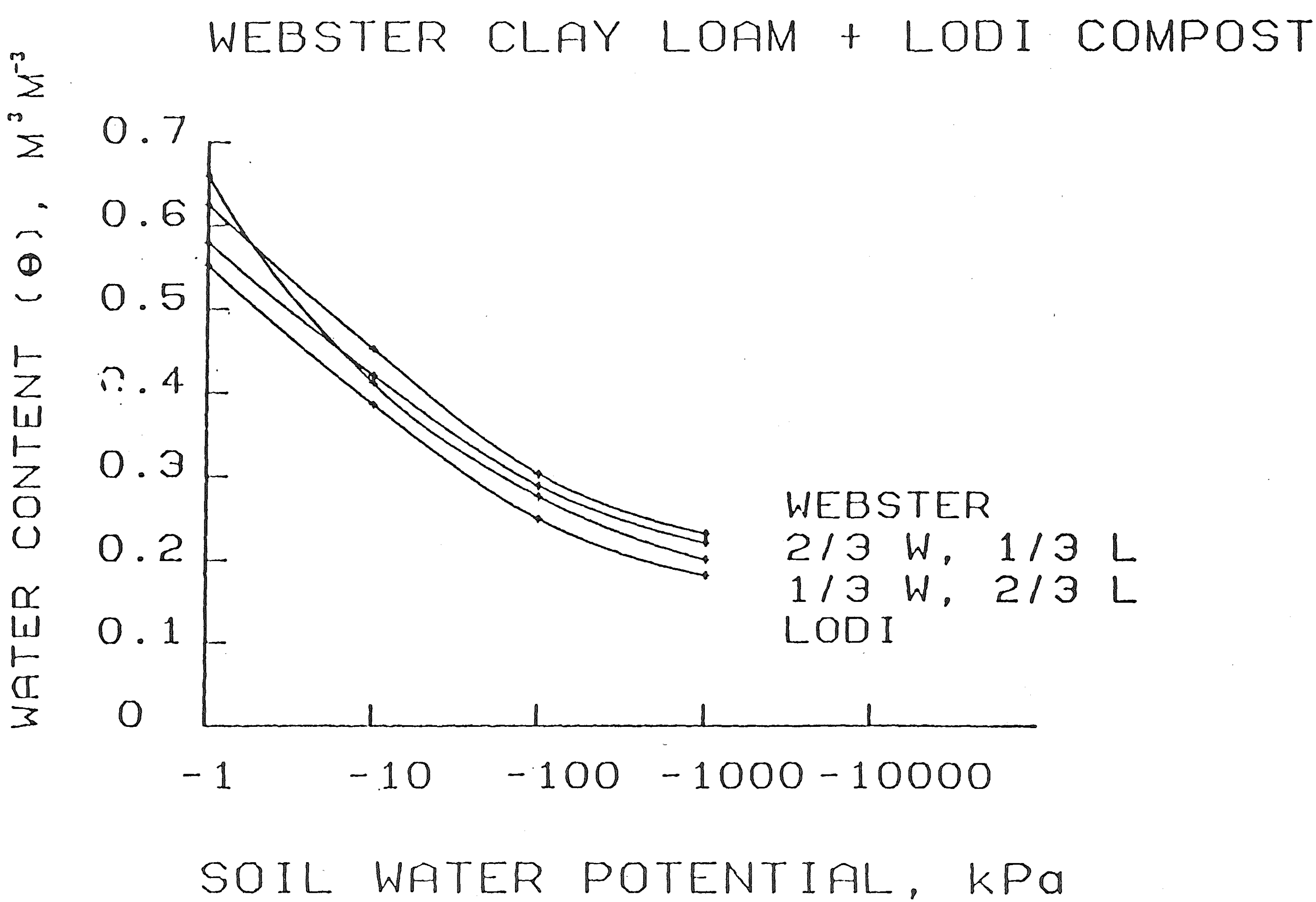


Figure 5. Soil water retention curve for Webster soil as affected by addition of Lodi compost, water content by volume

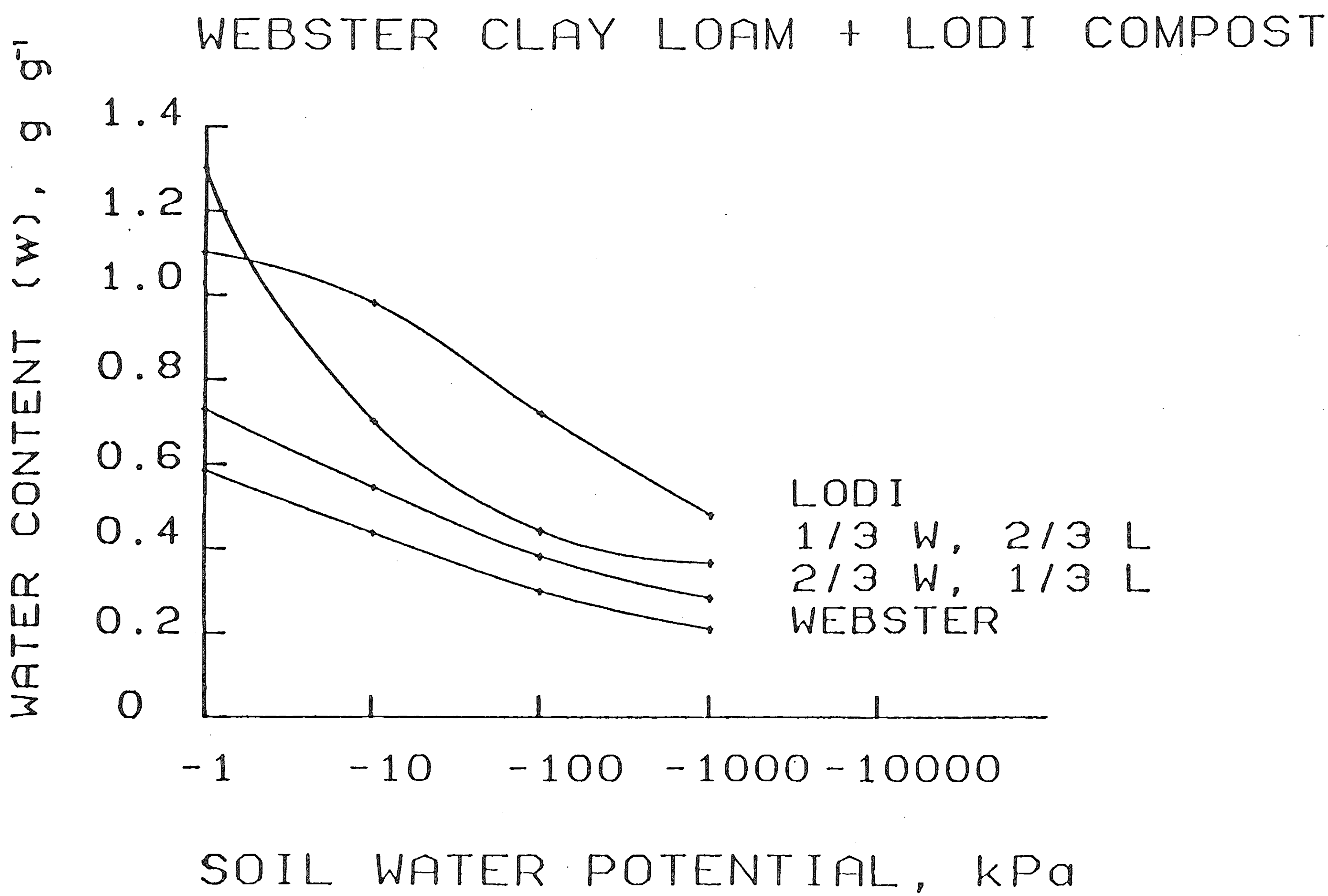


Figure 6. Soil water retention curve for Webster soil as affected by addition of Lodi compost, water content by weight.

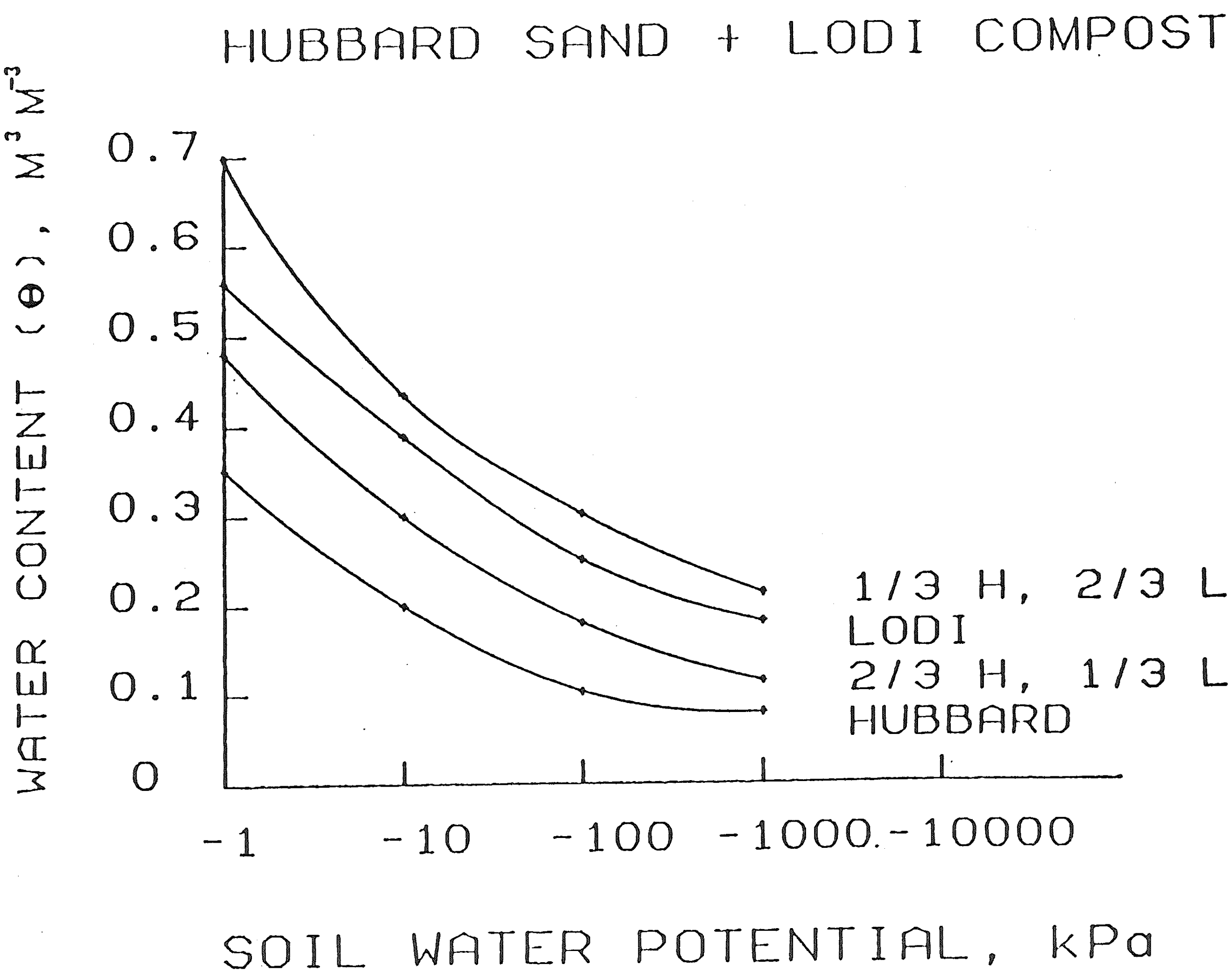


Figure 7. Soil water retention curve for Hubbard soil as affected by addition of Lodi compost, water content by volume.

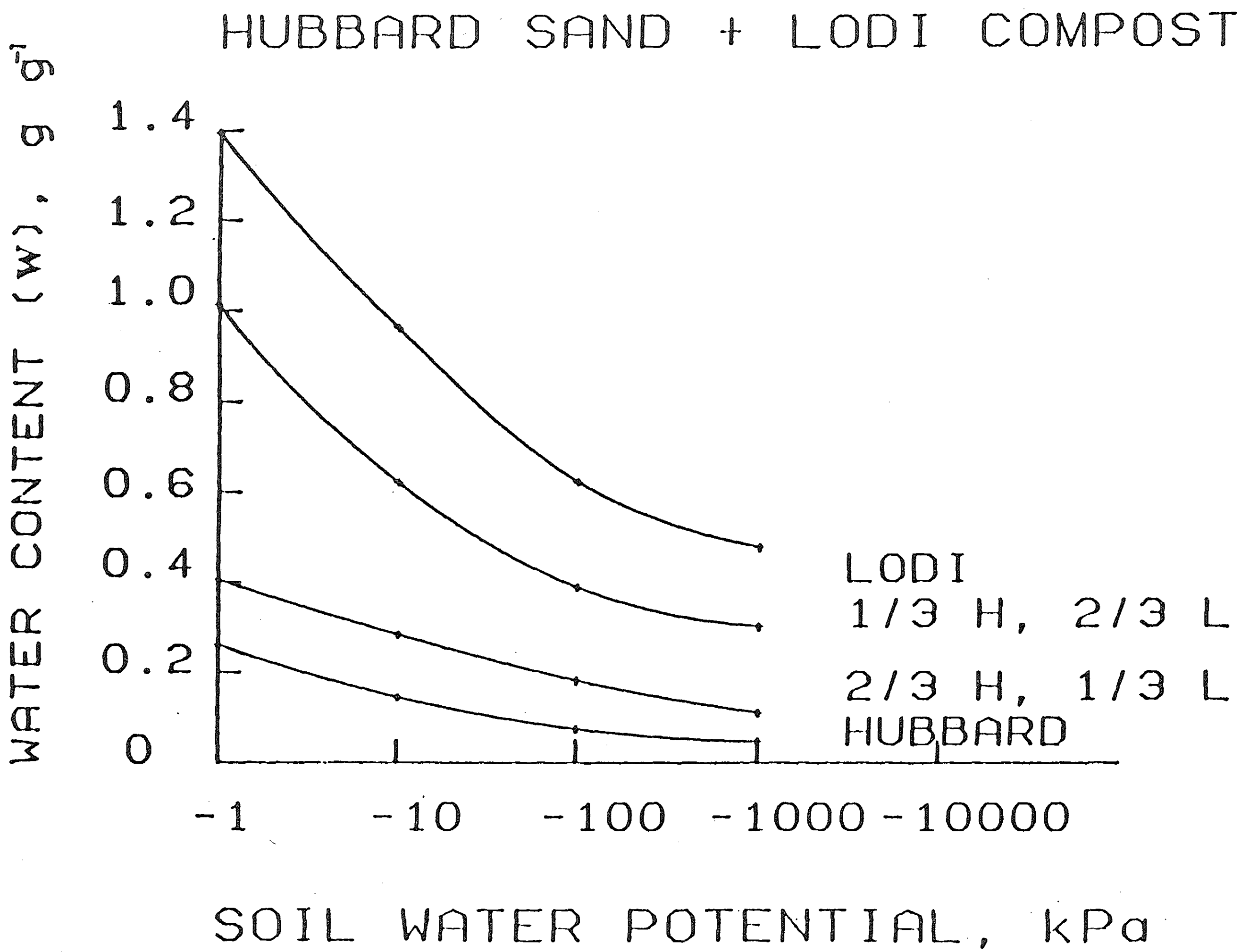


Figure 8. Soil water retention curve for Hubbard soil as affected by addition of Lodi compost, water content by weight.

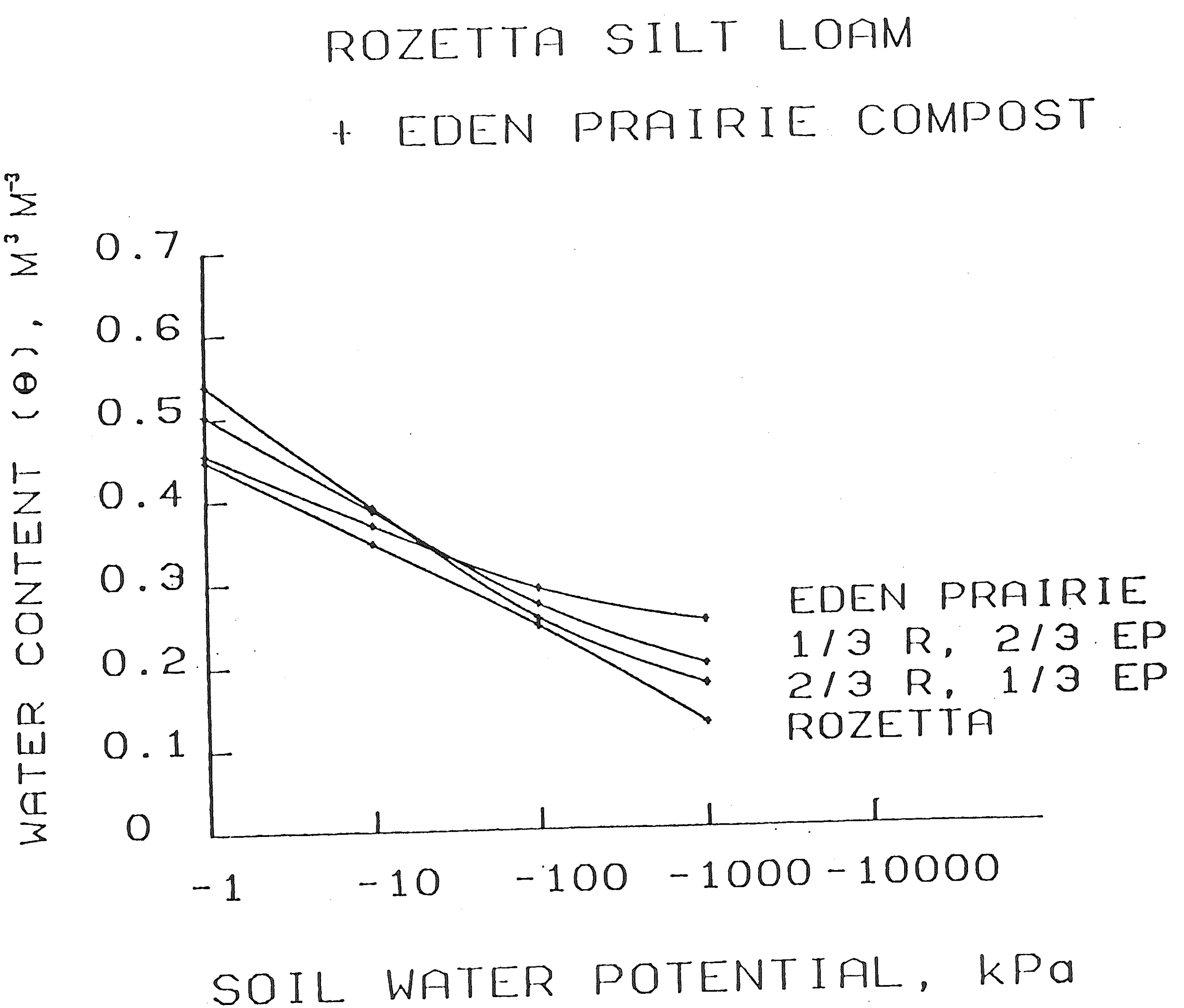


Figure 9. Soil water retention curve for Rozetta soil as affected by the addition of Eden Prairie compost, water content by volume.

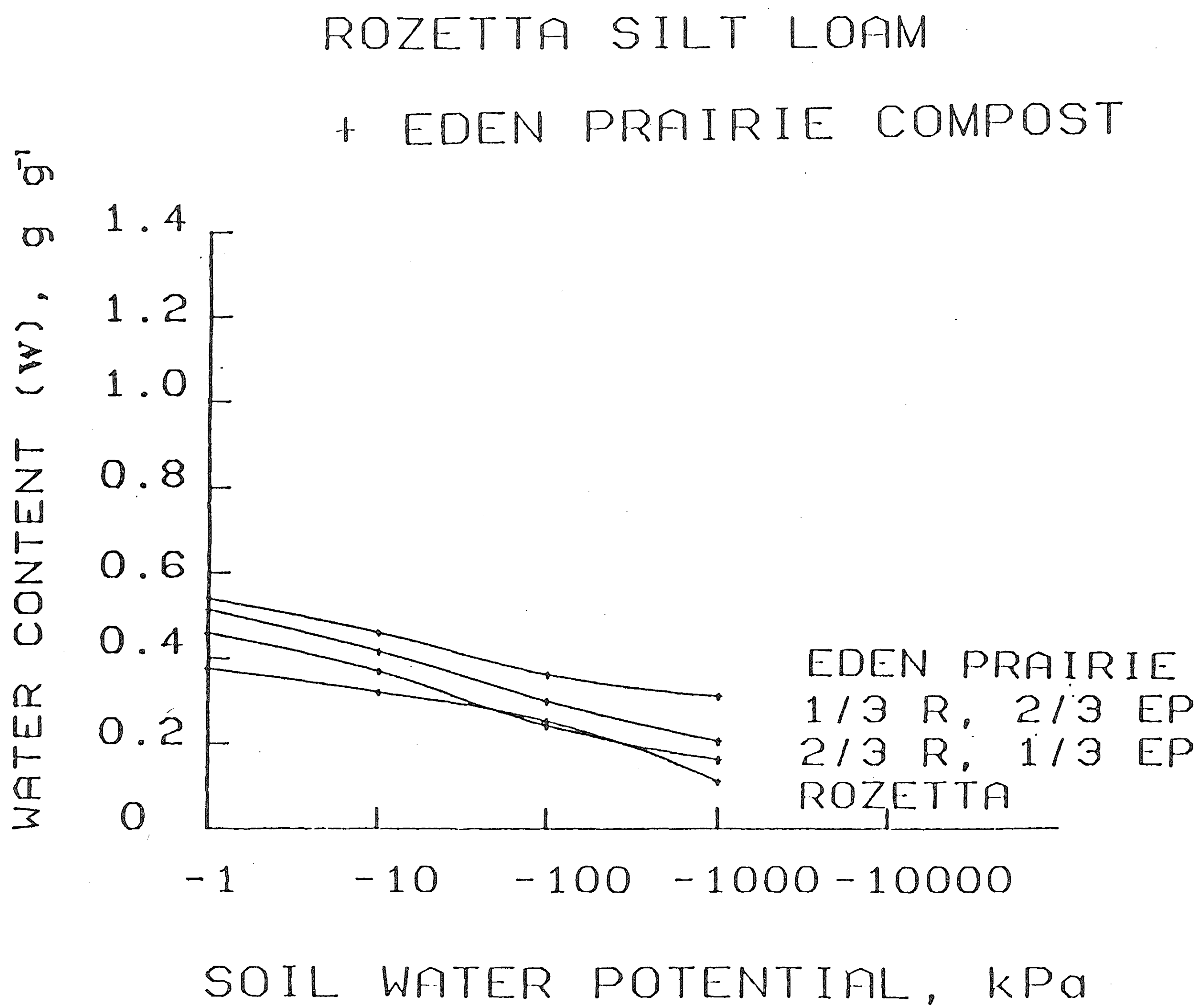


Figure 10. Soil water retention curve for Rozetta soil as affected by the addition of Eden Prairie compost, water content by weight.

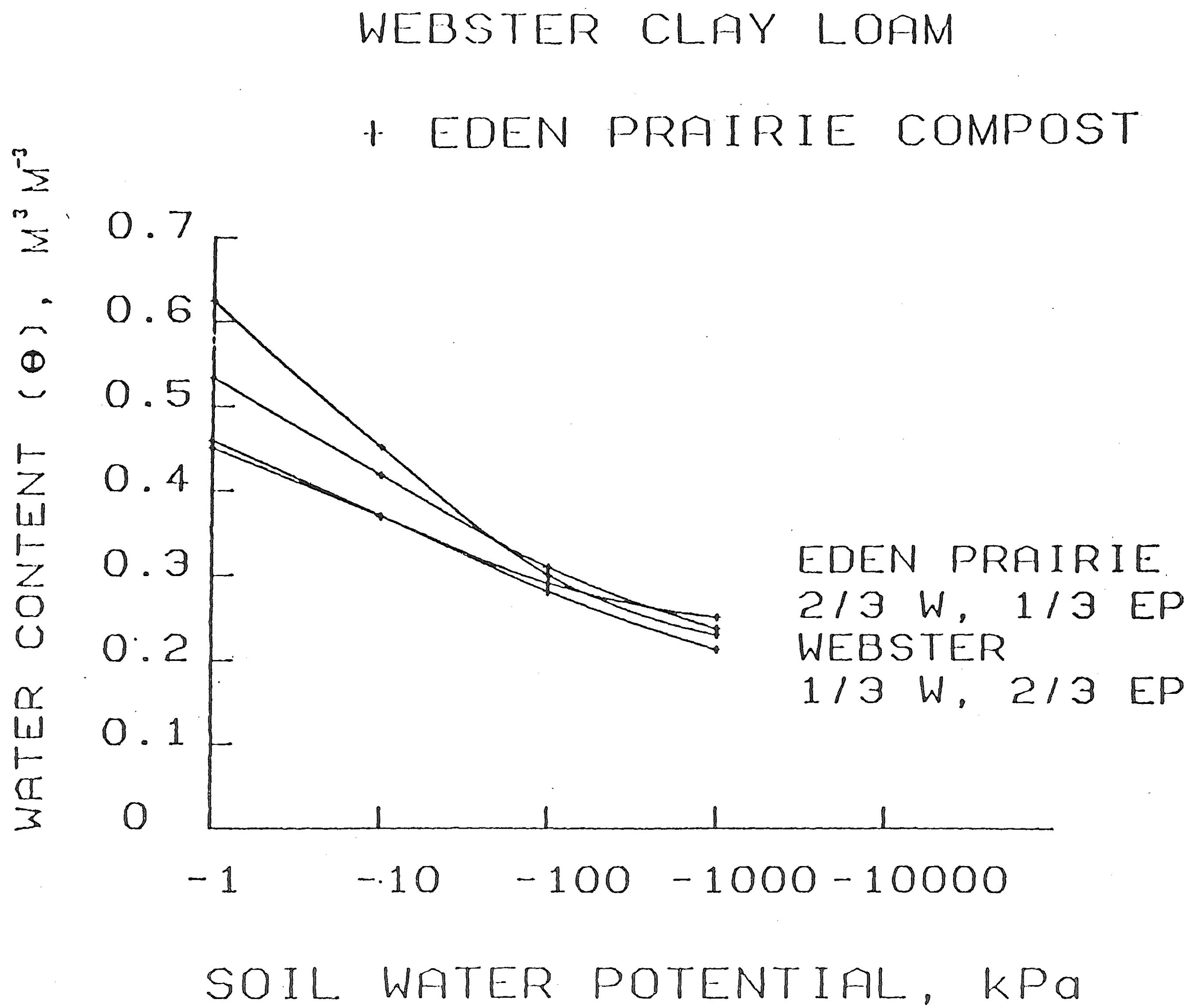


Figure 11. Soil water retention curve for Webster soil as affected by the addition of Eden Prairie compost, water content by volume.

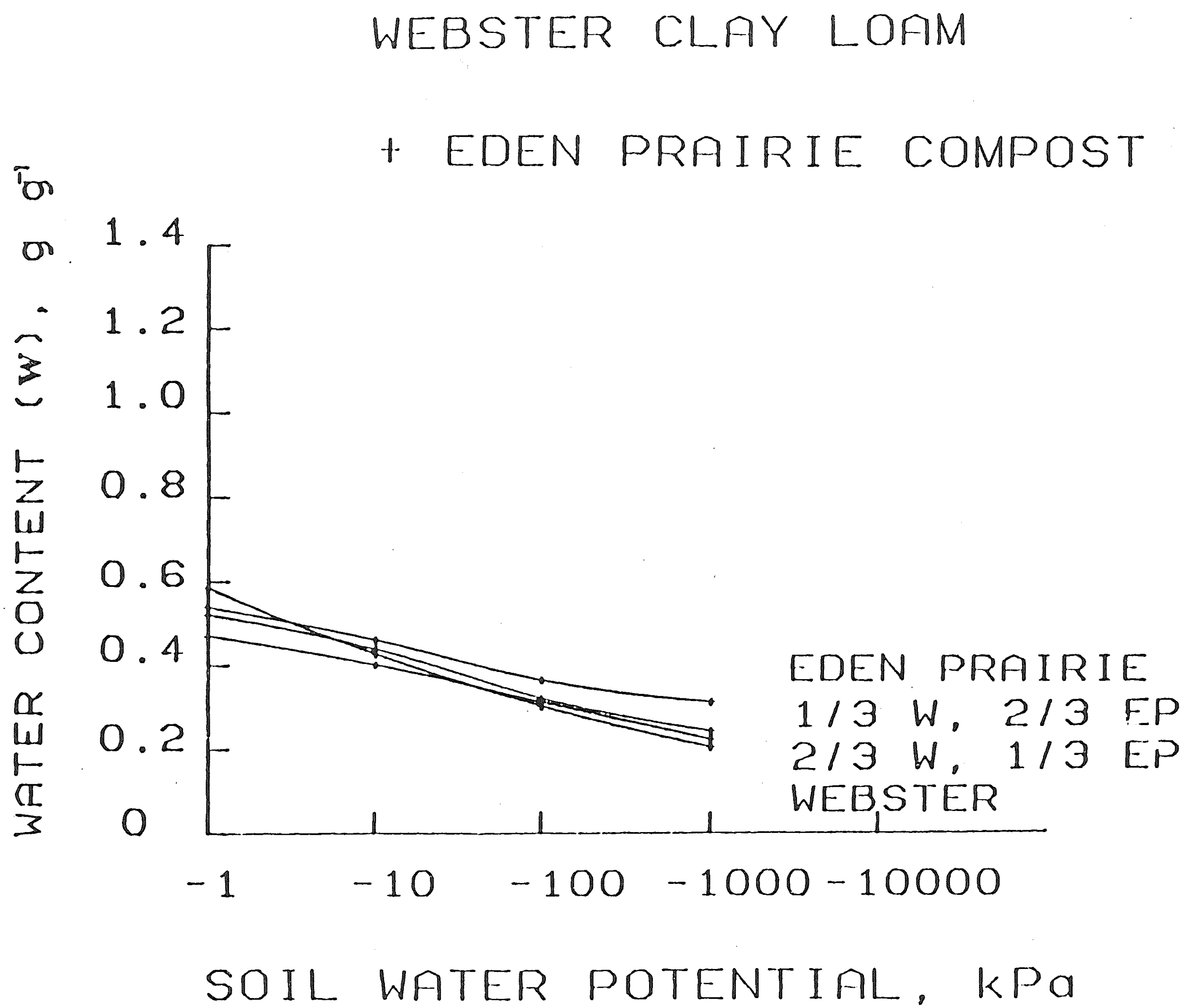
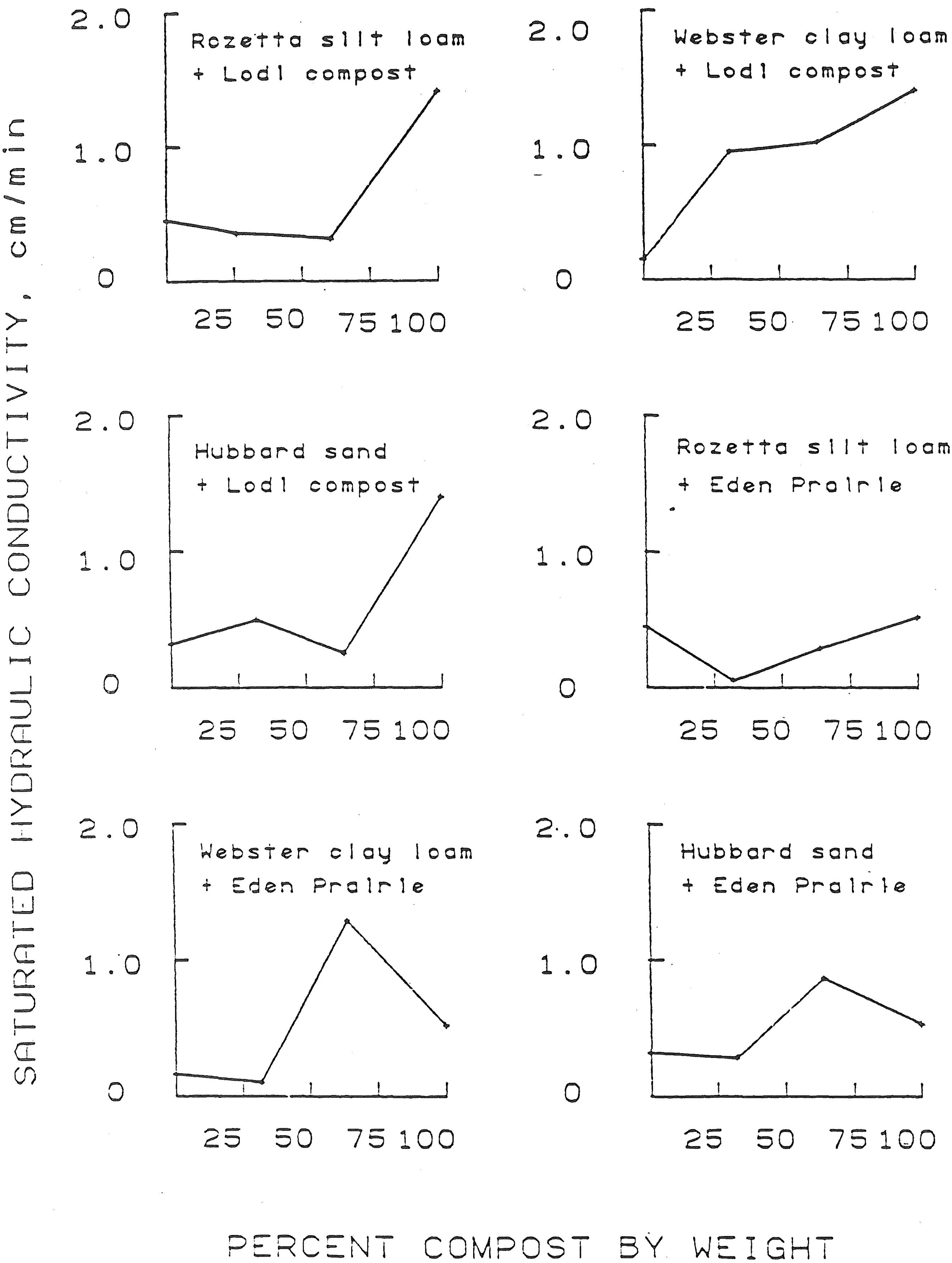


Figure 12. Soil water retention curve for Webster soil as affected by the addition of Eden Prairie compost, water content by weight.

Figure 13. Saturated hydraulic conductivity of Rozetta Webster, and Hubbard soil as affected by compost addition



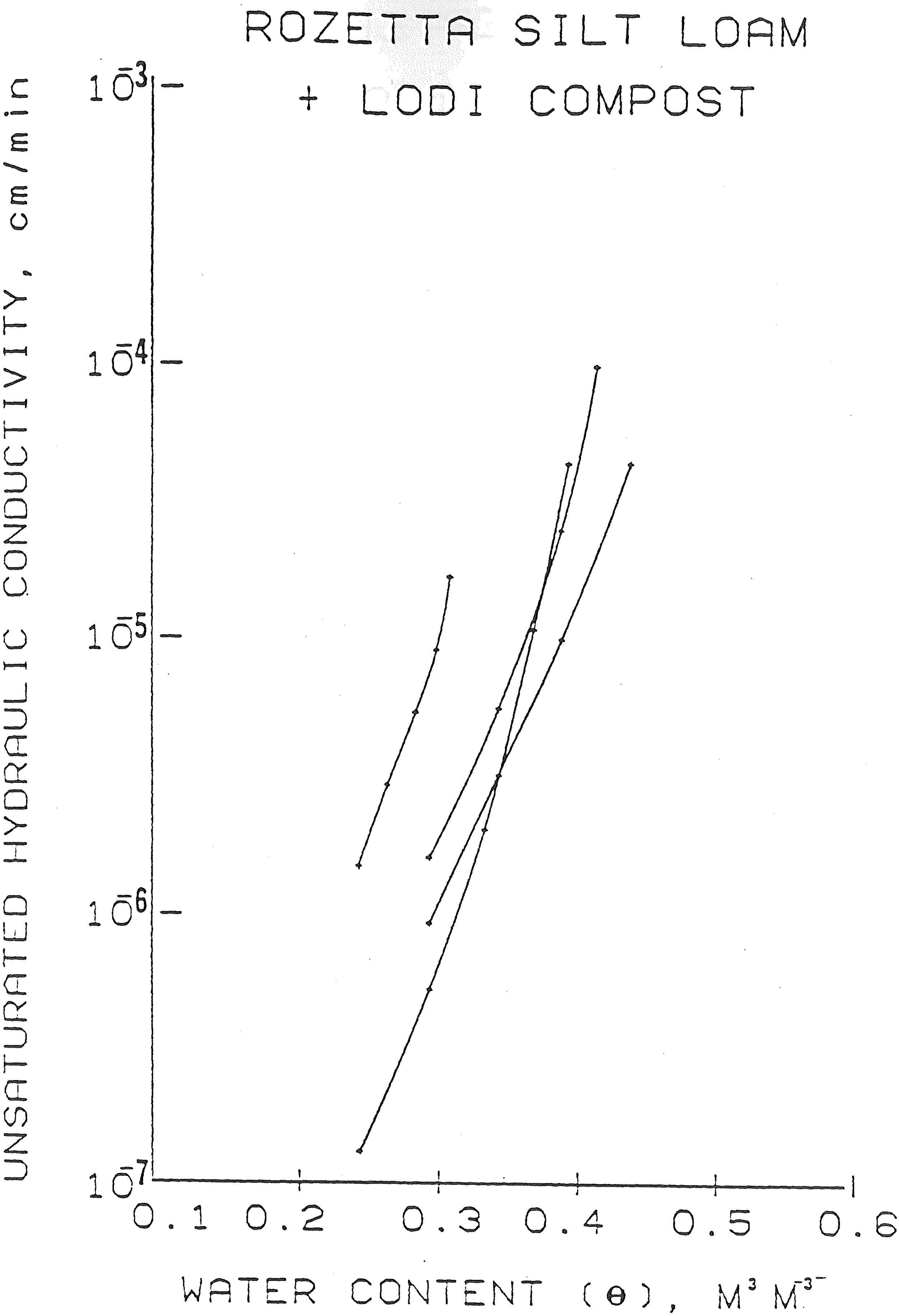


Figure 14. Soil water content versus unsaturated hydraulic conductivity of Rozetta soil as affected by compost addition

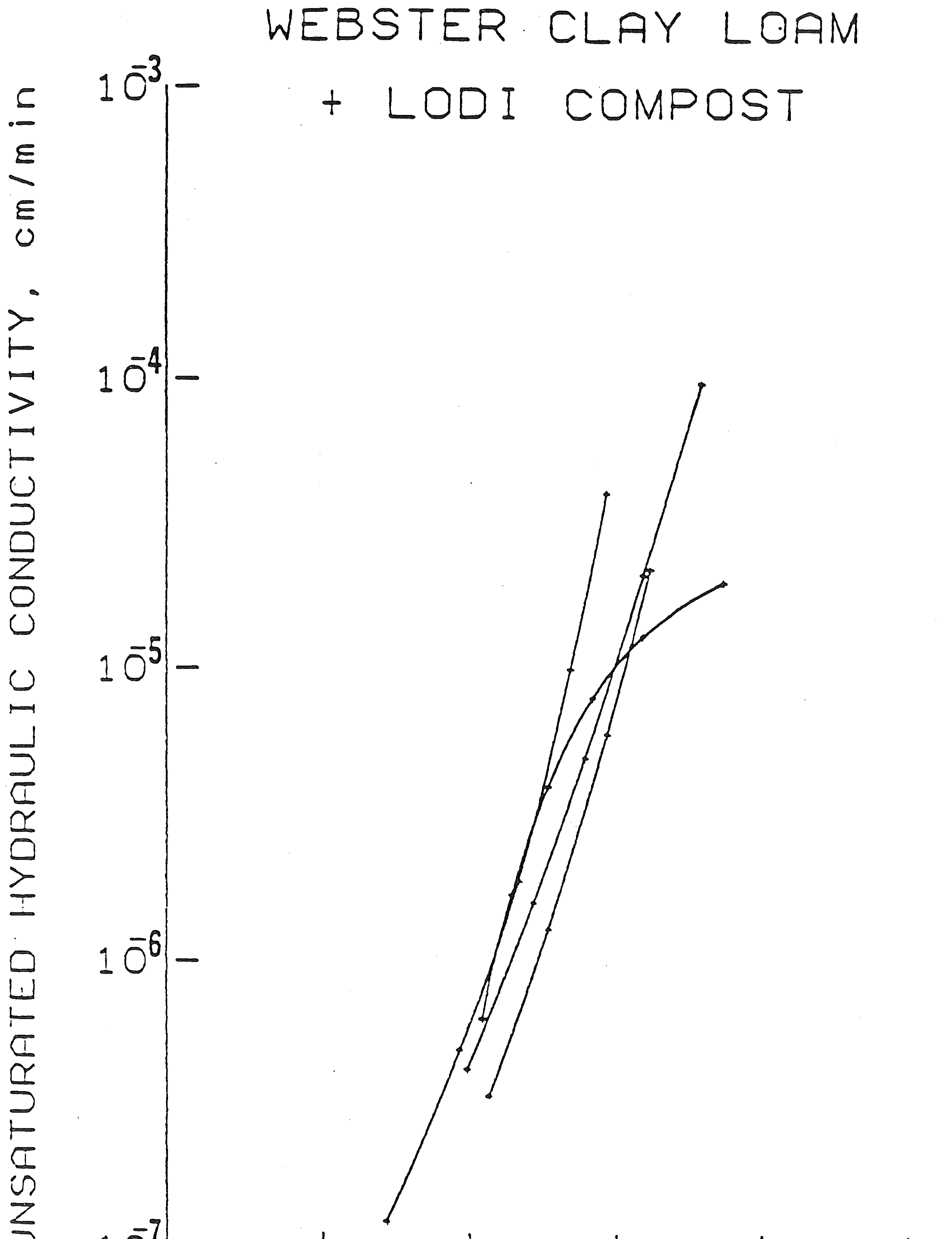


Figure 15. Soil water content versus unsaturated hydraulic conductivity of Webster soil as affected by compost addition

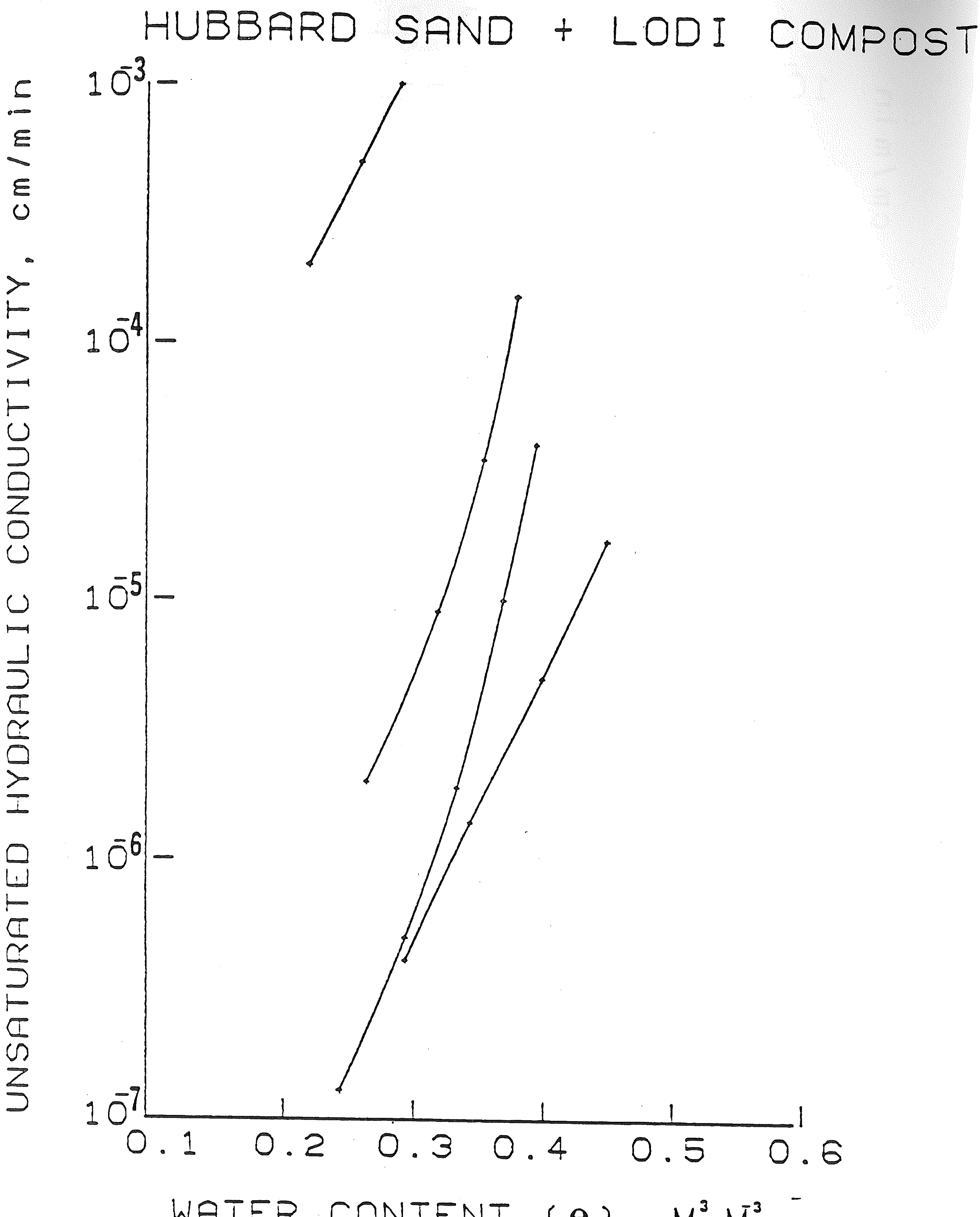


Figure 16. Soil water content versus unsaturated hydraulic conductivity of Hubbard soil as affected by compost addition.

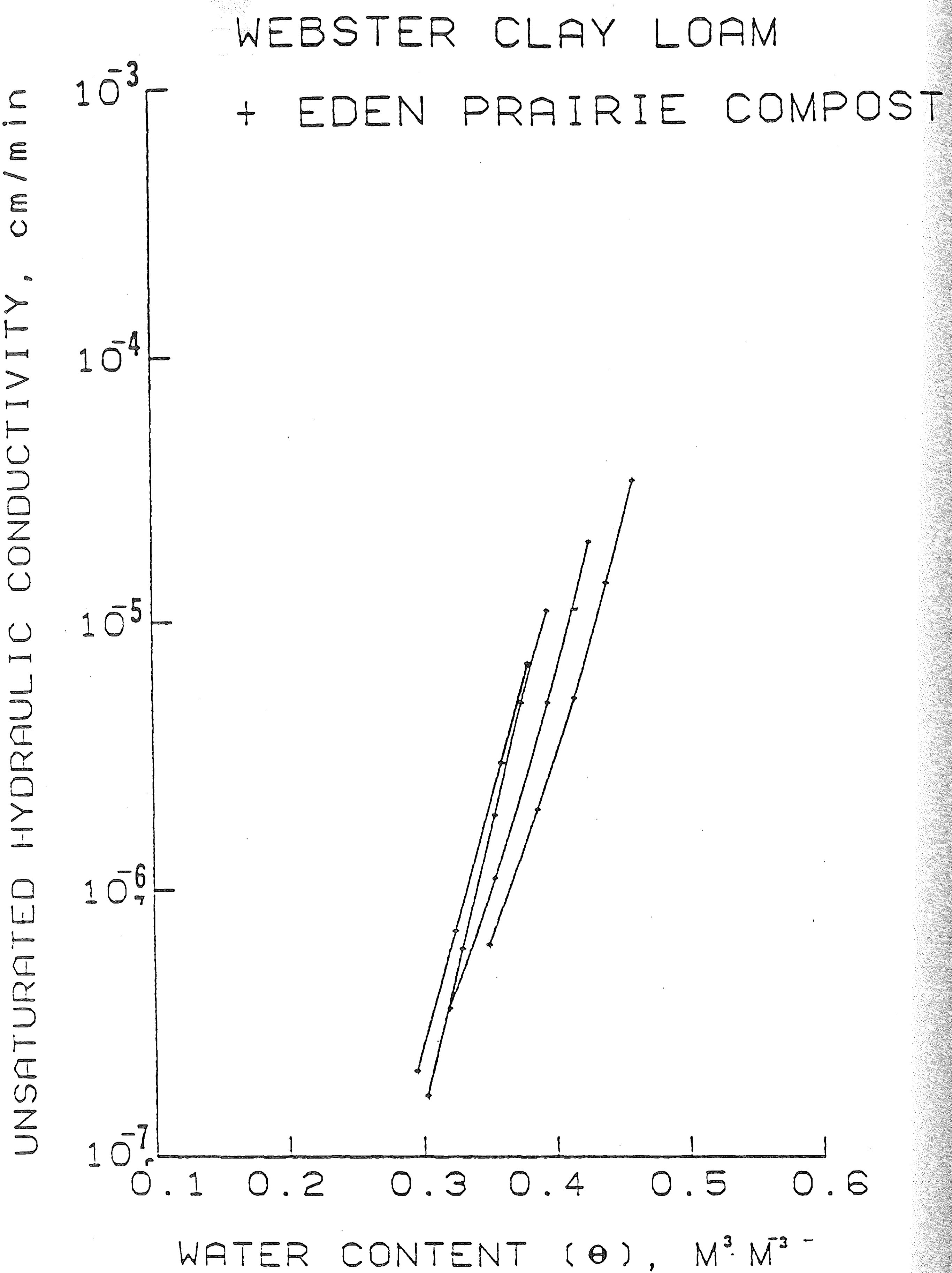


Figure 18. Soil water content versus unsaturated hydraulic conductivity of Webster soil as affected by compost addition.

ATTACHMENT G

TESTING STABILITY AND TOXICITY OF COMPOSTED MUNICIPAL SOLID WASTE WITH EARTHWORMS (*Eisenia fetida* Savigny)

This project was supported by the Legislative
Commission on Minnesota Resources and the
Metropolitan Council of the Twin Cities Area

Introduction:

Methods for measuring compost stability and/or toxicity often lack the ability to test for both. The ratios of total and soluble organic carbon to nitrogen (C:N) are useful indicators of stability. Compost with high ratios provide the proper nutritional environment for abundant microbial growth; nitrogen becomes tied up in microbes, and plants grown on such compost are nitrogen deficient. Bioassays to measure the availability of nitrogen in composted sewage sludge employ microbes (Willson and Dalmat, 1986) and plants (Spohn, 1981; Zucconi et al., 1981). Toxicity of water soluble components of sludges (including complex industrial hazardous wastes) has been estimated by measuring the reduction of light output by phosphorescent bacteria (Matthew and Bullich, 1986). Hirai et al., (1986); and the germination and growth of plants; for example, cress (Brassica campestris).

Direct exposure of earthworms (Eisenia fetida Savigny) to environmental samples containing hazardous wastes was carried out by Callahan et al. (1985). LC_{50} values for contaminated site soil were used to assess the toxicity level. However, no attempt was made to distinguish between toxicity and the inherent nutritional advantage or disadvantage to earthworms of uncontaminated soil samples.

Flack and Hartenstein (1984) gave preliminary evidence that earthworms gain most of their biomass from microorganisms and cellulose. They concluded that microbes provided a biological (i.e. non-mineral) form of N, P, and K, and cellulose was the significant source of carbon. Hartenstein and Neuhauser (1985) correlated decreasing cellulose concentrations in sewage sludge with reduced growth rate in worms.

Municipal Solid Waste Compost (MSWC) poses unique challenges for determining stability and/or toxicity. Although a compost may have reached maturity as defined by the various tests described above, toxins, either residual or byproducts of the composting process, may lower the quality of the compost. Tests on the water soluble fraction may over- or underestimate compost quality, and may be difficult to relate to field conditions. Direct chemical analyses (e.g. by gas chromatograph-mass spectrometer) are very expensive, and provide little information on the bioavailability and effect of detected but often non-identifiable compounds.

The earthworm E. fetida is a common inhabitant of composting organic material and comes into direct internal and external contact with organic material in various stages of decomposition. The intent of our work was to study E. fetida usefulness as an inexpensive and rapid bioindicator of MSWC stability and toxicity. Earthworms were added to MSWC samples, some supplemented with cellulose. Three patterns of earthworm behavior were observed (growth; rapid weight loss and/or death; and maintenance with only slight changes in weight) and were used to characterize the compost as follows: 1. Stable - growth in samples with cellulose and maintenance in samples without cellulose; 2. Unstable - growth in samples with or without cellulose; 3. Toxic - rapid weight loss and/or death in samples with or without cellulose.

Methods:

Study #1

Five composts from various U.S. facilities were tested (Table 1).

Table 1. Composition of municipal co-compost samples used in Study #1.*

Compost	C:N+	pH	EC (dS/m)
Lodi,batch #1++	14	7.4	4.6
Eden Prairie+++	17	7.7	0.9
Delaware$	23	7.4	6.7
St. Cloud,batch #1$	26	6.0	5.5
Thief Rvr. Falls,batch #1#	26	6.6	7.4

+ inorganic plus soluble
++ Municipal solid waste (MSW) + sewage sludge ("1984" compost).
+++ Leaf compost.
$ MSW with refuse derived fuel (RDF) removed + sewage sludge.
& MSW + septage and/or 10% chicken manure (wet weight).
# Raw MSW with RDF removed; not composted.

*data provided by DuBois et al., 1986, unpublished.

Three treatments were considered:

(1) soil + compost (5 g:25 g) = SoCo
(2) soil + compost + 1 earthworm (200 mg juvenile) = SoCoW
(3) soil + compost + 1 earthworm + cellulose (350 mg milled filter paper, Whatman #1) = SoCoWCe

Each treatment was replicated 3 times for sampling at 0, 7, 14, 21 and 28 days for a total of 375 samples. Samples were incubated at 30°C, in the dark, in small Mason jars (0.25 L) covered with Glad plastic wrap and kept at 99% relative humidity in a growth chamber. At each sampling time a jar for each treatment was sampled and worms were removed and weighed; results were expressed in terms of average biomass changes per worm (average biomass per worm at time t, minus average biomass per worm at origin). Compost samples were leached with 1 M KCl and analyzed for: a) total extractable N, b) extractable NH_4-N, and c) extractable NO_3-N.

Moisture content was uniquely defined for each mixture. This was based on the amount of water taken up by the mixture after repeated, measured additions over a 24-hr. period. When an addition produced standing water in the bottom of the covered test beaker, and this water was not absorbed within 1 hr., 60% of the total water added was used as the experimental moisture content for that mix. In cellulose treatments, an additional 2 mL of water was added. This resulted in water contents between 16-18% of mixes by weight except for Thief River Falls (33%).

Study #2

Five composts from various U.S. and one international facilities were tested (Table 2).

Methods were modified from those in Study #1 in an effort to standardize and simplify the bioassay and thus, make it practical to composting operations. Soil was replaced with acid washed sand (2-5 mm sieve, rinsed to pH 7.0), the incubation vessel, time and temperature were altered, and N analysis was not performed on mixes to which worms had been added. The two treatments considered were as follows:

(1) sand + compost + 3 worms = SaCoW (2) sand + compost + cellulose + 3 worms = SaCoWCe

Each treatment was replicated twice. A compost/sand mixture (25 g/125 g), and cellulose (13 g powdered, ash free Whatman chromatography) were added to appropriate treatments. Mixtures were placed in plastic bags (5" x 15") and 3 worms (each weighing 100 to 200 mg, juvenile) were placed in each bag. Incubation was carried out at 24 $\pm$ 2°C under constant fluorescent light to prevent worms from crawling out of the sample mixture. Before addition to bags, worms were starved for 24 hr. in phosphate buffered saline (pH 7.0, 0.85% NaCl), rinsed, blotted and weighed before addition to bags.

Table 2. Composition of municipal co-compost samples used in Study #2.*

Compost	C:N+	pH	EC (dS/m)
Lodi,batch 2++	13	7.3	5.2
St. Cloud,batch #2+++	14	7.8	3.5
Thief Rvr. Falls,batch #2$	16	7.3	1.5
Switzerland&	8	8.1	2.4

\+ inorganic plus organic

++ Municipal solid waste (MSW) + sewage sludge ("Sept. '85").

+++ MSW + septage and/or 25% chicken manure (wet weight); high levels of ammonia (NH_3).

$ Solid waste with refuse derived fuel removed; composted

& Yard wastes and source separated household organic wastes.

*data from DuBois et al., 1986, unpublished.

Moisture content of mixes was adjusted by equilibration at 0.33 bar of small samples of mixes on standard pressure plate apparatus. An additional 36 mL water was added to cellulose treatments. Water content thus obtained amounted to 10-13% of mixes by weight.

Worms were removed from bags at 7 and 14 days to determine total biomass and returned to their appropriate bags. On day 16, worms were removed and weighed individually and the experiment terminated. Biomass changes per worm were determined as in study #1; sample replications provided an assessment of reproducibility.

Results:

Study #1 - The results are summarized in Figure 1a, and Figure 1b.

The Eden Prairie sample behaved as stable compost. Eden Prairie-SoCoW allowed for biomass maintenance while SoCoWCe significantly induced earthworm growth by providing additional carbohydrate. Nitrogen profiles showed that addition of cellulose decreased total inorganic N while facilitating conversion of nitrogen into earthworm biomass. At 14 d, 100% of extractable nitrogen was NO_3-N.

St. Cloud-SoCoW and SoCoWCe showed similar responses initially, but, after 14 d, SoCoWCe allowed for greater increases in biomass. A high C:N of 26:1 is also associated with immature compost. Nitrogen mineralization did not occur until day 14 for the samples without cellulose.

The Thief River Falls sample was toxic. Thief River Falls-SoCoW and SoCoWCe were not significantly different during the first 14 d. The high C:N of 26:1 would indicate immaturity and the initial biomass decreases suggest the presence of toxic compounds. This sample was essentially uncomposted, shredded garbage. Perhaps the high EC (Table 1) or low molecular weight organic acids associated with immature composts (Hirai et al., 1986) caused the toxicity. Other toxic compounds may also have been responsible.

Delaware-SoCoW yielded little growth initially; however, the earthworms gained weight over time to greater levels than those observed in the Lodi and Eden Prairie composts. Addition of cellulose (SoCoWCe) did not create a significant advantage, and may even have suppressed growth. The nitrogen profiles show that the total inorganic N was initially high (95% NH_4-N). At 7 d, inorganic N dropped by nearly 90%, and at 21 d, NO_3-N predominated at concentrations twice those of NH_4-N.

The Delaware N curves showed a rapid N immobilization in the samples with and without cellulose. The Delaware compost had a high C:N (23:1), and had been composted for 1 week only. The composting process was probably not complete, explaining tie-up of nitrogen and the slight toxicity.

The Lodi-SoCoW mixture allowed for earthworm biomass maintenance without significant weight loss, suggesting a stable compost. However, the behavior of the compost upon the addition of cellulose (Lodi-SoCoWCe) was unexpected: weight loss between day 7 and 14, and one worm dead at day 28.

Inorganic N increased with time (N mineralization) in the Lodi-SoCo and SoCoW treatments. The addition of cellulose induced the biological immobilization of N, likely tied up in the microbial biomass derived from the decomposition of cellulose. After 14 d, 100% of inorganic N was NO_3-N for all mixes.

Study #2 - The results are summarized in Figure 2.

The Lodi, batch #2 treatment, exhibited strong toxic properties - 100% mortality in 7 d. Addition of cellulose to the Lodi compost, however, allowed for significant increases in biomass. The age class of the earthworms used in this study was considerably smaller than those used in the first study and, therefore, may have contributed to a greater sensitivity to the presence of toxins.

The St. Cloud, batch #2 sample, which had been manufactured with 25% chicken manure instead of 10% in batch #1, caused 100% mortality following d of severe weight loss in which only 1 worm survived in each replication. Addition of cellulose reversed the negative effects of compost alone, yielding variable weight increases.

The Thief River Falls compost (more thoroughly composted than that of Study #1) allowed for biomass increase with or without cellulose, suggesting an unstable but non-toxic product.

The Swiss compost was not conducive to growth without the addition of cellulose, implying stability without toxicity. The addition of cellulose provided needed carbohydrate and produced the largest biomass increases of all composts tested.

Reproducibility of results is shown in Table 3. The difference between initial and final worm biomass for each replication shows that for the stable compost (Thief River Falls), biomass changed uniformly with or without cellulose. For the unstable or toxic composts, biomass increases with cellulose were more variable, possibly due to worm or replication variability. Worm weights at the onset of the bioassay ranged from 100-200 mg, and this may have contributed to variability, along with differences in individual vigor. Where composts were toxic, all worms died in the absence of cellulose.

Table 3. Differences between initial and final worm biomass by replication. (N.A. = not applicable due to worm mortality.)

	no cellulose		cellulose	
	REPLICATION			
Compost	1	2	1	2
	------ mg live weight -------			
Thief River Falls	0.24	0.24	0.19	0.24
St. Cloud	N.A.	N.A.	0.65	0.27
Switzerland	0.00	0.03	0.63	0.33
Lodi	N.A.	N.A.	0.41	0.15

Discussion:

The two studies, while different in design and procedure, allow for some preliminary conclusions to be drawn about the usefulness of _E. fetida_ as a bioindicator of compost quality.

The bioassay showed sensitivity to differences between samples of varying C:N ratio and differences between samples with similar C:N ratios. A distinction could be made between stable, unstable (immature) and toxic composts.

The bioassay showed that earthworms had unique growth responses to composts with low C:N values. All composts in Study #2 had C:N values between 8 and 16 and thus would be considered as properly cured and matured. Yet, significant earthworm growth in the Thief River Falls, batch #2 was observed even in the absence of cellulose. By contrast, the Swiss compost, lowest in C:N (8:1), did not support earthworm growth. With additional cellulose, however, biomass increased significantly and without much variation between samples. A reserve of encysted protozoa or spore forming bacteria, released upon wetting, may have yielded a large amount of biologically available nitrogen which, together with the cellulose, provided an ample food source. Differences between various batches of compost from the same plant were observed by the earthworm bioassay. Thief River Falls, batch #1, which was not composted, was toxic; batch #2, which had been composted, was unstable. Volatile ammonia (NH_3) could be detected by smell in the St. Cloud, batch #2 compost, which was toxic; it had received 25% chicken manure, in contrast to the 10% added to batch #1, which was unstable.

E. fetida provided a sensitive biological indicator of differences not seen by chemical determinations. *E. fetida* is easily maintained in laboratory culture and, being extremely prodigious, provides a constant supply of test organisms. The bioassay is intermediate in length (14-21 days) and provides more qualitative information on food chain effects of compost utilization than microbial, enzyme or CO_2 output bioassays. The bioassay appears to provide an extremely inexpensive assessment of stability. Perhaps its greatest usefulness will be in screening batches of compost which might need further investigation in the event of earthworm mortality.

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Figure 1. Results of study #1: 1a) Biomass change per worm for 5 different municipal solid waste compost (MSWC) mixes, with and without cellulose. An * indicates mortality of a single worm for that treatment-time combination. 1b) Total extractable inorganic nitrogen for the same 5 MSWC mixes, with and without cellulose and a no worm control.

Fig. 1a

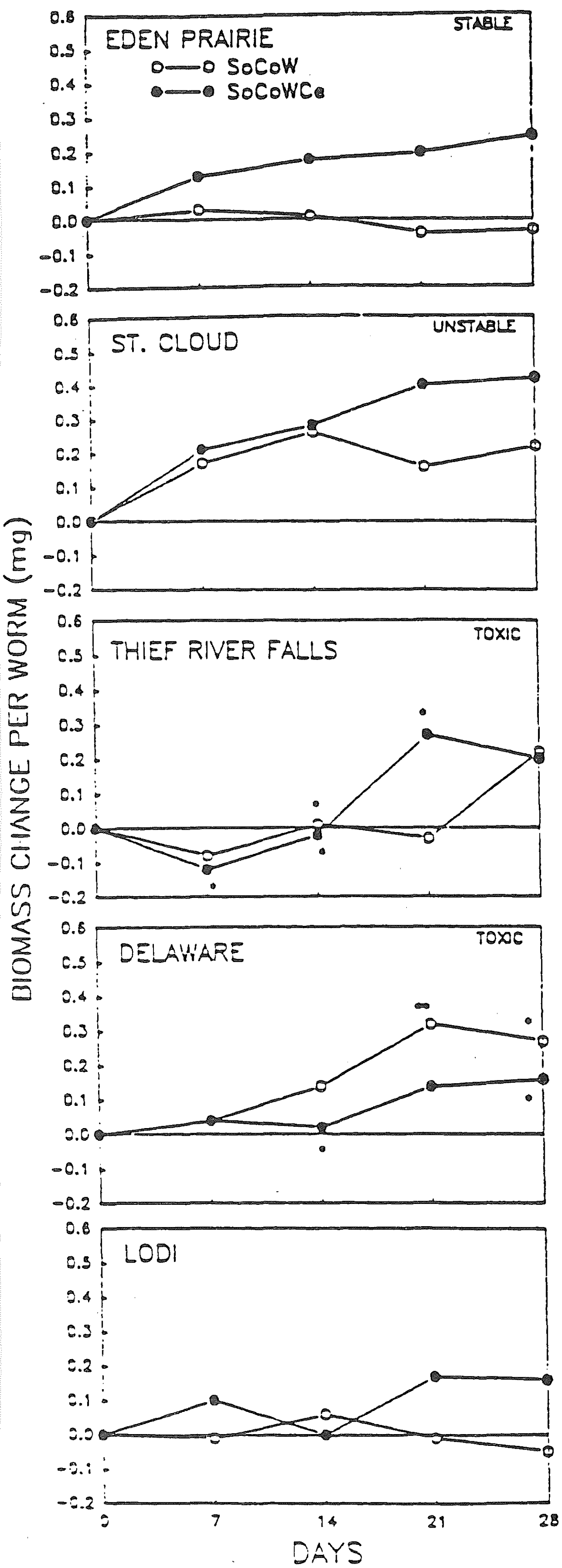

EDEN PRAIRIE
STABLE
SoCoW
SoCoWCe
ST. CLOUD
UNSTABLE
THIEF RIVER FALLS
TOXIC
DELAWARE
TOXIC
LODI
BIOMASS CHANGE PER WORM (mg)
DAYS
0
7
14
21
28

Fig. 1b

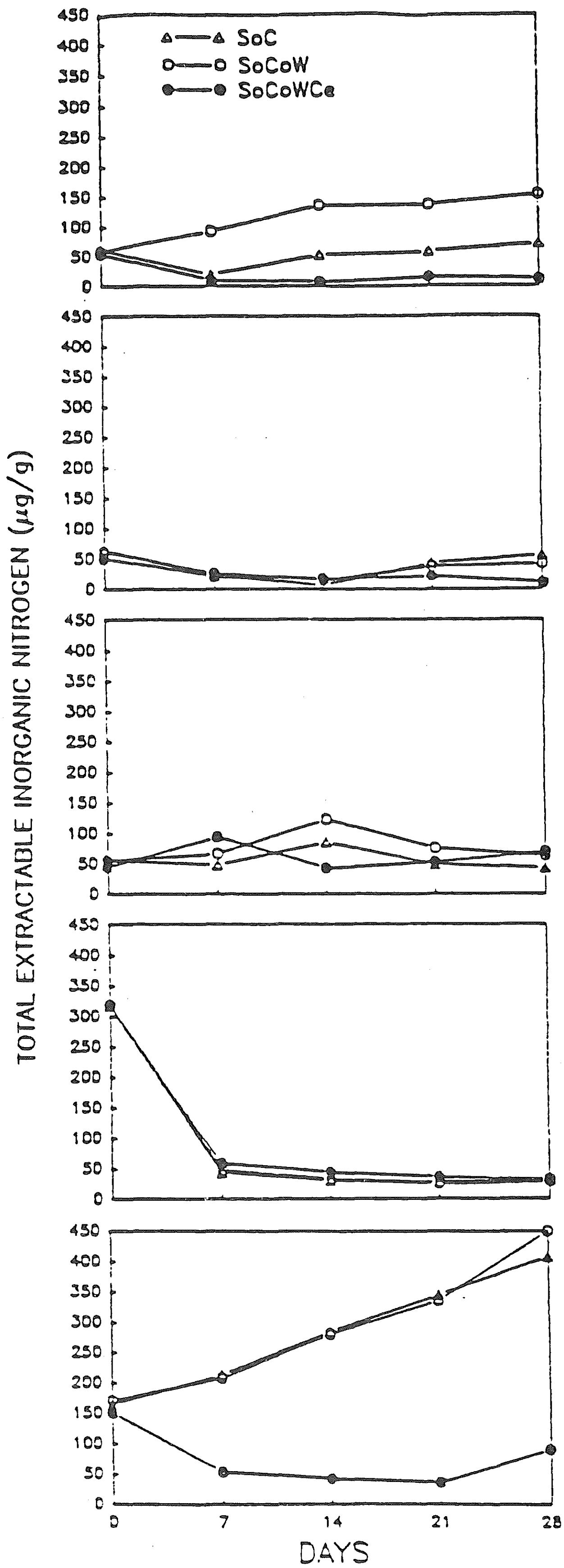
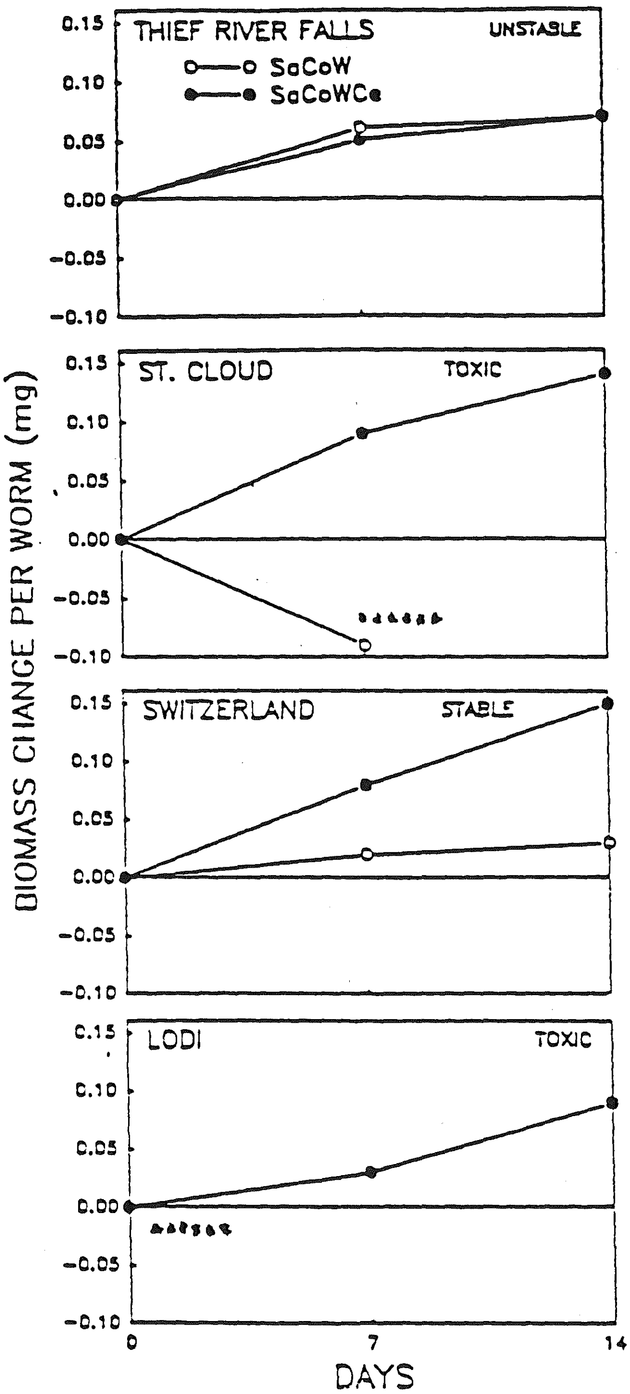

SoC
SoCoW
SoCoWCe
TOTAL EXTRACTABLE INORGANIC NITROGEN (μg/g)
DAYS
0
7
14
21
28

Figure 2. Results of study #2: Biomass change per worm for 4 different municipal solid waste compost (MSWC) mixes, with and without cellulose. An * indicates mortality of a single worm for that treatment-time combination.

Fig. 2


THIEF RIVER FALLS
UNSTABLE
SaCoW
SaCoWCe
ST. CLOUD
TOXIC
SWITZERLAND
STABLE
LODI
TOXIC
0.15
0.10
0.05
0.00
-0.05
-0.10
BIOMASS CHANGE PER WORM (mg)
0
7
14
DAYS

ATTACHMENT H

NON AGRICULTURAL USE OF SOLID WASTE COMPOST PRODUCTS IN MINNESOTA

A SURVEY OF POTENTIAL CONSUMERS

This project was supported by the Legislative Commission on Minnesota Resources and the Metropolitan Council of the Twin Cities Area

INTRODUCTION

Minnesota is faced with increasing pressures to reduce the amount of solid waste that is disposed of in landfills. One alternative to total landfilling is the production of compost from the biodegradable portion of the waste stream. Composting has been practiced in European and other overseas communities for several years. Technology and equipment are available for the process and are currently being introduced in the United States. Several Minnesota communities are considering composting as a means of handling a portion of their solid waste stream.

One of the often promoted attractions of composting is that, in addition to landfill abatement, the practice results in a useful product that can be used as a soil amendment and/or source of plant nutrients. On the other hand, skeptical attitudes and questions regarding whether or not all of the compost produced can be marketed, distributed, or disposed of have posed some of the greatest obstacles to the implementation of composting.

In July of 1985 the University of Minnesota began work on a compost/co-compost research project. Funding for the project was provided by the State through the Legislative Commission on Minnesota Resources and by the Metropolitan Council of the Twin Cities Area. The focus of the project has been on the use of solid waste products. An overall goal has been to gain a better understanding of composted waste products and how they might best be used.

One of the specific objectives of the project was to survey potential users in both the agricultural and non-agricultural sectors to assess interest in and the acceptability of composted solid waste products. This report summarizes the assessment of the non-agricultural sectors.

METHODS

A questionnaire mailing was used to survey potential consumers of solid waste composts. The questionnaire was developed with input from various project participants. Additional comments and suggestions were obtained from county solid waste officials, Metropolitan Council Staff, and selected members from some of the groups surveyed. The questionnaire was accompanied by a compost information sheet, providing a basic overview of potential benefits and limitations of compost use, and a listing of possible uses. The questionnaire, information sheet, and accompanying cover letter are included as appendix A.

The questionnaire was developed to address the following questions:

What materials similar to compost products (or that might be replaced or partially replaced by compost) are currently being used?

What are the costs of these products to the consumer?

How are the products used?

When are the majority of purchases made?

Do potential consumers have the ability to store and/or transport materials?

What are major interests and/or concerns with the use of composted waste products?

Are those surveyed willing to try or regularly use solid waste composts?

How much material might be used on an annual basis?

The mailing list was developed in a manner similar to the questionnaire. Suggestions and comments were obtained from several individuals both within and outside of the University group. Every attempt was made to include representation from all possible categories or types of potential consumers. Groups included in the mailing were:

Nurseries

Sod growers

Professional groundskeepers (at educational institutions)

Cemetery groundskeepers

Hospital groundskeepers

Golf course superintendents

Landscape contractors

State, regional, and city parks superintendents

Arborists

The questionnaire was mailed on December 5, 1986. It was anticipated that a better response could be obtained during winter months as compared to other times of the year when many of the industries or agencies surveyed are at their peak seasons.

RESPONSE TO QUESTIONNAIRE

The questionnaire was mailed to 1384 individuals, firms, and agencies throughout the state. A total of 339 were returned, an overall response rate of 24 percent. In addition, thirty-four questionnaires were returned by the post office as undeliverable due to lack of forwarding orders or because firms had discontinued business. The numbers of questionnaires mailed to and returned from the different categories of potential users are shown in Table 1.

The highest response rate (53 percent) was obtained from professional groundskeepers. However, it should be noted that they represent a fairly small group with only fifteen questionnaires mailed and eight returned. The second highest response rate (33 percent) was from landscape contractors. Forty of the 121 questionnaires mailed to this group were returned.

The lowest response (6 percent) was from arborists who returned only 8 of 124 questionnaires mailed. Sod growers also showed a low response at 8 percent.

Questionnaires were mailed to 114 firms or individuals in this group and only ten were returned.

CURRENTLY USED MATERIALS

The first section of the questionnaire consisted of a list of various products. Respondents were asked to indicate the amount(s) and cost(s) of any of materials they currently purchase or use. The list included topsoil, peat, manure, compost, mulches, other soil amendments, and other similar products (which respondents were asked to describe). The percentages of respondents who reported use and/or purchase of the different materials listed are shown in Table 2. Other soil amendments and other similar products were not included as very little information was obtained from those sections.

The material purchased and/or used in the largest quantity is topsoil. Table 3 summarizes the amounts purchased and/or used by respondents in the different categories. The average values shown in this and subsequent tables were calculated from only those respondents who reported specific amounts or costs. The total amount of topsoil used by those who reported specific amounts is approximately 331,000 cubic yards annually. The largest users of topsoil are parks and other public agencies with an average annual use of 3245 cubic yards per respondent. Landscape contractors are also significant topsoil users with an average annual use of 2800 cubic yards per respondent. Of the groups surveyed, sod growers, professional groundskeepers, and hospital groundskeepers purchase and/or use the smallest quantities of topsoil.

The second most commonly used and/or purchased material is peat. Quantities used and costs paid for peat by the different categories of potential users are shown in Table 4. Amounts given by those indicating purchase or use of peat total approximately 24,000 cubic yards per year.

Costs reported showed considerable variation ranging from free to $100.00 per cubic yard. This variation probably reflects the wide assortment of peat products on the market, differences in quality, and differences in purchase units (i.e. bulk versus bagged material).

Quantities of manure, compost, and mulches used and/or purchased by the respondents were considerably less than those of topsoil and peat. Respondents in all categories provided much less information on the amounts and costs of these materials making it difficult to draw conclusions or observe trends. Percentages of respondents that use or purchase these materials are shown in Table 2. Information obtained from the manure, compost, and mulch sections is summarized below.

Manure

Parks and public agencies: Four respondents in this category reported use of manure. Two respondents gave amounts used annually of 200 pounds and 10 tons. The other two did not specify amounts. Two respondents gave no price for the manure they use; the other two said that the manure is free.

Nurseries: Eighteen respondents in this category (34 percent) reported use or purchase of manure. Of those, fifteen specified amounts used ranging from 5 to 6500 cubic yards annually. Twelve respondents gave prices ranging from $2.50 per cubic yard for bulk purchases to $100.00 per ton for bagged material. One respondent, who uses twenty cubic yards of manure annually, stated that the manure is free. No attempt was made to average quantities or costs of manures because amounts were given in widely varying units (truck-loads, bags, yards, and tons) that could not be accurately compared or averaged.

Golf course superintendents: Only one respondent in this category reported use of manure. The five tons used annually is obtained at no cost.

Landscape contractors: Seven respondents (18 percent) reported purchase or use of manure. All seven specified amounts used. Quantities ranged from 1 to 1100 cubic yards annually with an average of sixty-nine cubic yards annually per respondent. Six respondents gave prices ranging from $4.00 to $70.00 (for bagged material) per cubic yard giving an average of $21.00 per cubic yard.

Hospital groundskeepers: No respondents in this category reported use or purchase of manure products.

Grounds and lawn maintenance-unspecified: Three respondents (25 percent) reported use or purchase of manure products. The amounts used annually and costs were: one truckload at $10.00 per truckload, ten cubic yards at no cost, and ten cubic yards with no cost given.

Professional groundskeepers: Two respondents (25 percent) reported use or purchase of manure. One respondent uses fifty cubic yards of manure annually which is obtained at no cost, the other uses three cubic feet annually at a cost of $3.00 per cubic foot.

Arborists: No arborists reported use of manure products.

Sod growers: Only one respondent in this category reported use of manure. The four tons used annually is obtained at no cost.

Compost

Parks and public agencies: Twenty-two respondents (21 percent) reported use or purchase of compost materials. Of those, seventeen specified an amount used. Quantities ranged from one ton to 2000 cubic yards annually with an approximate average of 405 cubic yards annually. Fifteen of the twenty-two respondents stated that the compost is free or that they have their own source of material, four gave no price, one gave a price of $11.00 per cubic yard, and one gave a price of $10.00 per ton.

Nurseries: Twelve respondents (21 percent) reported use or purchase of compost materials. All twelve specified amounts used. Quantities ranged from 5 to 6500 cubic yards annually with an average of 711 cubic yards annually. Four respondents make their own compost or obtain it at no cost. Three respondents did not give a price. Five respondents gave prices of $2.00, $5.00, $7.50, $18.00, and $32.00 per cubic yard. The average cost to these five respondents is $13.00 per cubic yard.

Golf course superintendents: Two respondents (4 percent) indicated use or purchase of compost material. One purchases six cubic yards of bagged compost annually at a cost of $100.00 per cubic yard. The other purchases 150 pounds of compost annually at a cost of $4.50 per pound.

Landscape contractors: Three respondents (8 percent) use compost materials. Quantities reported were ten, fifteen, and fifty cubic yards of material annually. All three said that the compost is free of charge.

Professional groundskeepers: One respondent in this category uses twenty cubic yards of compost annually which is free of charge.

Hospital groundskeepers: One respondent uses twenty cubic yards of compost annually. No price was given.

Cemetery groundskeepers: Five respondents in this category (15 percent) use compost materials. One uses one truckload annually and another uses sixty cubic yards annually. No quantities were given by the other three respondents. Four of the five using compost reported that it is free. No price was given by the fifth respondent.

Grounds and lawn maintenance-unspecified: Two respondents (15 percent) use compost materials. Amounts used are 25 cubic yards and 300 tons annually. Both respondents reported that the compost is free of charge.

Arborists: Only one respondent in this category indicated use of compost. The five cubic yards used annually is obtained at no cost.

Sod growers: One respondent in this category uses twenty yards of compost annually. No price was given.

Mulches

Parks and public agencies: Twenty respondents in this category (22 percent) purchase or use mulch materials. Eighteen of those reported amounts used ranging from 10 to 200,000 cubic yards annually. The average amount used by the eighteen is 11,470 cubic yards annually per respondent. The average excluding the highest and the lowest values is 404 cubic yards annually. Fourteen of the twenty respondents who use compost stated that it is free, two said that they have their own supply, one gave a price of $2.00 per cubic yard, and one gave a price of $7.00 per cubic yard.

Nurseries: Nineteen respondents in this category (33 percent) purchase or use mulch materials. Sixteen reported specific amounts used ranging from 20 to 13,000 cubic yards annually. The average amount used by the sixteen is 1183 cubic yards annually. The average excluding the highest and the lowest values is 442 cubic yards annually. Prices ranging form $3.50 to $27.00 per cubic yard were given by fourteen respondents. The average cost to these fourteen is $10.60 per cubic yard. Four respondents gave no price and one said that the mulch is free.

Golf course superintendents: Three respondents in this category (6 percent) use mulch materials. One respondent uses thirty cubic yards annually which is free of charge. The other two use ten and fifty cubic yards annually. No prices were given by these two respondents.

Landscape contractors: Sixteen of the landscape contractors responding to the questionnaire (40 percent) use or purchase mulch materials. Fifteen of those reported amounts used ranging from 1 to 12,000 cubic yards annually. The average amount used by the fifteen is 1334 cubic yards annually. Prices ranging from $4.00 to $15.00 per cubic yard were given by twelve respondents giving an average cost of $9.00 per cubic yard. Two of the sixteen who use mulch gave no price and two said that it is free.

Professional groundskeepers: Four respondents in this category (40 percent) use or purchase mulch materials. Quantities used by three of the four are fifty, eighty-five, and one hundred cubic yards annually. One respondent did not specify an amount used. Costs of $7.00, $9.00, and $32.00 per cubic yard were reported by three respondents. The fourth respondent obtains mulch at no cost.

Hospital groundskeepers: No hospital groundskeepers reported purchase or use of mulch materials.

Cemetery groundskeepers: Four respondents in this category (21 percent) use or purchase mulch materials. Two of the four each use 1000 cubic yards annually and another uses two truckloads annually. The fourth respondent did not specify an amount used. All four said that the mulch is free.

Grounds and lawn maintenance-unspecified: Five respondents in this category (38 percent) use or purchase mulch materials. Quantities reported by the five were one ton, twenty cubic yards, 120 cubic yards, 400 tons, and twenty-five truckloads annually. Three obtain the mulch at no cost. The other two respondents gave prices of $12.00 and $13.00 per cubic yard.

Arborists: One arborist uses 500 cubic yards of mulch annually which is obtained at no cost.

Sod growers: One sod grower uses 1100 tons of mulch annually at a cost of $48.00 per ton.

TIME OF PURCHASE

The use of compost materials will undoubtedly be seasonal in nature. This should be a consideration in any plans or efforts to distribute materials. In order to gain a better understanding of purchasing patterns, potential compost users were asked to indicate the season(s) in which the majority of purchases are made. As can be seen in Table 5, very few of those surveyed (less than 3 percent of all respondents) purchase any materials during the winter months.

Percentages of all respondents who purchase materials in the spring, summer, and fall are 66, 55, and 51, percent respectively. It appears that, all other factors being favorable, compost could be effectively distributed throughout these seasons. However, it would probably be necessary to store a large proportion of the compost generated during the winter months.

It should be noted that within some categories purchases are more concentrated in certain seasons. For example, 70 percent of the cemetery groundskeepers purchase materials in the spring while only 24 percent said that they make purchases in the fall. In contrast, nearly equal numbers of landscape contractors purchase materials in the spring, summer, and fall seasons.

USE OF MATERIALS

The next section of the questionnaire consisted of a list of possible ways that materials such as topsoil, peat, manure, mulches, compost, etc. might be used. Respondents were asked to check the way(s) that they use materials. Responses are summarized in Table 6.

The most frequently checked use was topdressing with 52 percent of all respondents indicating the use of the listed materials for this purpose. The least frequently checked use was fertilizer. Only 15 percent of all respondents reported using any of the listed materials as a fertilizer source.

Almost all respondents checked more than one type of use and more than 30 percent of all respondents checked more than two. It appears that many potential consumers are involved in a variety of operations and could have more than one type of use for compost. Many of the nursery operators for example, are also involved in landscaping operations. Suitable uses for compost are likely to exist in both areas of such businesses.

Respondents were also asked to describe any other way(s) that they use materials such as those listed. Very few responses were obtained from this section of the questionnaire. All additional comments are given below.

Build retaining walls
Construct golf course greens
Retail sales (three respondents)
Filling holes after grinding out stumps
Backfill for tree planting
Soil amendment for tree planting
Winter mulch for berries
Daily cover at landfill

TRANSPORT AND STORAGE CAPABILITIES

Transport of materials should be addressed in any composting plans. Proposals for the distribution of composts have often assumed that consumers will pick up or otherwise provide transport. Sometimes it is assumed that transport costs will be offset by or equal to revenue generated from the sale of the compost. These may or may not be realistic assumptions depending on the type of operation, haul distance, amount of material generated relative to the size of the market, quality of the compost, and several other factors. Consideration should be given to the fact that the cost of delivery is quite often included in the price of topsoil, peat, and other materials that are used in large quantities.

The need for product storage also deserves careful consideration. Because demand for compost products is most likely to be seasonal in nature, it may be necessary to store finished compost at the facility where it is generated. Another option would be to rely on storage capabilities of the consumer. Compost producers will need to evaluate different transport and storage options: their costs, dependability, and how different options can limit or expand potential markets.

Respondents were asked if their organization currently stores or has the capability of storing materials. Responses to this question are summarized in Table 7. As can be seen from the table, one-half or more of the respondents in almost all categories said that they are able to store material. Seventy percent of all respondents answered this question positively, 26 percent said that they do not have storage capabilities, and 4 percent provided no answer.

Respondents answering yes to this question were also asked to indicate the amount of material that they can store. Approximately half of those answering yes to the first part of this section provided a specific amount. Because amounts were given in such varying units it is not possible to draw any conclusion about typical storage capacity. Responses ranged from less than one cubic yard to several acres or thousands of cubic yards.

Fewer respondents said that they are able to transport materials as compared to those who are able to provide storage. As shown in Table 8, 59 percent of all respondents said that they have some sort of transport capability. There was considerable difference between categories. The most positive response was from the landscape contractors. Ninety percent of the respondents in this group said that they could transport materials. The least positive response was from the golf course superintendents with only 31 percent indicating transport capability.

It should be noted that several respondents, although answering yes to the question, added comments pertaining to limitations. Typical comments included: the only means of transport is a pick-up truck, or can haul materials only if they are within ten miles.

CONCERNS AND INTERESTS

The next section of the questionnaire contained a list of possible quality parameters and/or concerns that consumers might have with the use of composted waste products. Respondents were asked to rate each parameter on a 1 to 5 basis, with 1 being most important and 5 least important. Average ratings for each of the ten parameters were determined within each category. The parameter was then assigned a rank of importance for that category. Where average ratings were equal, equal rank was assigned. Thus, the distribution of ranks may not range from 1 to 10 within a category.

The ratings and rank of importance for the different categories of users are summarized in table 9. Overall, cost is the parameter of greatest concern. It was ranked most important by six of the ten categories of respondents. Availability was ranked as most important by the arborists and by those in the grounds and lawn maintenance - unspecified category. Odor is the major concern of professional groundskeepers and organic matter content is considered most important by hospital groundskeepers. Weight was rated least important by eight of the ten categories of respondents. Fertilizer value is considered least important by those in the nursery category while odor is the parameter of least concern to sod growers.

It is quite apparent that cost and availability are the areas of major concern while weight is considered least important. However it is important to recognize differences between groups. For example, fertilizer value was rated least important by nursery respondents, whereas it was rated second only to cost by sod growers.

Respondents were also asked to specify any other areas of concern or interest and to rate them along with the listed parameters. Only eleven respondents provided any additional items of concern. They are:

Presence of nonbiodegradable materials such as glass, plastics, and metals ------ 7 respondents

Presence of heavy metals ------------------ 2 respondents

Contamination (type not specified) ----------- 2 respondents

Nutrient holding ability ------------------ 1 respondent

Public acceptance ------------------------ 1 respondent

Transport distance ----------------------- 1 respondent

All of these items were assigned a rating of 1 or 2 by all respondents who included them as concerns.

In addition to rating the listed parameters, respondents were asked to specify desired or acceptable levels for any or all of the parameters. The response to this part of the questionnaire was disappointingly low. So few respondents provided any information that it is not possible to formulate conclusions regarding acceptable product specifications.

POTENTIAL DEMAND FOR COMPOST

The final sections of the questionnaire were designed in an attempt to estimate the extent of interest in compost products and, more specifically, the amount of compost that might be consumed by potential users. Individuals were asked both if they would be willing to try a solid waste compost and if they believed they would be a regular user. Responses to the two questions are summarized in Tables 10 and 11. Sixty-five percent of all respondents said that they would be willing to try a solid waste compost. Slightly less (60 percent of all respondents) believed that they would be regular users of compost products if a consistent reliable source was available. Nineteen percent of all respondents said that they would not be willing to try a solid waste compost and 24 percent do not believe that they would be regular users. Responses to the two questions do not total 100 percent as not all respondents provided answers.

Very favorable responses were received from landscape contractors and professional groundskeepers. Greater than 80 percent of the respondents in each of these categories answered yes to both questions. Strong interest was also shown by those in the parks and public agencies category. However, it should be noted that several of the respondents in this category reported that they have their own source of compost or are able to obtain yard waste compost at little or no cost. A few said that they have difficulty using all of the compost they currently produce.

Nurseries also represent a potential market for composted waste products. The extent of use by this group is more likely to depend on product characteristics and consistency than for many of the other groups surveyed. Nursery requirements, particularly for media components, are usually quite specific.

Those respondents who said they would be regular users of compost products were asked to speculate on the amount that they would use on an annual basis. Responses to this question are summarized in Table 12. As can be seen by comparing the percentage of those who answered yes to the question in Table

11 with the percentage that specified an amount that might be used on an annual basis in Table 12, many respondents were unwilling or unable to speculate on how much compost they would use.

The averages shown in the fifth column were calculated from only those respondents specified amounts. Thus, it should not be assumed that the averages are representative of the entire category. They do however, give an indication of the types of individuals that would use the greatest amounts of compost. The average for landscape contractors far exceeds that of any other category. The next highest averages were obtained from amounts given by those in the parks and public agencies and nursery categories.

The last column in Table 12 shows the total amount given by respondents in each category. Again, landscape contractors and those in the parks and public agencies category appear to be potentially large consumers. The total amount given by these two groups (94,848 cubic yards per year) represents more than eighty-five percent of the total for all categories.

Those who said that they would not be willing to try a solid waste compost or who did not believe that they would be regular users of solid waste compost were asked to give their major reason(s). A wide variety of comments were received from respondents who answered no to the questions as well as from those who said that they would be willing to try and/or use compost. There were not, however, major differences in comments from the two separate questions. In several cases, a respondent gave the same reason for not being a regular user as was given for not wanting to try a solid waste compost. Comments from the two questions are given in Tables 13 through 32 according to respondent categories.

No need or use for compost was the most frequently reported reason followed by comments pertaining to cost. Several respondents, particularly those in the parks and public agencies category, said that they have their own source of compost or are able to obtain it for free. Other frequently stated concerns were odors, inconvenience, and product contamination.

Lastly, respondents were asked if they were interested in more information about solid waste composts. Sixty-four percent of all respondents answered positively (Table 33) which is similar to the percentage of all respondents that said they would be willing to try a solid waste compost. Within categories there are some interesting differences in responses to the two questions. For example, even though only 27 percent of the cemetery groundskeepers would be willing to use compost, 48 percent said that they would like more information.

On the other hand, 76 percent of those in the parks and public agencies category said that they would be willing to try a solid waste compost, while only 57 percent said that they would like more information. This difference may reflect more experience with the use of composts (i.e. yard waste composts from the metro area centralized sites) and therefore less need for additional information. As was pointed out above, several respondents in this category who said that they would try or regularly use compost also commented that they have their own source of compost or are able to obtain it at little or no cost. These comments present some difficulty in assessing parks and/or other public agencies as potential markets for solid waste composts.

METRO AREA RESPONDENTS

Market uncertainties are sometimes viewed as especially critical when considering composting as an option for large metropolitan areas. Large quantities of compost could be produced, and therefore need to be distributed, in a relatively confined area. This situation is exemplified in Minnesota, where more than half of the State's solid waste is generated in the seven-county Metropolitan Area.

With this in mind, respondents were asked to designate the county in which they are located so that potential consumers in the Metropolitan Area could be identified. As is shown in Table 34, this group represents sixty-one percent of all respondents.

The percentages of all Metro Area respondents that would be willing to try (67 percent) and regularly use (63 percent) composted waste products (Tables 35 and 36) are very similar to the state wide figures (Tables 10 and 11). There are however, some noticeable differences within categories. For example, cemetery groundskeepers within the Metro Area appear to be much more receptive to trying and using compost. Sixty percent said that they believed they would be regular users of compost. State wide, only 27 percent of the cemetery groundskeepers responded positively to the question. The opposite is true for golf course superintendents, with fewer Metro Area respondents willing to try or regularly use compost as compared to all golf course superintendents in the State.

Perhaps of greatest interest or significance is the large proportion of compost that Metro Area respondents estimated they would use. As is shown in Table 37, the total amount estimated by all Metro Area respondents is 104,959 cubic yards per year. This represents 94 percent of the state wide total.

These figures may portray a somewhat biased picture of potential markets in the state. Some agencies gave very large estimates of amounts that might be used on an annual basis. Several of these values were included in the Metro Area totals according to the county indicated on the questionnaire. It is quite likely that estimates from some of these agencies included materials that would be used outside of the Metro Area.

It should also be noted that only landscape contractors in the Twin Cities Area were mailed questionnaires. Had landscape contractors throughout the State been included in the survey, the Metro Area proportion of estimated compost use might have been considerably less. Nonetheless, it does appear that a substantial market for composted waste products could be developed within the Metro Area.

SUMMARY

The results of this survey show that there is a definite interest in the use of solid waste compost. It appears that non-agricultural markets do exist and could be further developed in the state and particularly in the seven county metropolitan area. The large number of questionnaires returned (greater than 24 percent) is viewed as a positive response as is the high proportion of respondents (64 percent) who said that they would like more information on compost products.

In view of the fact that most solid waste composts have relatively low nutrient contents and would serve as poor substitutes for commercial fertilizers, it is encouraging to note that the types of soil products, organic materials, and other amendments currently consumed by many of those surveyed are used largely for their physical and conditioning properties and not as major sources of plant nutrients.

Although some industries, notably sod growers and arborists showed a lack of interest, other sectors such as landscape contractors and public agencies displayed a definite willingness to try compost products. Large percentages of the respondents in these groups believe that they would be regular users. It appears that these would be the most likely areas in which to initiate marketing efforts. Cost and availability of products are the major concerns of nearly all groups surveyed.

Table 1. OVERALL RESPONSE TO UNIVERSITY OF MINNESOTA COMPOST INFORMATION QUESTIONNAIRE.

Category	No. of Quest. Sent	No. of Quest. Received	Percent Response
Parks - Public Agencies	300	91	30
Nurseries	263	58	22
Golf Course Superintendents	262	48	18
Landscape Contractors	121	40	33
Professional Groundskeepers	15	8	53
Hospital Groundskeepers	65	12	18
Cemetery Groundskeepers	120	32	27
Grounds and Lawn[1] Maintenance - unspecified	---	13	--
Arborists	124	8	6
Sod Growers	114	10	9
Miscellaneous[2]		19	
TOTALS	1384	339	24

[1]Respondent did not specify type of grounds.

[2]Type of operation does not fit any of the categories.

Table 2. MATERIALS USED.

Percentage of respondents that currently use or purchase:

Category	Type of Material				
	Topsoil	Peat	Manure	Compost	Mulch
Parks - Public Agencies	65	11	24	21	22
Nurseries	74	64	31	21	33
Golf Course Superintendents	63	25	2	4	6
Landscape Contractors	90	38	18	8	40
Professional Groundskeepers	75	38	25	13	50
Hospital Groundskeepers	50	8	0	8	0
Cemetery Groundskeepers	73	9	9	15	12
Grounds & Lawn Maintenance - unspecified	62	31	23	15	38
Arborists	38	0	0	13	13
Sod Growers	10	0	10	10	10
All Categories	64	50	17	15	22

Table 3. AMOUNT AND COST OF TOPSOIL.

Category	Amount purchased or used (yd^3)			Cost (dollars)		
	low	high	average	low	high	average
Parks - Public Agencies	10	125,000	3245	1.00	15.00	7.50
Nurseries	15	10,000	840	1.00	16.00	10.50
Golf Course Superintendents	10	4,000	270	5.00	27.00	13.00
Landscape Contractors	25	20,000	2800	1.00	15.00	7.25
Professional Groundskeepers	5	500	125	5.00	12.00	8.00
Hospital Groundskeepers	3	70	20	5.00	15.00	11.00
Cemetery Groundskeepers	1	750	120	5.00	96.00	16.00
Grounds & Lawn Maintenance - unspecified	12	700	232	2.50	10.00	8.00
Arborists	10	500	190	1.00	10.00	9.00
Sod Growers	One respondent indicated use of 1000 yd^3, no price given.					

Table 4. AMOUNT AND COST OF PEAT.

Category	Amount purchased or used (yd^3)			Cost (dollars)		
	low	high	average	low	high	average
Parks - Public Agencies	0.5	250	51	12.50	40.00	26.25
Nurseries	0.5	5000	503	2.00	46.00	16.00
Golf Course Superintendents	5	300	52	4.50	45.00	15.00
Landscape Contractors	5	1500	322	5.00	95.00	22.00
Professional Groundskeepers	5	20	11	2.00	100.00	47.00
Hospital Groundskeepers	one respondent indicates purchase of one cubic yard per year at $30.00 per yard					
Cemetery Groundskeepers	2	100	51	only one respondent gave price at $0.25 per pound		
Grounds & Lawn Maintenance - unspecified	1	200	67	2.50	54.00	28.00
Arborists	no respondents indicate use/purchase					
Sod Growers	no respondents indicate use/purchase					

Table 5. SEASONAL BREAKDOWN OF MATERIAL PURCHASES.

Category	Percentage that purchase materials during:			
	Spring	Summer	Fall	Winter
Parks - Public Agencies	65	51	57	2
Nurseries	91	64	69	9
Golf Course Superintendents	65	63	54	0
Landscape Contractors	88	83	70	0
Professional Groundskeepers	75	75	50	0
Hospital Groundskeepers	58	33	17	0
Cemetery Groundskeepers	70	45	24	0
Grounds & Lawn Maintenance - unspecified	69	62	62	8
Arborists	38	25	25	0
Sod Growers	60	40	30	0

Table 6. WAYS THAT ARE LISTED PRODUCTS ARE USED.

Percentage of respondents that use topsoil, manure, compost etc., for the following purposes.

CATEGORY	USE			
	Topdressing	Amendment in beds	Amendment prior to seeding	Amendment prior to sodding
Parks - Public Agencies	55	24	38	35
Nurseries	40	36	33	25
Golf Course Superintendents	90	19	40	27
Landscape Contractors	55	48	48	65
Professional Groundskeepers	63	63	38	25
Hospital Groundskeepers	33	50	33	16
Cemetery Groundskeepers	64	15	39	27
Grounds & Lawn Maintenance - unspecified	54	23	31	38
Arborists	13	25	0	13
Sod Growers	0	0	10	20
TOTAL	52	27	27	31

Table 6.(con't) WAYS THAT LISTED PRODUCTS ARE USED.

Percentage of respondents that use topsoil, manure, compost etc., for the following purposes.

CATEGORY	USE			
	Fertilizer	Mulch	Component of potting media	Fill
Parks - Public Agencies	21	41	10	30
Nurseries	13	55	80	24
Golf Course Superintendents	8	15	4	27
Landscape Contractors	13	53	40	33
Professional Groundskeepers	0	63	13	25
Hospital Groundskeepers	25	16	8	33
Cemetery Groundskeepers	3	18	9	52
Grounds & Lawn Maintenance - unspecified	46	62	23	23
Arborists	25	13	0	13
Sod Growers	50	10	0	0
TOTAL	15	35	23	27

Table 7. STORAGE CAPABILITY.

Category	Have Storage		Do not have storage	
	Number	Percentage	Number	Percentage
Parks - Public Agencies	64	70	23	25
Nurseries	49	84	8	4
Golf Course Superintendents	36	75	11	23
Landscape Contractors	28	70	10	25
Professional Groundskeepers	6	75	2	25
Hospital Groundskeepers	4	33	7	58
Cemetery Groundskeepers	22	67	9	27
Grounds & Lawn Maintenance - unspecified	6	46	7	54
Arborists	4	50	2	25
Sod Growers	5	50	5	50
TOTALS	224	70	84	26

Table 8. TRANSPORT CAPABILITY.
Numbers and percentages of respondents that currently transport or have the ability to transport materials.

Category	Have capability Number	Have capability Percentage	Do not have capability Number	Do not have capability Percentage
Parks - Public Agencies	69	76	23	25
Nurseries	32	55	25	43
Golf Course Superintendents	15	31	33	69
Landscape Contractors	36	90	3	8
Professional Groundskeepers	6	75	1	13
Hospital Groundskeepers	4	36	7	64
Cemetery Groundskeepers	13	39	18	55
Grounds & Lawn Maintenance - unspecified	9	69	4	31
Arborists	6	75	1	13
Sod Growers	4	40	5	50
TOTALS	190	59	113	35

Table 9. RATING OF MAJOR CONCERNS AND INTERESTS WITH THE USE OF A SOLID WASTE COMPOST.

	PARAMETER									
	Fertilizer Value	Weight	Granule Size	Water Holding	Organic Matter	pH	Odors	Handling	Cost	Availability
PARKS-PUBLIC AGENCIES										
Number of respondents that gave rating	86	80	82	84	84	84	85	84	84	83
Average Rating	2.21	1.30	2.70	2.52	2.07	2.15	1.92	2.14	1.58	1.83
Rank	7	10	9	8	4	6	3	5	1	2
NURSERIES										
Number of respondents that gave a rating	57	54	56	55	56	53	56	56	57	57
Average Rating	2.54	2.53	2.34	1.98	1.61	1.89	2.04	1.88	1.33	1.75
Rank	10	9	8	6	2	5	7	4	1	3
GOLF COURSE SUPERINTENDENTS										
Number of respondents that gave a rating	45	45	46	44	46	45	46	46	46	46
Average Rating	2.40	2.89	1.89	1.93	1.89	1.62	1.98	1.96	1.61	1.65
Rank	8	9	4	5	4	2	7	6	1	3
LANDSCAPE CONTRACTORS										
Number of respondents that gave rating	39	39	38	39	39	39	38	39	39	39
Average Rating	2.33	3.00	2.63	2.41	2.15	2.77	2.24	2.38	1.41	1.53
Rank	5	10	8	7	3	9	4	6	1	2
PROFESSIONAL GROUNDSKEEPERS										
Number of respondents that gave a rating	7	7	7	7	7	7	7	7	7	7
Average Rating	3.00	2.29	2.14	1.71	1.86	2.00	1.43	1.71	1.86	1.86
Rank	6	7	5	2	3	4	1	2	3	3

Table 9. (con't) RATING OF MAJOR CONCERNS AND INTERESTS WITH THE USE OF A SOLID WASTE COMPOST.

	PARAMETER									
	Fertilizer Value	Weight	Granule Size	Water Holding	Organic Matter	pH	Odors	Handling	Cost	Avail-ability
HOSPITAL GROUNDSKEEPERS										
Number of respondents that gave a rating	9	9	9	9	9	9	9	9	9	9
Average Rating	2.67	3.67	2.56	2.56	2.00	2.11	1.44	2.11	2.11	2.78
Rank	5	7	4	4	1	3	2	3	3	6
CEMETERY GROUNDSKEEPERS										
Number of respondents that gave a rating	22	22	21	21	21	21	21	23	23	23
Average Rating	2.39	3.75	2.88	2.64	2.74	2.36	2.17	2.24	1.67	2.02
Rank	6	10	9	7	8	5	3	4	1	2
GROUNDS & LAWN MAINTENANCE UNSPECIFIED										
Number of respondents that gave a rating	11	1	11	11	11	11	11	11	11	11
Average Rating	2.50	2.73	2.64	2.73	2.64	2.18	1.91	1.91	1.91	1.64
Rank	5	7	6	7	6	4	3	3	2	1
ABORISTS										
Number of respondents that gave a rating	5	4	4	5	5	5	5	5	5	5
Average Rating	2.00	2.75	2.50	2.60	1.80	2.20	1.80	2.20	1.80	1.40
Rank	3	7	5	6	2	4	2	4	2	1
SOD GROWERS										
Number of respondents that gave a rating	9	7	7	8	8	9	8	9	10	9
Average Rating	1.33	3.14	2.71	2.75	1.88	2.00	3.125	1.67	1.00	1.89

Table 10. NUMBER AND PERCENTAGE OF RESPONDENTS WILLING TO TRY A SOLID WASTE COMPOST.

Category	Willing to try		Not willing to try	
	Number	Percentage	Number	Percentage
Parks - Public Agencies	69	76	12	13
Nurseries	42	72	11	19
Golf Course Superintendents	31	65	13	27
Landscape Contractors	33	83	4	10
Professional Groundskeepers	7	88	1	13
Hospital Groundskeepers	8	67	1	8
Cemetery Groundskeepers	9	27	13	39
Grounds & Lawn Maintenance - unspecified	11	85	2	15
Arborists	3	38	3	38
Sod Growers	6	60	3	30
TOTALS	219	65	63	19

Table 11. NUMBER AND PERCENTAGE OF RESPONDENTS BELIEVING THEY WOULD BE REGULAR USERS OF SOLID WASTE COMPOST.

CATEGORY	Would be a regular user		Would not be a regular user	
	Number	Percentage	Number	Percentage
Parks - Public Agencies	62	68	21	23
Nurseries	39	69	15	26
Golf Course Superintendents	30	63	13	27
Landscape Contractors	33	83	5	13
Professional Groundskeepers	7	88	1	13
Hospital Groundskeepers	6	50	1	8
Cemetery Groundskeepers	9	27	13	39
Grounds & Lawn Maintenance - unspecified	9	69	4	31
Arborists	2	25	4	50
Sod Growers	5	50	4	40
TOTALS	202	60	81	24

Table 12. ESTIMATED ANNUAL SOLID WASTE COMPOST USE.

CATEGORY	% Giving Specific Amount	Amount in cubic yards			
		Low	High	Average	Category Total
Parks - Public Agencies	42	1	35,000	1196 (282)[1]	45,448
Nurseries	34	2	3,500	421 (259)[1]	8,420
Golf Course Superintendents	52	<1	1,500	142	3,550
Landscape Contractors	50	<1	30,000	2470 (1021)[1]	49,400
Professional Groundskeepers	75	3	100	49	294
Hospital Groundskeepers	42	2	50	26	130
Cemetery Groundskeepers	12	24	100	44	176
Grounds & Lawn Maintenance - unspecified	38	4	800	120	600
Arborists	25	50	100	75	150
Sod Growers	30	20	2,000	1010 (20)[1]	3030
ALL CATEGORIES	38				111,198

[1]Average excluding highest and lowest value.

Table 13. COMMENTS GIVEN BY PARKS-PUBLIC AGENCIES WHEN ASKED WHY THEY WOULD NOT BE WILLING TO TRY A SOLID WASTE COMPOST.

---Response---		Comment
Yes	No	
	X	Not enough need
	X	Can't be used in eating areas, equipment
X		In certain areas but not parks
--	--	Very small amount
	X	Too much hassle, too little return
	X	Have own source, more than enough
	X	Odors
	X	City did composting in the past, poor participation
--	--	Have tried
	X	Very small use
X		If safe and not harmful
X		Currently using 60-70 yds of leaf compost
Maybe		Depends on quality
X		If product is clean and right sized with no sticks
	X	Space availability
?	?	Odors, glass
	X	Must follow state specs for soils
	X	Tried sludge and it smelled

Table 14. COMMENTS GIVEN BY PARKS-PUBLIC AGENCIES WHEN ASKED WHY THEY WOULD NOT BE REGULAR USERS OF SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
	X	Not enough need
	X	Limited potential for regular use
	X	Limited use because of dangers (lead)
X		Concern for complaints
X		Depending on cost
	X	Do not have help or areas for use
	X	Too much bother
	X	Not a steady demand
	X	Hard time using our own
X		On a trial basis at first
	X	Not a significant need
	X	Odors
	X	Have our own supply
	X	Little interest, lack of equipment
—	—	Only if good equipment is available for handling
X		Sporadic use
X		Amount depends on projects - variable
X		Amount depends on price
X		If cheap could use a lot
	X	Have our own supply
	X	No uses
X		Small amount, limited budget
X		If free
X		Have just begun making leaf compost
X		If competitively priced
Maybe		Depends on quality and price
X		Limited, use county yard waste compost
	X	Depends on location, ease of access
X		Transport would be a problem
X		Cost, quality, availability - many factors
	X	Have own compost
X		Very limited
?	?	Depends on odor, amount of glass, and product consistency
X		Amount would vary from year to year
	X	Demand changes
	X	Hire contractors who would be the users

Table 15. COMMENTS GIVEN BY NURSERIES WHEN ASKED WHY THEY WOULD NOT BE WILLING TO TRY A SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
X		If no heavy metals
	X	No consumer demand or customer acceptance
X		If baled like sphagnum could be easily sold
	X	No use, too small
	X	Don't want to change what works
	X	Local peat available and inexpensive
	X	Current mix works well
X		Concerned about finger injuries from glass
--	--	Needs more testing
	X	No need, use other materials
	X	Toxics, odor, amount needed
X		Would customer accept it?
?	?	Haven't thought about using it
X		Need more information
?	?	Solid waste cleared only for grains, not vegetables

Table 16. COMMENTS GIVEN BY NURSERIES WHEN ASKED WHY THEY WOULD NOT BE REGULAR USERS OF SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
X		Amount would depend on cost
X		If it meets potting needs
	X	Our use is small, not sure about customers
X		But only a small amount
X		Amount depends on cost
--	--	Possibly
X		But not very much
	X	Not enough use, small operation
--	--	Just depends
	X	Use local peat
	X	Would only use small amount if free
	X	Questions concerning heavy metals, toxics and salt content
X		Only if suitable for container growing
X		Hard to say how much
X		Need more information
	X	No need, use other materials
--	--	Transport would be a problem
X		Amount depends on cost
	X	Toxics
X		Amount depends on customer
	X	Have own peat supply - very cheap
X		Amount depends on cost
	X	Transportation costs
?	?	Cost and benefits are major factors. If cost is low could topdress sandy areas
X		If right product available
	X	Don't use much

Table 17. COMMENTS GIVEN BY GOLF COURSE SUPERINTENDENTS WHEN ASKED WHY THEY WOULD NOT BE WILLING TO TRY A SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
	X	Topdressing must be compatible with existing topsoil
--	--	Need to know more about nutrient value
	X	Aesthetic reasons
	X	Not enough experience or knowledge
	X	Low nitrogen content, hard on equipment
	X	No area for compost
X		With limited effort
	X	Only in flower beds, not on greens
	X	Aesthetics, handling
	X	Limited applications
	X	Appearance
	X	Odors, handling
	X	No use on golf course
X		Concern for heavy metals
	X	Not necessary in our work

Table 18. COMMENTS GIVEN BY GOLF-COURSE SUPERINTENDENTS WHEN ASKED WHY THEY WOULD NOT BE REGULAR USERS OF SOLID WASTE COMPOST.

---Response---		Comment
Yes	No	
	X	Need more information on value and price
	X	Not enough use
	X	Not sure
	X	Limited application
—	--	No application at golf course
	X	Public attitudes, nutrients too variable
X		Would need to fulfill requirements and be competitively priced
?	?	First would like to see it work on other courses
	X	Limited use
X		Can't have glass in product
	X	use very little compost
	X	Only if needed
	X	Low nutrient value
X		Currently make own so only supplemental
X		For flower beds

Table 19. COMMENTS GIVEN BY LANDSCAPE CONTRACTORS WHEN ASKED WHY THEY WOULD NOT BE WILLING TO TRY A SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
X		If free of herbicides
	X	Odor, pH, organic matter content
?	?	Lack of information
	X	No use
	X	No request for it
--	--	Experience with waste lime
?	?	Depending on cost and ease of implementation

Table 20. COMMENTS GIVEN BY LANDSCAPE CONTRACTORS WHEN ASKED WHY THEY WOULD NOT BE REGULAR USERS OF SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
X		Depending on contract specifications
X		Depends, only a small amount
	X	Use would be sporadic depending on project needs
X		When will product be available
X		Amount depends on how product performs
X		Cost a major factor in amount used
	X	Only for certain uses such as trees and shrubs-not on vegetables
	X	Wouldn't be regular, biggest use is fill
	X	Have to see, cost a major factor
X		Depending on appeal to public
X		Cost the major consideration
X		If price were right (or free)

Table 21. COMMENTS GIVEN BY PROFESSIONAL GROUNDSKEEPERS WHEN ASKED WHY THEY WOULD NOT BE REGULAR USERS OF SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
x		Amount depending on cost

Table 22. COMMENTS GIVEN BY PROFESSIONAL GROUNDSKEEPERS WHEN ASKED WHY THEY WOULD NOT BE WILLING TO TRY A SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
x		If no odor

Table 23. COMMENTS GIVEN BY HOSPITAL GROUNDSKEEPERS WHEN ASKED IF THEY WOULD BE WILLING TO TRY A SOLID WASTE COMPOST.

---Response---		Comment
Yes	No	
?	?	Don't know until tried
--	--	Minimal interest
	X	Not needed
X		Amount depends on cost, availability and transport
?	?	Depends on many factors

Table 24. COMMENTS GIVEN BY HOSPITAL GROUNDKEEPERS WHEN ASKED WHY THEY WOULD NOT BE REGULAR USERS OF SOLID WASTE COMPOST

---Response---		Comment
Yes	No	
	X	Not needed
?	?	Limited use, lawn maintenance is contracted out

Table 25. COMMENTS GIVEN BY CEMETERY GROUNDSKEEPERS WHEN ASKED IF THEY WOULD BE WILLING TO TRY A SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
—	--	We are a very small operation
	X	No room, appearance
	X	Nature of the business
	X	We like what we are using now
	X	Aesthetic reasons
	X	Have no need
Maybe		Tell me more
—	--	Never use fertilizer or compost
—	--	We don't use this type of product
	X	Have no need at present
	X	Have no need
	X	Have own compost supply at no cost
	X	Have leaf mulch compost
?		Questionable because of cost
	X	Can get free milk sludge

Table 26. COMMENTS GIVEN BY CEMETERY GROUNDSKEEPERS WHEN ASKED WHY THEY WOULD NOT BE REGULAR USERS OF SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
X		But only our own material
	X	Possibly, if it works for soil mix prior to sodding
	X	Nature of the business
	X	Need to know more about solid waste
	X	Inconvenience
	X	Not interested in changing present procedures
	X	Not needed
	X	Use no chemicals other than the mortician uses
X		Currently use compost for about 60% of needs
—	--	Only if it is free
X		Depending on cost
—	—	Grass grows well without additions
—	--	Don't use compost products
	X	No need at present time
	X	Have own compost supply
—	--	May try it
?	?	Cost is important
	X	Odor, low nutrient content

Table 27. COMMENTS GIVEN BY GROUNDS & LAWN MAINTENANCE - UNSPECIFIED WHEN ASKED WHY THEY WOULD NOT BE WILLING TO TRY A SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
X		Would like to try in ground cover beds
	X	Too much material needed to meet nutrient requirements

Table 28. COMMENTS GIVEN BY GROUNDS AND LAWN MAINTENANCE - UNSPECIFIED WHEN ASKED WHY THEY WOULD NOT BE REGULAR USERS OF SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
X		Keep checking, Milorganite is a good product
	X	Limited applications, only in gardens
X		Probably limited usage, but are interested
	X	Volume too low to be regular, consistent user
	X	Inconvenience of handling

Table 29. COMMENTS GIVEN BY ARBORISTS WHEN ASKED WHY THEY WOULD NOT BE WILLING TO TRY A SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
	X	No present use
—	—	Not applicable
	X	Not pleasing to customers
	X	Not until saw performance and had a need
—	—	Only if it can be applied to existing trees and lawns

Table 30. COMMENTS GIVEN BY ARBORISTS WHEN ASKED WHY THEY WOULD NOT BE REGULAR USERS OF SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
	X	No present use
—	—	Not applicable
	X	Not pleasing to customers
	X	No seed for a lot of materials
X		Using county leaf compost
	X	Have own compost supply

Table 31. COMMENTS GIVEN BY SOD GROWERS WHEN ASKED WHY THEY WOULD NOT BE WILLING TO TRY A SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
	X	No need
	X	Use crop rotations to increase organic matter
—	—	Need to know more
	X	Equipment and handling needs

Table 32. COMMENTS GIVEN BY SOD GROWERS WHEN ASKED WHY THEY WOULD NOT BE REGULAR USERS OF SOLID WASTE COMPOST.

---Response--- Yes	No	Comment
—	—	Need more information
	X	No need
	X	Inconvenience of handling
	X	Have not yet had a need
	X	Equipment and handling needs

Table 33. NUMBER AND PERCENTAGES OF RESPONDENTS THAT WOULD LIKE MORE INFORMATION ON SOLID WASTE COMPOST.

Category	Would like more information		Do not want more information	
	Number	Percentage	Number	Percentage
Parks - Public Agencies	52	57	13	14
Nurseries	45	78	9	16
Golf Course Superintendents	32	67	9	19
Landscape Contractors	32	80	5	13
Professional Groundskeepers	7	88	1	12
Hospital Groundskeepers	6	50	2	17
Cemetery Groundskeepers	16	48	10	30
Grounds & Lawn Maintenance - unspecified	8	62	4	31
Arborists	1	13	5	63
Sod Growers	7	70	2	20
ALL CATEGORIES	206	64	60	19

Table 34. NUMBER AND PERCENTAGE OF RESPONDENTS FROM SEVEN COUNTY METROPOLITAN AREA.

CATEGORY	Total Number of Respondents	Metro Area Respondents Number	Metro Area Respondents Percentage
Parks - Public Agencies	91	60	66
Nurseries	58	27	47
Golf Course Superintendents	48	24	50
Landscape Contractors[1]	40	40	100
Professional Groundskeepers	8	4	50
Hospital Groundskeepers	12	9	75
Cemetery Groundskeepers	32	10	31
Grounds & Lawn Maintenance - unspecified	13	11	85
Arborists	8	6	75
Sod Growers	10	5	50
Miscellaneous	19	10	53
ALL CATEGORIES	339	206	61

[1]All landscape contractors surveyed are located in Twin Cities Metro Area.

Table 35. NUMBER AND PERCENTAGE OF METRO AREA RESPONDENTS WILLING TO TRY A SOLID WASTE COMPOST.

CATEGORY	Willing to try		Not willing to try	
	Number	Percentage	Number	Percentage
Parks - Public Agencies	43	72	8	13
Nurseries	22	81	4	15
Golf Course Superintendents	10	42	12	50
Landscape Contractors	33	83	4	10
Professional Groundskeepers	3	75	1	25
Hospital Groundskeepers	7	70	0	0
Cemetery Groundskeepers	6	60	2	20
Grounds & Lawn Maintenance - unspecified	9	82	2	18
Arborists	3	50	1	17
Sod Growers	2	40	2	40
TOTALS	138	67	36	17

Table 36. NUMBER AND PERCENTAGE OF METRO AREA RESPONDENTS BELIEVING THEY WOULD BE REGULAR USERS OF SOLID WASTE COMPOST.

CATEGORY	Would be a regular user		Would not be a regular user	
	Number	Percentage	Number	Percentage
Parks - Public Agencies	39	65	15	25
Nurseries	21	78	4	15
Golf Course Superintendents	10	42	10	42
Landscape Contractors	33	83	5	13
Professional Groundskeepers	3	75	1	25
Hospital Groundskeepers	6	60	0	0
Cemetery Groundskeepers	6	60	3	30
Grounds & Lawn Maintenance - unspecified	9	69	3	27
Arborists	2	33	2	33
Sod Growers	1	20	3	60
TOTALS	130	63	46	22

Table 37. ESTIMATED ANNUAL SOLID WASTE COMPOST USE-METRO AREA RESPONDENTS.

CATEGORY	% Giving Specific Amount	Amount in cubic yards			
		Low	High	Average	Category Total
Parks - Public Agencies	42	1	35,000	1,743 (358)[1]	43,596
Nurseries	41	10	3,500	649 (403)[1]	7,135
Golf Course Superintendents	46	7	1,500	169 (40)[1]	1,864
Landscape Contractors	50	<1	30,000	2,470 (1021)[1]	49,400
Professional Groundskeepers	100	20	60	48	190
Hospital Groundskeepers	40	2	50	21	85
Cemetery Groundskeepers	20	24	25	25	49
Grounds & Lawn Maintenance - unspecified	27	4	400	123	490
Arborists	33	50	150	75	150
Sod Growers	20	2,000	2,000	2,000	2,000
ALL CATEGORIES					104,959

[1]Average excluding highest and lowest values.

APPENDIX A

COVER LETTER, QUESTIONNAIRE, AND COMPOST INFORMATION SHEET

UNIVERSITY OF MINNESOTA
TWIN CITIES

Soil Science Department
Borlaug Hall
1991 Buford Circle
St. Paul, Minnesota 55108

December 5, 1986

Dear Sir or Madam:

In July of 1985, the University of Minnesota began work on a compost research project. The project is a part of state and local efforts to study and develop waste management strategies for the future. Composting the organic or biodegradable portion of solid wastes (garbage) is an attractive option because a portion of waste is diverted from landfills and, at the same time, a useful product is created.

We need your help!

We ask that you take a few minutes of your time to complete the enclosed questionnaire to help us gather information. This is an opportunity to express your opinions and to provide input into decisions that will lead to environmentally sound management practices.

The production of high quality composts from solid wastes is technically feasible and various studies have shown clear benefits from the use of compost products. However, the lack or uncertainty of proven uses remains a major obstacle to the development of compost operations. It is for this reason that we are seeking your help. From your comments we hope to gain a better understanding of the conditions necessary to create a demand for compost products and be able to estimate the extent of interest. We want to know what would be needed to make you a regular and satisfied compost user.

The information provided by the questionnaire will play an important role in the market assessment done as a part of the University project. It may also prove to be a useful tool for those decision makers that have the difficult task of selecting appropriate waste management practices for the future.

A pre-addressed, stamped envelope is enclosed for returning the questionnaire.

If you have questions, please feel free to contact me at (612) 624-2782. Your comments are encouraged.

Thank you for your help.

Sincerely,

Nancy A Schumacher

Nancy A. Schumacher
Project Coordinator

NAS:md

University of Minnesota Compost Information Questionnaire

Type of operation or agency

___ Nursery
___ Park maintenance
___ Highway maintenance
___ Golf course maintenance
___ Arborist
___ Private or ___ Public operation
___ Groundskeeper
___ Landscape contractor
___ Sod production
___ Lawn care
___ Cemetary groundskeeper
___ Other, please describe ___________

County in which you are located ______________________________

Please indicate the amount(s) and cost(s) of any of the following products that you purchase and/or use.

Product	Amount used annually	Unit cost
Topsoil	____________	________
Peat	____________	________
Manure	____________	________
Compost	____________	________
Mulches	____________	________
Other soil amendments	____________	________
Other similar product(s), please describe ________	____________	________

When are the majority of products purchased? If possible, indicate percentage of purchases for each season.

Spring ________ Summer ________ Fall ________ Winter ________

In what way(s) do you use the product(s)?

___ Topdressing
___ Soil amendment in beds
___ As a fertilizer
___ Mixed with existing soil or surface applied before seeding
___ As a fill material
___ Mulch for trees, shrubs, flowers, etc.
___ As a component of potting media
___ Mixed with existing soil or surface applied prior to sodding

___ Other (please explain): ______________________________

Does your organization currently stockpile or have the capability of stockpiling or storing materials such as those listed above? Yes ___ No ___
If yes, what quantity? ______________________.

Does your organization currently transport or have the capability of transporting materials such as those listed above? Yes ___ No ___.

What would be your major interest(s) and concern(s) with the use of a solid waste product? Please rate each of the following on a 1 to 5 basis, where 1 is important and 5 is unimportant. Also, if there is a specific level that you require for any of the parameters listed, please indicate that level in the space provided at the right.

	Important				Unimportant	Desired level or range
Fertilizer value	1	2	3	4	5	________
Weight	1	2	3	4	5	________
Size of granules	1	2	3	4	5	________
Water holding ability	1	2	3	4	5	________
Organic matter content	1	2	3	4	5	________
pH	1	2	3	4	5	________
Odors	1	2	3	4	5	________
Ease of handling/equipment needed	1	2	3	4	5	________
Cost	1	2	3	4	5	________
Availability	1	2	3	4	5	________
Other (specify) ____________	1	2	3	4	5	________

Based on your experience and knowledge, would you be willing to try a solid waste compost? Yes ____ No ____.

If not, please give your major reason(s) ______________________________

____

If a consistent, reliable source of compost were available do you believe that you would be a regular user? Yes ____ No ____.

If no, please give your major reason(s) ______________________________

____

If yes, could you speculate on the amount that you would use annually?

______________________.

Are you interested in more information about solid waste compost?
Yes ____ No ____

Additional comments ____

____

Would you like to recieve a copy of the survey results? If yes, please indicate so and provide your name and address below.

Name/Firm Name ____

Address ____

____

COMPOST INFORMATION SHEET

WHAT IS COMPOST

Broadly defined, compost is the product created by the biological decomposition of organic matter. For the purpose of this questionnaire and the University of Minnesota project, compost refers to the product created by the biological decomposition of solid waste materials such as household garbage, leaves, and grass clippings.

Solid waste composting usually involves one or several waste processing steps that remove large and recyclable objects and shred the material into smaller uniformly sized segments to increase the efficiency of decomposition. Manure, sewage sludge or other nitrogen-rich materials may also be added. It is often necessary to add water to bring the moisture content to a desirable level.

These steps are essentially a process of creating a suitable environment for microbial activity. The mixed mass of material is then allowed to "compost" for several weeks. Oxygen is supplied by turning or forcing air through piles of the material.

The microbial activity generates considerable heat. Temperatures ranging up to 160°F occur at different stages of the composting process. The heat is effective in reducing pathogenic organisms and killing weed seeds.

When properly produced, compost will be a dark colored, highly organic, crumbly material with what is sometimes described as an "earthy" odor. Depending on the initial materials used and the degree of processing (shredding, screening and separating), compost may contain small fragments of glass and/or plastics.

The nutrient contents vary somewhat depending upon the types of feed materials and the composting process but nitrogen, phosphorus and potassium contents are almost always quite low compared to conventional fertilizer materials. Typical reported nitrogen concentrations are usually less than 2.0%. Phosphorus and potassium concentrations are commonly less than 1.0% each. Consideration must also be given to the fact that a large percentage of the nutrients may not be readily available to growing plants. In situations where slowly available forms of nutrients are desired, this characteristic may be an advantage. Compost is well recognized as a soil amendment or conditioner. Due to its high organic matter content, compost has the ability to condition soil in ways that can directly and indirectly improve plant growth. Some of these are mentioned on the reverse side.

ATTACHMENT I

UTILIZATION OF WASTE COMPOSTS IN NURSERY CONTAINER MEDIA FOR THE PRODUCTION OF WOODY ORNAMENTALS

This project was supported by the Legislative Commission on Minnesota Resources and the Metropolitan Council of the Twin Cities Area.

Utilization of Waste Composts in Nursery Container Media for Production of Woody Ornamentals

Introduction

Much of the research that has been conducted on use of composts has focused on application to agricultural lands as a soil amendment. Horticultural industries also represent a significant portion of the demand for soil amendments. Commercial nurseries in particular are large consumers of organic soil amendments such as peat, manures, and other locally produced organic wastes. These materials are used as components of media for production of container grown plants. High priority is placed on local availability of product in order to minimize transportation costs. Nurseries have the potential to use large amounts of solid waste composts if they prove suitable for their needs.

When used as a portion of the media, waste composts have the potential to enhance both the physical and chemical qualities of container media. The purpose of this research was to evaluate the feasibilty of utilizing waste composts as replacements for organic amendments currently in use in container media for nursery production.

Objective

The objective of this study was to compare media containing composted and uncomposted waste with media containing peat and manure in terms of physical and chemical characteristics, and effects on plant growth.

Materials and Methods

Container growth media were prepared using varying amounts of hypnum or sphagnum peat, rotted animal manure, paunch manure, turkey manure compost, horse manure and cornstalk compost, municipal waste co-compost (Lodi, Wisconsin), and an uncomposted organic fraction from a refuse derived fuel (RDF) process (Thief River Falls, Mn). Other materials used in the media included wood chips, soil, and sand (Table 1). Fertilizers were incorporated into selected mixes.

Rooted cuttings of three deciduous and three coniferous species (Table 2) were potted into one gallon containers in May, 1986. Half of the plants were grown in the TRE Nursery on the St. Paul campus (Figure 1). The other half were grown in the container field at Bailey's Nursery in Newport. The plants were overwintered (1986-87) in the respective nurseries under a plastic/straw/plastic sandwich.

Samples of all media were chemically analyzed at the time of potting, after four and sixteen weeks of growth, and after one year of growth. Chemical analysis included determination of pH, soluble salts, nitrate nitrogen, ammonium nitrogen, available phosphorus, potassium, calcium, and magnesium. Bulk density, porosity, available water holding capacity, and hydraulic conductivity were determined for all media from samples collected at the time of potting.

The plants were monitored for bud break throughout the first month after potting. Mortality was recorded after one month, and throughout the summer as it occurred. Data was also collected on weed growth in each media. Quantitative and qualitative growth measurements were taken after eight and sixteen weeks of growth in the first year, and after ten weeks of growth in the second year. Tissue samples were collected from plants grown in mixes containing material from Lodi and Thief River Falls in September, 1986 for determination of heavy metal concentrations. Final data collection will be completed in July, 1987.

Results and Discussion

Final data analysis is incomplete at this time. The results and discussion which follow are based on data collected through September, 1986.

Chemical properties

The addition of waste and manure composts to a growing medium tended to raise the pH of the medium. The initial pH was as high as 7.2 in certain of the compost amended media; these values rose to 7.6 by the end of the first season. Increases in pH occurred in all media over the course of the season and were attributed to the alkalinity of the Twin Cities water supply (pH approximately 8) which was used for irrigation. Since nutrient availability is directly related to pH level, maintenance of proper media pH is essential to producing high quality plants. Although preferred pH ranges vary between species, the optimum media pH for many plants is around 6.5. Media pH can be altered and is generally adjusted prior to planting.

The addition of waste and manure composts and RDF material all increased the soluble salts content of the media. In some cases levels present in the media were sufficient to cause death of the plants. Soluble salt levels in all media were leached down to satisfactory levels within a month through rainfall and normal watering practices, and no further problems were observed. This suggests that media containing certain waste composts may have to be leached prior to planting.

Potassium and phosphorus levels were increased by the addition of manure compost to a medium. Lodi compost and RDF material also contributed small amounts of potassium. Ammonium nitrogen levels were not appreciably increased by the addition of any of the materials evaluated. Nitrate nitrogen levels were increased by the addition of manure composts and Lodi compost. Initial nitrate levels were substantially above those needed to support growth, but these levels were reduced by normal leaching within the first month and remained at acceptable levels thereafter.

Physical properties

The physical properties that are of most importance in container media are bulk density, available water holding capacity, hydraulic conductivity, and porosity (Table 3). One of the functions of organic amendments in container media is to modify these characteristics so that the media retains adequate amounts of air and water and is not excessively heavy.

Bulk density of the media was generally related to the percentage of organic matter present, regardless of origin. Increasing amounts of organic matter resulted in lower bulk density values (that is, the mixture weighed less per unit volume).

The addition of compost to a medium appeared to increase available water holding capacity. This was most evident with the manure composts, but was also observed in the Lodi compost and the RDF material. The presence of manure compost resulted in large increases in the hydraulic conductivity of the media, while the presence of Lodi compost or soil decreased the hydraulic conductivity. The hydraulic conductivity of all mixes was satisfactory by container media standards.

Total porosity was increased by the presence of compost, but air-filled porosity was often decreased as compared with other media which did not contain compost. This quality is not desirable, since plant roots need oxygen and excessive water-filled pore space decreases aeration in the container.

Effects on Plant Growth

Quantitative differences in plant growth in the first year were clearly related to fertilizer treatments (Figure 2). In all species, maximum amounts of growth were observed in media containing supplemental fertilizer. The importance of providing adequate fertility is illustrated by the fact that the presence of fertilizer tended to mask other shortcomings of any given medium.

Quality of growth was best for those plants which received fertilizer treatments (Figure 3). However, media pH was also related to plant quality. The mixes which produced the poorest quality of growth were also the ones with the highest pHs at the end of the first season. This is partially due to deficiency of essential nutrients which occurs at high pHs. Since mortality is reflected in the quality rating, mixes which produced high mortality also had low quality ratings.

First year mortality of plants in the study was almost totally attributable to the initial presence of high soluble salts in some media (Figure 4). Of the 33 dead plants, 29 died within the first month. Two thirds of the dead plants were of one variety, Ribes alpinum (alpine currant), which is particularly sensitive to salts. At the time the plants were removed from their winter covering in April, 1987 no losses due to winter injury were observed.

Species sensitivity to differences in media was apparent in the first year of observation. Responses varied from the fairly uniform growth regardless of media characteristics, exhibited by Potentilla fruticosa 'Jackmanni' (Jackmanni potentilla), to the extreme sensitivity of the Ribes alpinum. It is anticipated that some differences in media preference will be observed between the deciduous and evergreen species as well.

Metal Uptake

Leaf samples of both deciduous and coniferous species were analyzed for tissue concentrations of metals, including aluminum, boron, cadmium, chromium, lead, nickel, and zinc (Table 4). There were no differences in tissue concentrations of aluminum, cadmium, chromium, lead, or nickel between plants grown in media containing Lodi compost or RDF material and plants grown in a control mix without compost. Plants grown in media containing Lodi compost contained higher levels of boron than plants grown in either RDF material or the control mix. Zinc levels were higher in plants grown in Lodi compost and in RDF material than for plants grown in the control mix. Although these differences were statistically significant, levels of boron and zinc in all plants were well within the normal ranges for concentrations of these elements in plant tissues as cited in the available literature.

Conclusion

First year results of this study suggest that composted waste materials can provide some desirable qualities to container media. Among these are decreased bulk density, increased water holding ability, and increased porosity. However, careful attention must be paid to managing negative aspects such as high soluble salts and nitrates, high pH, and the tendency for some materials to reduce aeration in the container. These problems are not unlike those encountered with other organic soil amendments. Specific recommendations for avoiding problems with these materials will be included in the final report.

Table 1. Container Media and Fertility Combinations

		Hypnum peat	Sphagnum peat	Rotted manure	Paunch manure	Bailey's soil	TRE soil	Composted chips	Lodi compost	Bailey's sand	TRE sand	Turkey manure compost	RDFR*	Horse manure compost	Fertilizer
1.	Bailey's conifer mix	4			3					1		2			
2.	Bailey's deciduous mix	2			1	1				1					
3.	TRE mix		1	1			1	2			1				X
4.	Bailey's #1 w/o paunch and chips	2						1				2			
5.	Lodi/RDFR/chips							1	4			2	4		
6.	Modified TRE #1						1	2	1		1		1		X
7.	Modified TRE #2		1	1			1	2			1				X
8.	Cornstalks and horse manure compost	1				2				2				5	
9.	33% Lodi					1		2	2	1					
10.	33% RDFR					1		2		1			2		
11.	60% RDFR					1		2		1			6		
12.	Soilless Lodi							3	3	2					X
13.	Soilless RDFR							2	2	1			1		X

*RDFR = Refuse derived fuel rejects

Table 2. Species List

1. Sea green juniper (*Juniperus chinensis* "Sea green")
2. Webberi juniper (*Juniperus horizontalis* "Webberi")
3. Pyramidal arbor vitae (*Thuja occidentalis pyramidalis* "Emerald Queen")
4. Jackmanni potentilla (*Potentilla fruticosa* "Jackmanni")
5. Alpine currant (*Ribes alpinum*)
6. Variegated dogwood (*Cornus elegantissima*)

Table 3. Physical Properties of Container Media

Mix	Bulk Density (g/cm^3)	Available Water Capacity (% by volume)	Hydraulic Conductivity (cm/hr)	Total Porosity (% by volume)	Water Filled (% of total)	Air Filled (% of total)
1	.58	13.9	33.6	34.7	55.2	44.8
2	.62	12.0	69.6	29.9	42.8	57.2
3	.76	3.8	64.8	36.8	57.0	43.0
4	.38	14.0	109.2	33.6	54.7	45.3
5	.36	8.3	88.2	47.9	66.5	33.5
6	.79	2.4	28.8	39.2	62.4	37.6
7	.80	7.1	33.6	36.0	63.3	36.7
8	.78	6.4	84.6	33.4	50.6	49.4
9	.78	3.4	46.8	36.8	66.9	33.1
10	.71	3.6	58.2	41.1	62.4	37.6
11	.58	9.7	52.8	43.5	64.6	35.4
12	.78	6.9	25.2	30.3	58.9	41.1
13	.72	10.0	21.6	----	----	----

Table 4. Metals Concentrations in Leaf Tissue

Species: <u>Potentilla</u> <u>fruticosa</u> "Jackmanni"

Mix	ppm of metal (dry weight) Al	B	Cd	Cr	Cu	Ni	Pb	Zn
3 (control)	271	49	.53	.47	29	.57	.93	51
9 (Lodi)	271	46	.17	.40	26	.33	1.90	61
10 (RDF)	297	50	.47	.37	26	.17	1.20	45

Species: <u>Juniperus</u> <u>horizontalis</u> "Webberi"

Mix	ppm of metal (dry weight) Al	B	Cd	Cr	Cu	Ni	Pb	Zn
3 (control)	215	26	.13	.40	13	.27	.00	32
9 (Lodi)	223	44	.20	.50	11	.33	.00	37
10 (RDF)	260	25	.03	.50	12	.13	.00	36

Figure 2. Quantitative Growth Measurements

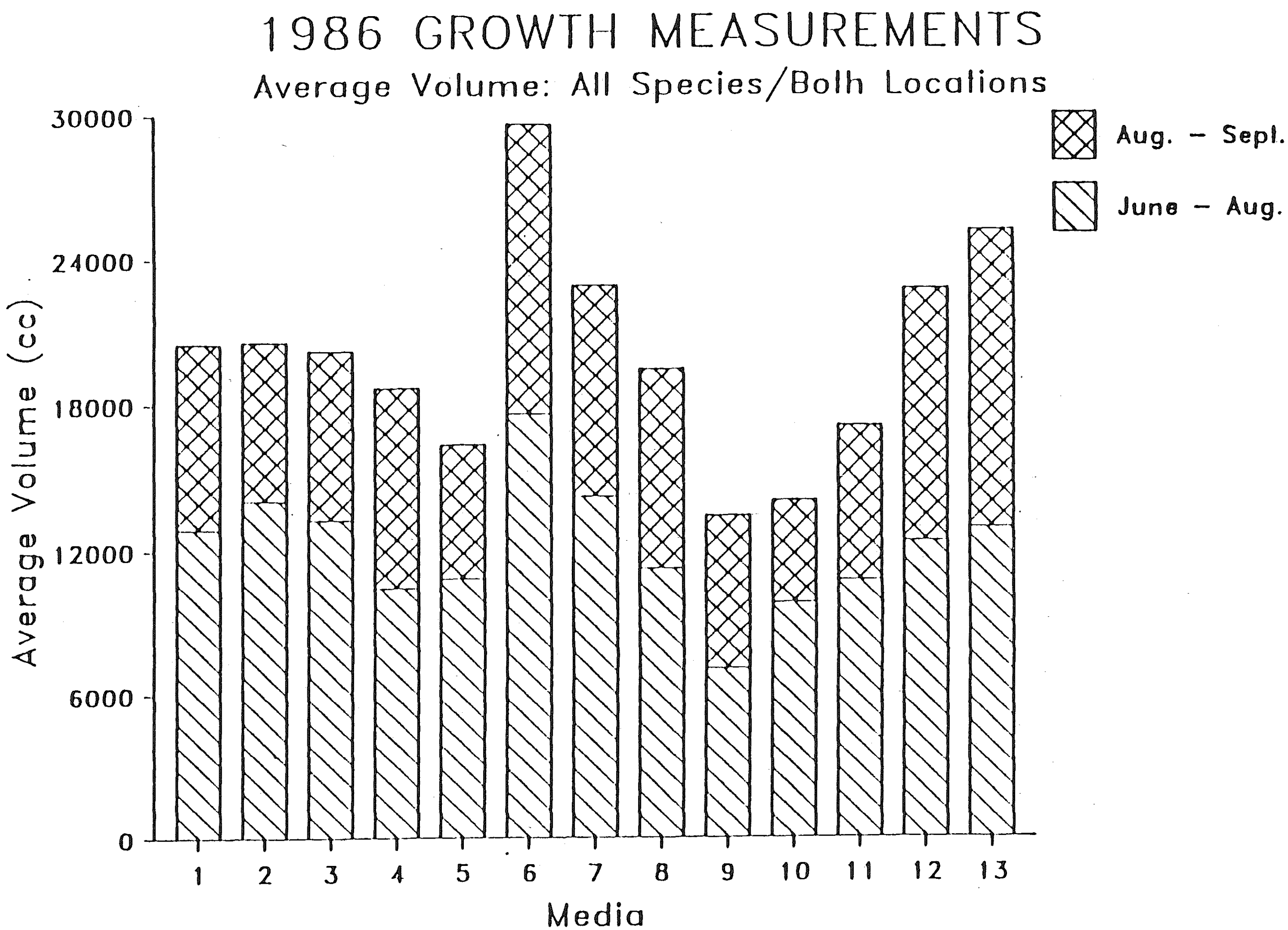
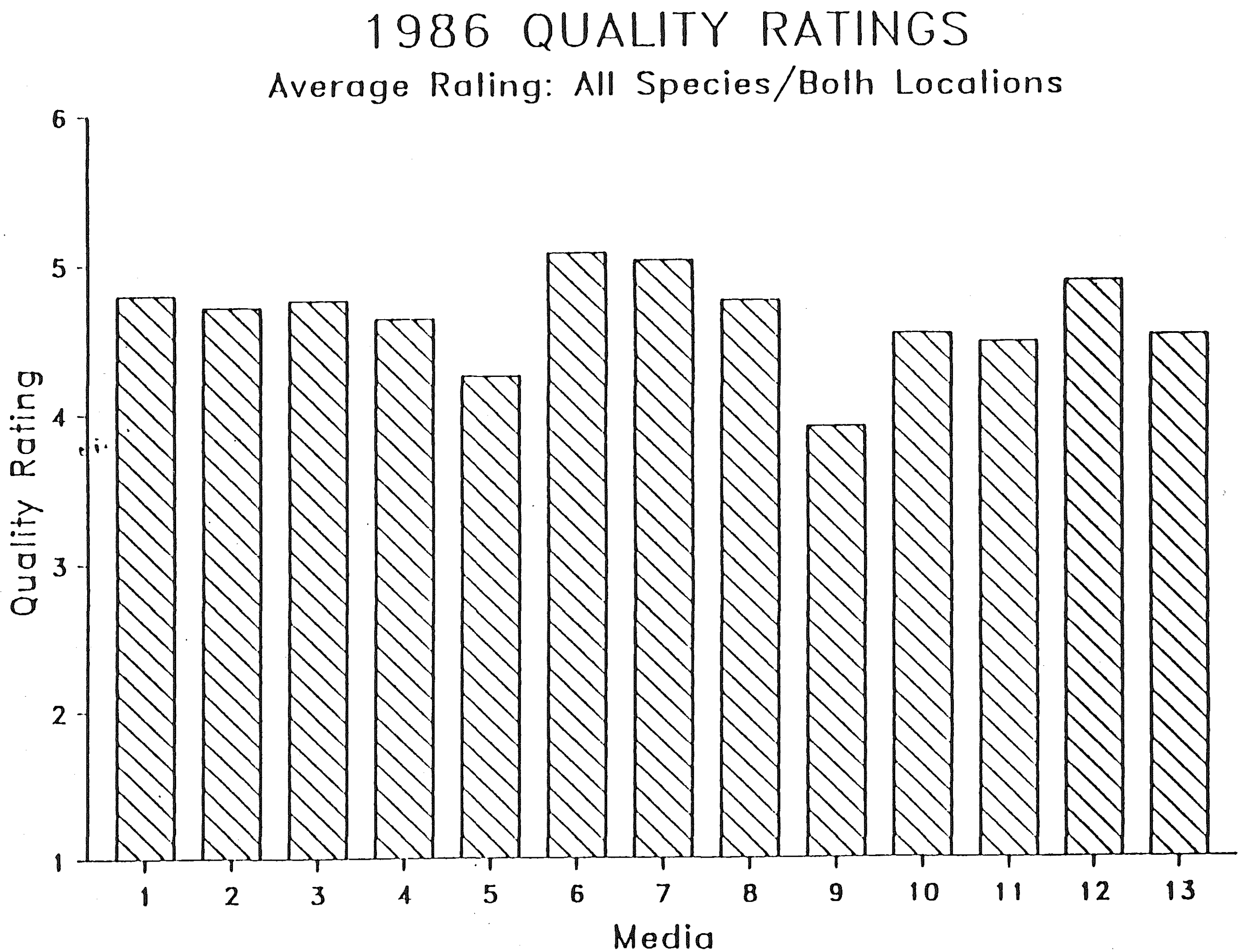


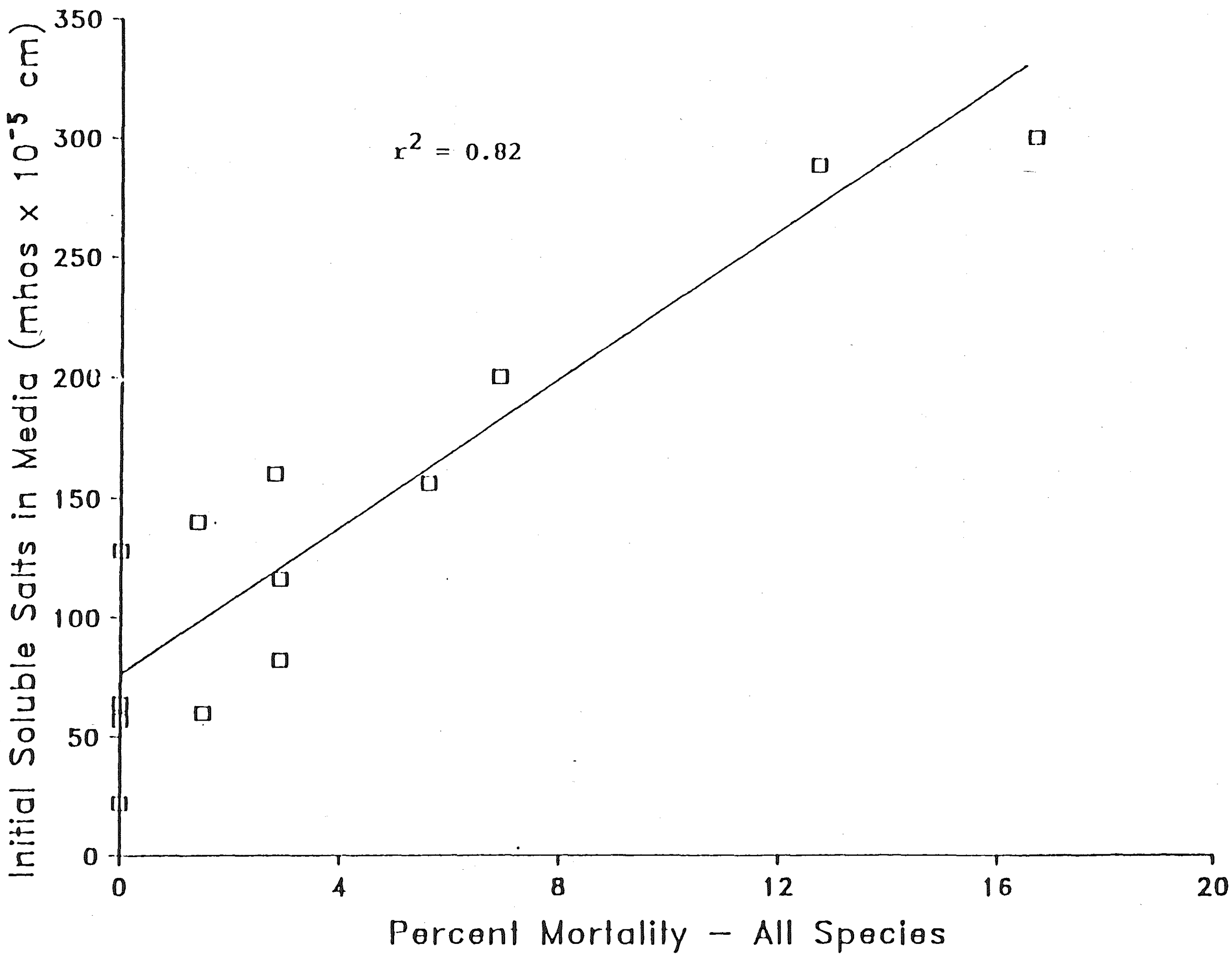
Figure 3. Qualitative Evaluation



The following scale was used:

6 - excellent
5 - good
4 - fair
3 - poor
2 - unusable
1 - dead

Figure 4. Relationship between plant mortality and initial soluble salt levels in media



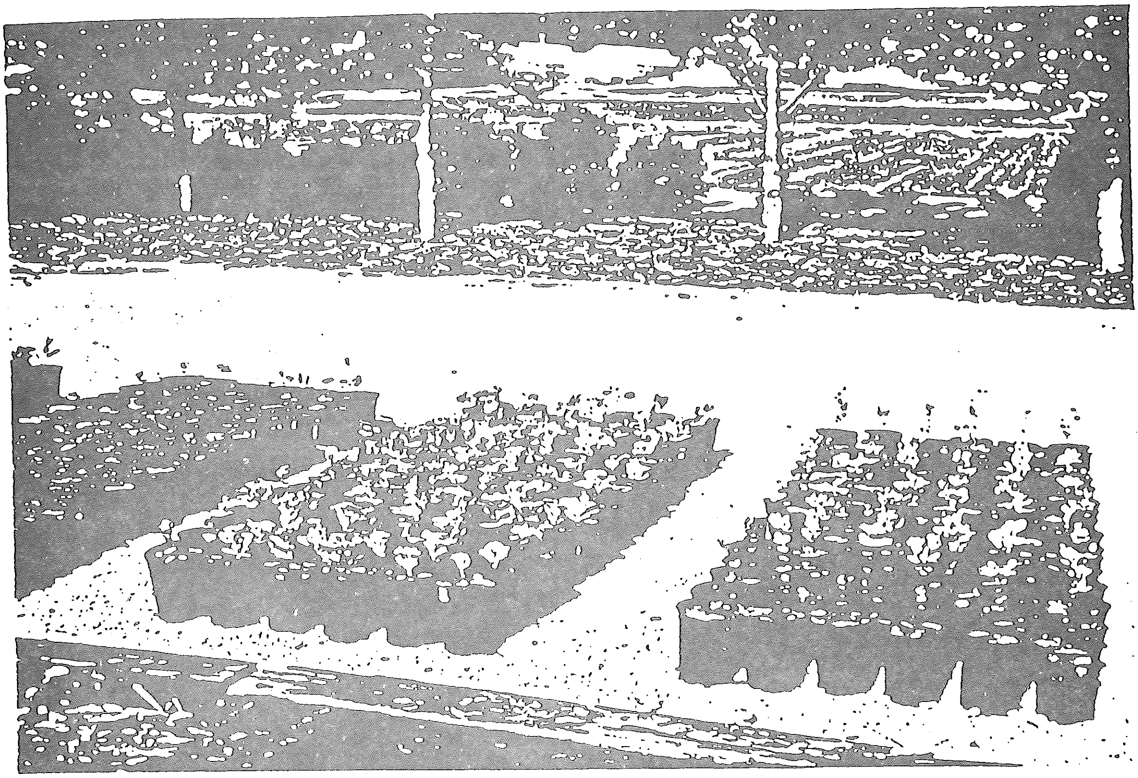


Figure 1a. Newly planted shurbs in the TRE Nursery on the St. Paul campus, June 1986.

Figure 1b. *Potentilla fruticosa* "Jackmanni" in the TRE Nursery in September 1986, after one growing season.

ATTACHMENT J

PERFORMANCE OF SOLID WASTE COMPOSTS AS AIDS IN ESTABLISHING VEGETATION ON A MARGINAL SOIL

This project was supported by the Legislative
Commission on Minnesota Resources and the
Metropolitan Council of the Twin Cities Area

INTRODUCTION

Roadsides, parklands, and soils requiring reclamation are often cited as appropriate areas for the use of composted waste products. Factors which contribute to the attractiveness of these options include:

1. The soils are often low in organic matter, highly compacted and in need of modification.

2. Food chain crops are not grown on these areas, thus there is less concern with potential contamination.

3. It may be possible to use large volumes of material at an individual site when compost is used as an amendment to or partial replacement for topsoil.

4. The sites are often located in or near metropolitan areas where transport costs would be low as compared to using compost on agricultural land.

In addition to these factors, in May of 1985 an executive order was issued by the Governor which directs public agencies to evaluate the use of compost and to give preference to the use of such materials if opportunities exist and if the materials meet specifications and are competitively priced.

Discussions concerning potential users of composted waste products have almost always included reference to the Minnesota Department of Transportation (MnDOT). It is often pointed out that the agency purchases large quantities of topsoil and peat for use on construction projects and that these materials might be replaced with compost products. This is certainly an over simplification which does not take into consideration MnDOT specifications for growing materials, the contractual nature of work performed and materials purchased for a large portion of highway construction, or equipment and handling variables in using a new material. However, it is true that very large quantities of topsoil, peat, and mulch are used annually by the Department. In 1985 for example, 120,000 cubic yards of topsoil were used on MnDOT projects. The average cost was about $7.00 per cubic yard which included delivery and placement. If compost could be shown to serve as a suitable replacement, partial replacement, or amendment for one or more of these materials it is conceivable that MnDOT could be a large consumer of compost products.

OBJECTIVES

This study, was undertaken in cooperation with the Minnesota Department of Transportation to evaluate the performance of solid waste composts as aids in establishing vegetation on a marginal soil along a highway right-of-way. Specific objectives include:

1. Observe the plant performance of a standard highway seed mix on a compost amended soil.

2. Determine changes in soil properties as a result of compost addition.

3. Determine plant uptake of trace metals from compost-amended soil as compared to non amended soil.

MATERIALS AND METHODS

The experimental site is located in Coon Rapids in the median area of State Highway 10. The soil type is a Sartell fine sand (mixed, frigid, Typic Udipsamment). Slope is 0 - 2 percent. The site has no recent fertilizer history. A composite soil sample (0 - 6" depth) was collected on September 26, 1986 prior to site preparation. Soil pH was 6.0, Brays phosphorus 103 pounds per acre, and potassium 99 pounds per acre. Organic matter level was low at 1.8 percent. The soluble salt level was 0.2 mmhos/cm.

Original vegetation at the site was sparse and consisted primarily of bromegrass, crabgrass, and artemesia. This vegetation was destroyed so that the experiment could be initiated on a barren soil. Roundup was applied on September 23 and again on October 1. Persistent broadleaves were spot treated with Trimec on October 8. On October 15 the entire area was roto-tilled to a depth of six inches.

The plot layout (Figure 1) consists of a randomized block design. Individual plots are five by ten feet. Compost (Table 1) was applied and incorporated on October 16. Three different compost types are included in the study: a solid waste compost, a yard waste compost and a composted turkey manure. Each material was spread at thicknesses of 0.5, 1.0, or 1.5 inches (Table 2). Treatments were replicated three times.

The experiment was dormant seeded on November 19 with highway mixture Number 5 (Table 3) at a rate equal to 50 pounds per acre according to MnDOT specifications. The seed was bulked with approximately 15 pounds of Milorganite and applied with a broadcast spreader over the entire test area. A non-woven polypropylene fabric cover was placed over the area and secured with wire staples to protect the seeding over the winter.

The site was checked at approximately two week intervals over the winter months. There was a lack of any significant snowfall throughout the entire winter. Because of this, the fabric was never securely weighted down as had been expected and was subjected to blowing winds. On several occasions, portions of the cover had been blown off - particularly on the east one-third of the test area. This became especially problematic in the spring after the soil had thawed. The very sandy soil at the site provided very poor anchorage for the wire staples.

Beginning March 15, the site was checked at approximately five day intervals. The cover was consistently blown off sections of the test area, the soil was extremely dry due to a lack of precipitation, and the surface showed evidence of scouring by the wind. Weeds began to germinate in mid-April. Observations were made on the types and distribution of weeds. There were some isolated spots where weed growth was most pronounced. However there was no relationship between those spots and the different treatments. The predominant weed species were lambsquarter, wooly alyssum, barnyard grass, and rough pigweed.

By the tenth of May, weeds were becoming well established and there was still no apparent germination of the seeded species. It was concluded that the seed had been lost and a decision was made to reseed the site.

On May 21, the site was prepared for reseeding. Weeds were hand pulled to prevent mixing of soils and composts amongst the different treatments. 12-12-12 (N-P-K) fertilizer was hand broadcast on the controls at a rate of 500 pounds per acre. The entire surface was scarified with a power rake and then reseeded using the same rate and methods as the initial seeding except that the cover was not applied and the surface was firmed using a lawn roller.

Germination at the site was first noted on June 1. At that time there were no obvious differences between treatments.

Weed growth and exceptionally hot, dry weather have continued to be problems at the site. On June 14 a decision was made to apply water to the site. Watering has been scheduled in an effort to simulate normal spring precipitation and to prevent total loss of the study rather than to create an artificial, irrigated situation.

Observations have continued at approximately three to four day intervals and will be carried out throughout the summer and fall of 1987 and, if necessary, into the 1988 growing season. Yield data and tissue samples will be collected when vegetation has become well established. Final results and discussion will be prepared at that time.

Table 1. Compostion of Composts

Characteristic	Compost Type: Yard Waste	Solid Waste	Turkey Manure
	----------%	----------	----------
Solids	67.7	61.7	43.5
Carbon	24.4	18.9	20.3
Nitrogen	1.09	1.36	1.88
Phosphorus	0.18	0.36	2.33
Potassium	0.40	0.86	1.41
Calcium	4.77	5.91	5.04
Magnesium	1.29	0.31	1.13
Sodium	0.02	0.43	0.28
Iron	0.41	0.76	0.31
Aluminum	0.17	1.18	0.21
	----------mg/kg	----------	----------
Manganese	696	372	756
Zinc	101	578	436
Copper	27	302	87
Lead	47	207	11
Chromium	6	47	8
Nickel	9	29	13
Boron	62	70	39
Cadmium	ND	3.3	0.5
pH (1:1)	8.2	7.5	6.4
Electrical conductivity (mmho/cm)	0.8	3.5	10.0

ND = Not detected

Table 2. Compost Application Rates

Compost Type	Appplication Rate	
	inches of material	dry tons per acre
Yard waste	0.5	20.3
	1.0	40.6
	1.5	60.9
Solid waste	0.5	21.5
	1.0	43.0
	1.5	64.5
Manure	0.5	15.3
	1.0	30.6
	1.5	45.9

Table 3. Minnesota Department of Transportation Highway Mix Number 5.

Species	Percentage
Park Kentucky Bluegrass (Poa pratensis)	40
Smooth Bromegrass (Bromus inermis)	14
Red Top (Agrostis alba)	6
Timothy (Phelum pratense)	8
Perennial Ryegrass (Lolium perene)	20
White Clover (Trifolium repens)	6
Birds Trefoil, Empire (Lotus corniculatus)	6

ATTACHMENT K

EVALUATION OF WASTE COMPOSTS AS COMPONENTS OF MEDIA FOR GREENHOUSE PRODUCTION

This project was supported by the Legislative Commission on Minnesota Resources and the Metropolitan Council of the Twin Cities Area

Evaluation of Waste Composts as Components of Media for Greenhouse Production

Bedding plant production in Minnesota is currently a ten million dollar per year wholesale business. Industry-wide, bedding plant production has been the steadiest, most consistently growing segment of the industry. Because of the large volume of this market and the steady demand for media, bedding plant producers may represent potential users of high quality composts.

The objective of this research is to evaluate the feasibility of composts as components of greenhouse media for production of bedding plants. Specific questions being addressed are:

Are composts feasible components of greenhouse media ?

What is the optimum rate of compost to include in media ?

How do the differences between composts influence their use in media ?

What is the ability of compost to supply nutrients to plants within the time frame utilized for bedding plant production ?

Three different composts are being used in this study: a whole waste stream compost produced by the in-vessel method in St. Cloud, Mn; a composted refuse derived fuel (RDF) process fraction produced in Thief River Falls, Mn.; and a poultry manure compost produced in Northfield, Mn. The latter two composts are both produced by the windrow method.

In order to evaluate the responses of plants with different nutrient requirements and tolerance to salts, three species are being used. These are tomato (salt tolerant), snapdragon (salt sensitive), and zinnia (intermediate between the two).

In the initial experiment, each compost was mixed with a 1:1 mixture of peat and perlite at rates of 10, 20, 30, and 50% of the total mix. Plants were either seeded or transplanted into these mixtures and grown in the greenhouse (Figure 1). Based on growth data collected at two week intervals, dry weights collected at the end of the growth period, and toxicity and deficiency symptoms, appropriate mixture ratios will be selected for each compost. Growth trials will then be conducted using different fertilizer treatments. Comparisons of rate and amount of growth, as well as tissue analysis to determine levels of plant nutrients present, will be used to evaluate the nutrient contributions of compost to the media. Results of the first experiment indicate major differences in plant response to the various media (Figure 2).

This study will help to identify the appropriate uses of composts in greenhouse media, as well as to evaluate their potential as a nutrient source for rapidly growing plant species.

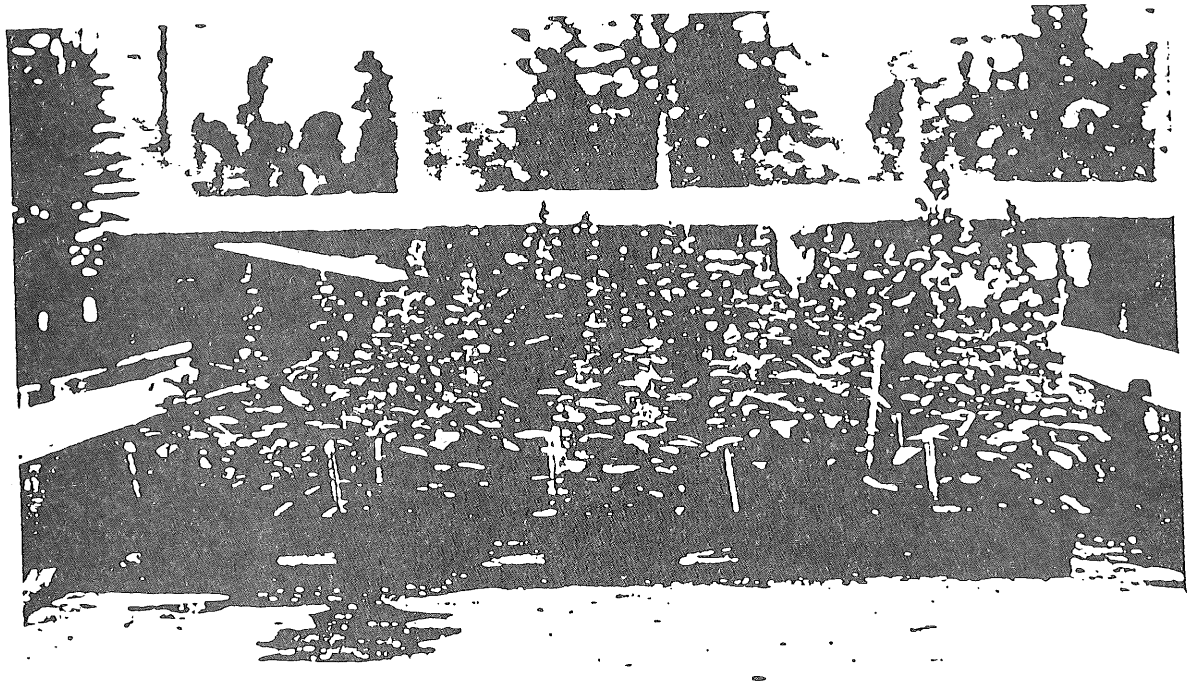


Figure 1. Snapdragons growing in compost mixes in the greenhouse.

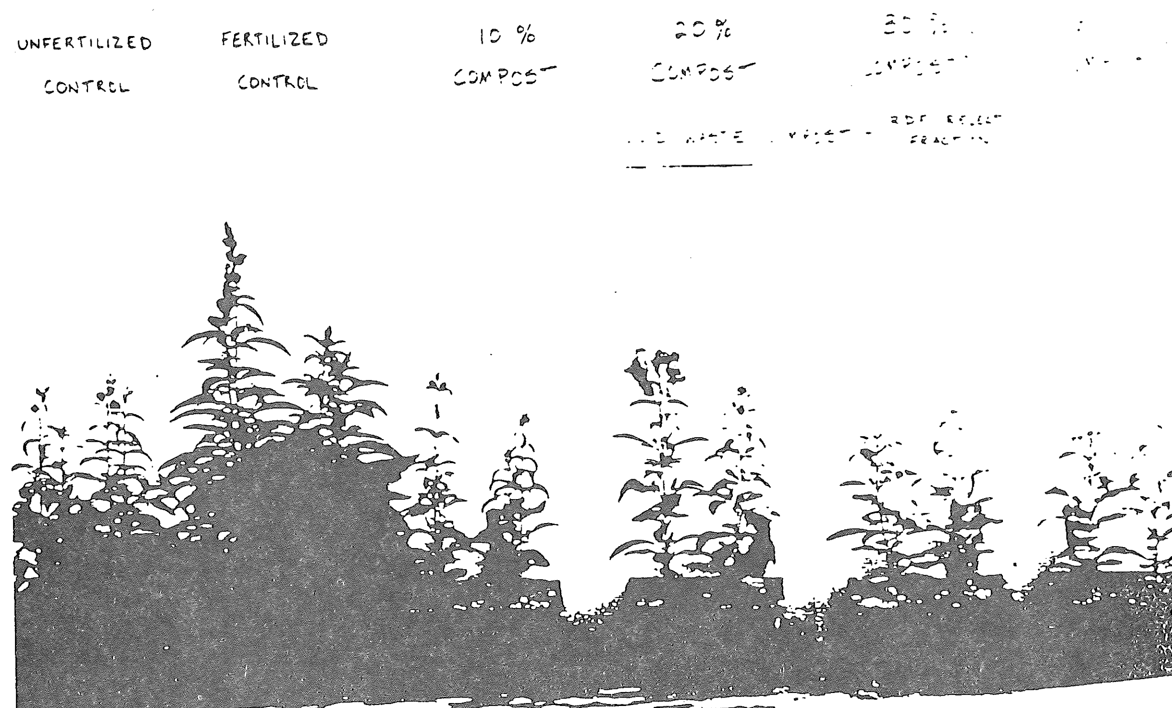


Figure 2. Size differences in snapdragons grown in control mixes and four rates of RDF compost.

APPENDIX XVII.

COST ESTIMATES FOR FIVE DISPOSAL FACILITY MODELS

SOLID WASTE RULES PROGRAM SUMMARY

STAFFING:

THREE FULL-TIME PROFESSIONAL STAFF (ECONOMIST, ENGINEER, HYDROGEOLOGIST) ARE INVOLVED IN THE RULEMAKING PROCESS. ADDITIONAL STAFF WERE INITIALLY INVOLVED WITH, GENERALLY SPEAKING, THESE STAFF HAVING BEEN REASSIGNED TO WORK ON THE RULE DEVELOPMENT FROM SOLID WASTE AND OTHER PROGRAM IMPLEMENTATION AREAS.

RULE PROCESS:

THE RULE REVISION PROCESS IS PRESENTLY ENTERING ITS FOURTH YEAR. IT IS ANTICIPATED FINAL RULES WILL BE ADOPTED IN THE SUMMER OF 1987.

THE PROCESS HAS BEEN FOUR YEARS LONG DUE TO THE LENGTH AND COMPLEXITY OF THE RULES AND EFFORTS TO OBTAIN PUBLIC INPUT. THE RULE AMENDMENTS WERE DEVELOPED TO ADDRESS PERMIT, DESIGN AND OPERATIONAL CONCERNS AT MIXED MUNICIPAL SOLID WASTE LANDFILLS, DEMOLITION DEBRIS WASTE LANDFILLS, COMPOST FACILITIES, TRANSFER FACILITIES, REFUSE-DERIVED FUEL PROCESSING FACILITIES AND SOLID WASTE STORAGE.

THE AMOUNT OF MATERIAL INCLUDED IN SUCH AN ALL-ENCOMPASSING SET OF RULES REQUIRES CONSIDERABLE TIME IN BACKGROUND RESEARCH, LANGUAGE DEVELOPMENT, AND DEFINING REGULATORY IMPACTS.

PUBLIC INVOLVEMENT WAS CONSIDERED CRITICAL TO THE DEVELOPMENT OF THE RULE AMENDMENTS. PRIOR TO DRAFTING ANY LANGUAGE 15 MEETINGS WERE HELD IN 1983 TO DETERMINE WHAT WERE THE CONCERNS OF LOCAL GOVERNMENTAL OFFICIALS, THE SOLID WASTE INDUSTRY, AND OTHER INTERESTED PARTIES. DRAFT LANGUAGE WAS WRITTEN AND COMMENTS SOLICITED DURING 1984 AND 1985. EIGHT MEETINGS AROUND THE STATE WERE HELD ON THE FINANCIAL ASSURANCE SECTION OF THE RULES AND AN ADDITIONAL 18 MEETINGS ON THE ENTIRE SET OF DRAFT RULES. BASED ON THE COMMENTS RECEIVED DURING THIS TIME REVISIONS WERE MADE TO THE DRAFT. IN 1986 THE REVISED DRAFT RULES WERE DISTRIBUTED FOR COMMENTS AND SIX MORE MEETINGS WERE HELD AROUND THE STATE TO EXPLAIN THESE REVISIONS. THE PROCESS OF ACCEPTING PUBLIC COMMENT AND MAKING REVISION TO ADDRESS THESE CONCERNS REQUIRES A SUBSTANTIAL COMMITMENT OF TIME AND STAFF RESOURCES TO THE RULEMAKING PROCESS.

RULE GOALS AND OBJECTIVES:

THE DOCUMENTATION OF GROUND WATER POLLUTION AT LANDFILLS DUE TO THE IMPROPER DISPOSAL OF HAZARDOUS WASTE AT SOME FACILITIES AND THE IMPROPER LOCATION OF OTHERS SHOWED THAT THE EXISTING RULES ARE INADEQUATE IN PROTECTING THE ENVIRONMENT. FEW EXISTING LANDFILLS WERE SITED OR CONSTRUCTED FOR CONTAINMENT OF LEACHATE. THE RESULTING GROUND WATER POLLUTION HAS BEGUN TO EXACT LARGE COSTS. THESE INCLUDE THE COSTS OF CONTAINING AND TREATING GROUND WATER, AND IN SOME CASES, PROVISION OF ALTERNATIVE WATER SUPPLIES AND REQUIRING THE INSTALLATION OF PUBLIC WATER SUPPLY SYSTEMS TO REPLACE PRIVATE WELLS. THE MOVE TOWARDS ALTERNATIVE WASTE MANAGEMENT SYSTEMS HAS REQUIRED THE DEVELOPMENT OF STANDARDS IN THESE AREAS ALSO.

THE ULTIMATE GOAL OF THE RULE AMENDMENTS IS ADEQUATE PROTECTION OF THE ENVIRONMENT. THE NECESSITY FOR THE CONSTRUCTION OF LEACHATE CONTAINMENT AND TREATMENT SYSTEMS IS APPARENT AND IS ONE OF THE MAIN OBJECTIVES OF THE RULE REVISION PROCESS. THIS NEED ARISES BECAUSE:

- VOLATILE ORGANIC CHEMICALS HAVE BEEN FOUND IN DOWNGRADIENT WELLS AT 60 OF 61 LANDFILLS TESTED.

- OF 133 PERMITTED MIXED MUNICIPAL SOLID WASTE LANDFILLS:

  - 41 ARE ON THE STATE SUPERFUND LIST (7 MORE PROPOSED).

  - 8 ARE ON THE NATIONAL PRIORITIES LIST (4 MORE PROPOSED).

ONE ADDITIONAL OBJECTIVE OF THE RULE REVISION PROCESS IS THE ESTABLISHMENT OF FINANCIAL ASSURANCE REQUIREMENTS FOR LANDFILL OWNERS. IN THE PAST, LANDFILL OPERATORS HAVE EITHER ABANDONED THE DISPOSAL SITE WITHOUT COMPLETING, AS A MINIMUM, CLOSURE ACTIVITIES OR HAVE NOT BEEN FINANCIALLY ABLE TO ENSURE PROPER CLOSURE AND POSTCLOSURE CARE AND ANY NECESSARY CONTINGENCY ACTION TO ADDRESS CONTAMINATION EVENTS. NO FUNDS WERE AVAILABLE TO COMPLETE THE ACTIVITIES NEEDED TO MINIMIZE ENVIRONMENTAL IMPACTS AFTER CLOSURE. THEREFORE, IT WAS NECESSARY TO REQUIRE THE ESTABLISHMENT OF FUNDS TO BE HELD IN TRUST BY A THIRD PARTY TO ENSURE CLOSURE, POSTCLOSURE AND CONTINGENCY ACTIONS WERE COMPLETED. THE 1984

STATE LEGISLATURE AGREED WITH THIS APPROACH, AND PASSED THE 1984 AMENDMENTS TO THE WASTE MANAGEMENT ACT REQUIRING FINANCIAL ASSURANCE.

PROGRAM GOALS:

UPON COMPLETING THE RULE REVISION PROCESS, THE MPCA INTENDS TO WORK WITH THE SOLID WASTE INDUSTRY IN THE DEVELOPMENT OF A PROGRAM THAT ADEQUATELY PROTECTS THE ENVIRONMENT.

THROUGH THE PERMITTING PROCESS AND TECHNICAL ASSISTANCE, LANDFILLS WILL BE DESIGNED, CONSTRUCTED, AND OPERATED TO CONTAIN LEACHATE AND GAS MIGRATION. THE GROUND WATER MONITORING PROGRAM WILL PROVIDE FOR EARLY DETECTION OF ANY LEAKAGE FROM THE CONTAINMENT SYSTEM AND ALLOW FOR EARLY INITIATION OF CORRECTIVE ACTIONS AND ASSOCIATED COSTS.

ADEQUATE RISK MANAGEMENT IS THE OVERRIDING PROGRAM GOAL. RISK MANAGEMENT CAN BE ACCOMPLISHED IN MANY WAYS:

- ADEQUATE FINANCIAL MEANS FOR PROPER OPERATION;

- DESIGN AND CONSTRUCTION TO MINIMIZE POLLUTANT MOVEMENT INTO THE ENVIRONMENT;

- ESTABLISHMENT OF PERFORMANCE STANDARDS FOR PROTECTION OF THE ENVIRONMENT; AND

- THE USE OF ALTERNATIVE MANAGEMENT TECHNIQUES THAT HAVE LOW POTENTIAL FOR ENVIRONMENTAL IMPACTS.

OPERATOR TRAINING AND PUBLIC EDUCATION ARE VITAL TO THE REALIZATION OF MINIMIZED ENVIRONMENTAL RISKS FROM SOLID WASTE MANAGEMENT.

MAJOR RULE REQUIREMENTS:

FINANCIAL ASSURANCE:

DEVELOPMENT OF CLOSURE, POSTCLOSURE CARE AND CONTINGENCY ACTION COST ESTIMATES BASED ON ASSOCIATED ENGINEERING PLANS;

ESTIMATED COSTS FOR A "TYPICAL" MINNESOTA LANDFILL WITH 25 ACRES OF FILL AREA WOULD BE SIMILAR TO:

- CLOSURE	\$292,000-\$626,000 (MEMBRANE CAP TO CLAY 20 MILES AWAY).
- POSTCLOSURE	\$18,300-\$75,100/YR (NO LEACHATE COLLECTION TO LEACHATE COLLECTION).
- CONTINGENCY ACTION	\$200,000-\$2,101,993 CAPITAL COSTS (REMEDIAL INVESTIGATION TO ALTERNATIVE WATER SUPPLY)
	\$2,000-\$100,000/YR OPERATIONAL COSTS

ESTABLISHMENT OF SET ASIDE FUNDS SECURED BY A THIRD PARTY AND NAMING MPCA AS BENEFICIARY.

- 6 MONTHS AFTER RULES EFFECTIVE FOR FACILITIES WITH MORE THAN 5 YEARS OR 500,000 CUBIC YARDS REMAINING CAPACITY.

- 12 MONTHS FOR ALL OTHER FACILITIES.

FIRST PAYMENT INTO FUNDS FOR ALL FACILITIES 12 MONTHS AFTER RULES EFFECTIVE.

ESTABLISHMENT OF 3 ACCEPTABLE FINANCIAL INSTRUMENTS: TRUST FUNDS, SURETY BONDS AND LETTERS OF CREDIT.

ESTABLISHMENT OF AN ABILITY-TO-PAY TEST TO DETERMINE THE AFFORDABILITY OF THE FINANCIAL ASSURANCE REQUIREMENTS ON ANY ONE FACILITY OWNER. THE TEST IS BASED ON THE CASH FLOW ABILITIES OF PRIVATE SECTOR PERMITTEES AND THE PER CAPITA INCOME FOR PUBLIC SECTOR PERMITTEES. IF THE COST CANNOT BE MADE AFFORDABLE BY ADJUSTING THE PAY-IN PERIOD OR ANOTHER MEANS, THE RULES PROVIDE FOR CLOSURE OF THE LANDFILL.

<u>GROUND WATER MONITORING AND PERFORMANCE STANDARDS</u>:

ESTABLISHMENT OF GROUND WATER STANDARDS.

- 25 PERCENT OF DRINKING WATER LIMITS.

- ENFORCED AT COMPLIANCE BOUNDARY.

- INTERVENTION WHEN CONTAMINATION IS DETECTED, BEFORE STANDARDS ARE EXCEEDED. IF CONTAMINATION IS DETECTED, THE PERMITTEE MUST NOTIFY THE MPCA, EVALUATE THE NEED FOR IMMEDIATE RESAMPLING, EVALUATE THE NEED FOR IMPLEMENTING CONTINGENCY ACTION PLAN AND EVALUATE THE NEED TO MODIFY THE MONITORING SYSTEM INCLUDING NUMBER AND FREQUENCY OF POINTS SAMPLED.

- EXISTING FACILITIES CAN DEVELOP A CASE FOR LESS RESTRICTIVE STANDARDS.

ESTABLISHMENT OF COMPLIANCE BOUNDARIES.

- SURROUNDS DISPOSAL AREA AND LEACHATE MANAGEMENT SYSTEM.

- MAXIMUM DISTANCE OF 200 FEET FROM WASTE BOUNDARY (POSSIBLY 500 FEET FOR EXISTING FACILITIES).

ESTABLISHMENT OF MONITORING PROGRAM.

- VOLATILE ORGANIC CHEMICALS MONITORED 3 TIMES EACH YEAR.

- ADDITIONAL INORGANIC CHEMICALS MONITORED ONCE PER YEAR.

- DETECTION MONITORING NEAR WASTE BOUNDARY; IF POLLUTANTS FOUND, PLUME IDENTIFICATION.

- QUALITY ASSURANCE/QUALITY CONTROL FOR SAMPLING AND ANALYSES.

LANDFILL DESIGN/CONSTRUCTION:

ESTABLISHMENT OF MINIMUM LINER STANDARDS.

- NO LINER REQUIRED ON VERTICAL EXPANSION.

- LINER REQUIRED ON HORIZONTAL EXPANSION AND NEW SITES. EXISTING SITES MAY RECEIVE UP TO 18 MONTHS DELAY.

- CONTAIN LEACHATE FOR COLLECTION AND TREATMENT.

- COLLECTION LYSIMETER BELOW LINER TO MONITOR LINER INTEGRITY.

- THICKNESS (4 FEET CLAY, 60 MIL SYNTHETIC).

- PERMEABILITY (1×10^{-7} CM/SEC). THIS WOULD MEAN 39 YEARS FOR A DROP OF WATER TO MOVE THROUGH THE 4 FEET OF CLAY ON A THEORETICAL BASIS. THIS ASSUMES SATURATED FLOW AND NO NEGATIVE PRESSURES ACTING ON THE WATER. UNDER REAL CONDITIONS, FLOW WOULD BE MUCH FASTER.

ESTABLISHMENT OF COLLECTION/TREATMENT STANDARDS.

- COLLECT 90 PERCENT OF PRECIPITATION INFILTRATION COVER.

- OVERALL SYSTEM EFFICIENCY OF 98.5 PERCENT OF PRECIPITATION FALLING ON THE FILL AREA.

- LEACHATE DETECTION SYSTEM.

- COLLECTION CLEAN-OUT SYSTEM.

- ON- OR OFF-SITE TREATMENT SYSTEM COMPLY WITH NPDES DISCHARGE STANDARDS.

ESTABLISHMENT OF MINIMUM FINAL COVER STANDARDS.

- LESS STRINGENT STANDARDS FOR FACILITIES CLOSING WITHIN 18 MONTHS OF DATE RULES EFFECTIVE (LESS MATERIAL, LOWER SLOPES).

- DRAIN OR RETAIN 90 PERCENT OF PRECIPITATION FALLING ON SYSTEM.

- BARRIER SYSTEM TO MINIMIZE INFILTRATION AND AMOUNT OF LEACHATE ULTIMATELY GENERATED.

- BARRIER LAYER (24 INCHES CLAY, 30 MIL SYNTHETIC);

  DRAINAGE LAYER (6 INCHES SAND);

  COVER LAYER (18 INCHES OF WHICH 6 INCHES IS TOPSOIL).

<u>OTHER STANDARDS</u>:

- GAS DETECTION/VENTILATION STANDARDS.

- CONSTRUCTION CERTIFICATION PROGRAM (DETAILED INSPECTION/DOCUMENTATION).

- OPERATION.

- CLOSURE/POSTCLOSURE CARE/CONTINGENCY ACTION.

- HYDROGEOLOGIC EVALUATION.

- LOCATION.

TIPPING FEES:

EXISTING TIPPING FEES VARY FROM ZERO FOR COUNTY-OWNED LANDFILLS SUBSIDIZED BY PROPERTY TAXES TO A RANGE OF $1.50 to $10.00 PER CUBIC YARD AT FACILITIES USING A TIPPING FEE.

BASED ON REVISED RULES, TIPPING FEES WOULD NEED TO INCREASE TO PROVIDE FOR CLOSURE/POSTCLOSURE CARE/CONTINGENCY COSTS AS WELL AS THE LINER/COVER DESIGN CHANGES AND MONITORING CHANGES.

AS AN EXAMPLE, A 45-ACRE FILL AREA (ON A 100 ACRE PROPERTY) WOULD RESULT IN THE FOLLOWING TIPPING FEE (EXCLUDING PROFIT, LOCAL CHARGES).

		COST	COST/YD^3
I.	CLOSURE (ASSUME ON-SITE CLAY)	$ 1,178.260.00	$ 0.46
II.	POSTCLOSURE CARE (INCLUDES LEACHATE TREATMENT)	$ 4,838,700.00*	$ 1.90
III.	CONTINGENCY ACTION CAPITAL	$ 1,481,270.00	$ 0.58
	OPERATION	$ 1,291,020.00**	$ 0.51
IV.	LINER/LEACHATE COLLECTION	$ 5,072,800.00	$ 2.00
V.	OPERATIONS (INCLUDES MONITORING, LEACHATE TREATMENT)	$15,448,400.00***	$ 6.08
VI.	OTHER SITE CAPITAL COSTS (INCLUDES HYDROGEOLOGIC STUDY)	$ 681,300.00	$ 0.27
		TOTAL TIPPING FEE	$11.80/YD^3

* ASSUMES 20-YEAR POSTCLOSURE CARE PERIOD @ $241,940/YR
** ASSUMES 20-YEAR CONTINGENCY PERIOD @ $64,550/YR
*** ASSUMES 42-YEAR OPERATING LIFE @ $367,820/YR

THE FOLLOWING ASSUMPTIONS SHOULD BE RECOGNIZED IN EVALUATING THE TIPPING FEE OF $11.80/YD^3:

1. ASSUMES A NEW SITE WITH SUFFICIENT TIME TO COLLECT FUNDS.

2. DOES NOT ACCOUNT FOR INFLATION, EARNINGS OF SET-ASIDE FUNDS, OR THE FACT THAT COSTS DECREASE OVER TIME DUE TO STABILIZATION OF THE FILL.

3. CONTINGENCY ACTION COSTS ARE VERY SITE-SPECIFIC AND COULD COST CONSIDERABLY MORE THAN ESTIMATED.

4. COST ESTIMATES ARE BASED ON VALUES RECEIVED ON PROJECT BIDS AND ENGINEERING ESTIMATES.

EXISTING LANDFILL A

ORIGINALLY 20 ACRE FILL ON A 25 ACRE PARCEL.

THE SITE HAS BEEN IN OPERATION 15 YEARS WITH 5 YEARS (121,000 YD^3) REMAINING LIFE.

THERE ARE 5 ACRES TO BE FILLED.

FINAL COVER HAS BEEN PLACED ON 10 ACRES.

TWO MONITORING WELLS EXIST AT THE SITE.

			COST	COST/YD^3
I.	CLOSURE (10-MILE HAUL)		$ 350,000.00	$ 2.90
II.	POSTCLOSURE CARE (INCLUDES LEACHATE TREATMENT)		$ 820,000.00*	$ 6.80
III.	CONTINGENCY ACTION	CAPITAL	$ 1,481,000.00	$12.30
		OPERATION	$ 1,291,000.00*	$10.70
IV.	LINER/LEACHATE COLLECTION		$ 653,000.00	$ 5.40
V.	OPERATIONS (INCLUDES MONITORING, LEACHATE TREATMENT)		$ 425,000.00	$ 3.50
VI.	OTHER SITE CAPITAL COSTS (INCLUDES HYDROGEOLOGIC STUDY)		$ 193,000.00	$ 1.60
			TOTAL TIPPING FEE	$43.20/$YD^3$

* ASSUMES POSTCLOSURE PERIOD OF 20 YEARS @ $41,000/YR
CONTINGENCY PERIOD OF 20 YEARS @ $64,550/YR

THIS COST COULD BE REDUCED NOTICABLY IF A VARIANCE WERE GIVEN ON THE NEED FOR A LINER/LEACHATE COLLECTION SYSTEM.

LANDFILL A ON A VOLUME BASIS WOULD REPRESENT EXISTING LANDFILLS SUCH AS:

1. MAPLE
2. FARIBAULT COUNTY
3. ROCK COUNTY
4. RENVILLE COUNTY (ONLY ONE PROJECTED TO CLOSE IN ABOUT 5 YEARS)
5. LINDALA

EXISTING LANDFILL B
("TYPICAL" MINNESOTA LANDFILL)

ORIGINALLY 20 ACRE FILL AREA ON 25 ACRE PARCEL.

OPERATING 15 YEARS REMAINING CAPACITY FOR 12 YEARS (356,400 YD^3).

ACCEPTS 29,000 YD^3 EACH YEAR.

THERE ARE 11 ACRES TO BE FILLED.

FINAL COVER PLACED ON 5 ACRES.

TWO MONITORING WELLS EXIST AT SITE.

			COST	COST/YD^3
I.	CLOSURE (10-MILE HAUL)		$ 495,000.00	$ 1.39
II.	POSTCLOSURE CARE (INCLUDES LEACHATE TREATMENT)		$ 1,502,000.00*	$ 4.21
III.	CONTINGENCY ACTION	CAPITAL	$ 1,481,000.00	$ 4.20
		OPERATION	$ 1,291,000.00*	$ 3.62
IV.	LINER/LEACHATE COLLECTION		$ 1,534,000.00	$ 4.30
V.	OPERATIONS (INCLUDES MONITORING, LEACHATE TREATMENT)		$ 1,619,760.00	$ 4.54
VI.	OTHER CAPITAL COSTS (INCLUDES HYDROGEOLOGIC STUDY)		$ 221,000.00	$ 0.62
			TOTAL TIPPING FEE	$23.00/$YD^3$

* POSTCLOSURE PERIOD OF 20 YEARS @ $75,100/YR
CONTINGENCY PERIOD OF 20 YEARS @ $64,500/YR

LANDFILL B ON A VOLUME BASIS WOULD REPRESENT LANDFILLS SUCH AS:

1. IRON RANGE
2. KORF BROTHERS
3. RED WING
4. KANABEC
5. NORTHWOODS

EXISTING LANDFILL C

ORIGINALLY 50 ACRE FILL ON 70 ACRE PARCEL.

THE SITE HAS BEEN OPERATING 10 YEARS AND HAS 20 YEARS (1,411,700 YD^3) OF REMAINING CAPACITY.

THERE ARE 35 ACRES TO BE FILLED.

FINAL COVER HAS BEEN PLACED ON 10 ACRES.

THREE MONITORING WELLS EXIST AT SITE.

			COST	COST/YD^3
I.	CLOSURE (10-MILE HAUL)		$ 1,307,000.00	$ 0.93
II.	POSTCLOSURE CARE (INCLUDES LEACHATE TREATMENT)		$ 3,856,000.00*	$ 2.73
III.	CONTINGENCY ACTION	CAPITAL	$ 1,481,000.00	$ 1.05
		OPERATION	$ 1,291,000.00*	$ 0.92
IV.	LINER/LEACHATE COLLECTION		$ 5,639,000.00	$ 3.99
V.	OPERATIONS (INCLUDES MONITORING, LEACHATE TREATMENT)		$ 6,329,600.00	$ 4.48
VI.	OTHER CAPITAL COSTS (INCLUDES HYDROGEOLOGIC STUDY)		$ 257,000.00	$ 0.18
			TOTAL TIPPING FEE	$14.28/$YD^3$

* POSTCLOSURE PERIOD OF 20 YEARS @ $192,800/YR
CONTINGENCY PERIOD OF 20 YEARS @ $64,500/YR

LANDFILL C ON A VOLUME BASIS WOULD REPRESENT LANDFILLS SUCH AS:

1. POLK COUNTY
2. LINDENFELSER
3. GREATER MORRISON
4. BECKER COUNTY

EXISTING LANDFILL D

CAPACITY BASED ON CERTIFICATE OF NEED (CON).

HAS BEEN OPERATING 10 YEARS RECEIVES CON FOR 10 YEARS.

HAS FILLED 10 ACRES OF WHICH 5 ACRES HAS BEEN COVERED.

WILL FILL 10 MORE ACRES DURING CON PERIOD.

FILL CAPACITY FOR NEXT 10 YEARS EQUALS 242,000 CUBIC YARDS.

			COST	COST/YD^3
I.	CLOSURE (10-MILE HAUL)		\$ 508,900.00	\$ 2.10
II.	POSTCLOSURE CARE (INCLUDES LEACHATE TREATMENT)		\$ 1,334,000.00*	\$ 5.51
III.	CONTINGENCY ACTION	CAPITAL	\$ 1,481,000.00	\$ 6.12
		OPERATION	\$ 1,291,000.00*	\$ 5.33
IV.	LINER/LEACHATE COLLECTION (10-MILES HAUL)		\$ 1,169,000.00	\$ 4.83
V.	OPERATIONS (INCLUDES MONITORING, LEACHATE TREATMENT)		\$ 1,253,800.00	\$ 5.18
VI.	OTHER CAPITAL COSTS (INCLUDES HYDROGEOLOGIC STUDY)		\$ 203,400.00	\$ 0.84
			TOTAL TIPPING FEE	\$29.90/YD^3

* POSTCLOSURE CARE PERIOD OF 20 YEARS @ \$66,700/YR
CONTINGENCY ACTION PERIOD OF 20 YEARS @ \$64,500/YR

SOLID WASTE OPERATOR TRAINING PROGRAM

STAFFING:

TWO FULL TIME PROFESSIONAL STAFF TO ESTABLISH SEMINAR PROGRAM.

OTHER STAFF INVOLVEMENT FOR SEMINAR PRESENTATIONS AND TRAINING COURSES.

SUMMARY OF ACTIVITIES:

CURRENT PROGRAM DIRECTED TOWARDS THE TRAINING OF LANDFILL OPERATORS IN THE PRINCIPLES AND OBJECTIVES GOVERNING ENVIRONMENTALLY-SOUND WASTE MANAGEMENT.

THE OPERATORS ARE CERTIFIED BASED ON EXPERIENCE AND TRAINING RECEIVED.

THREE 2½-DAY TRAINING COURSES ARE SPONSORED BY THE MINNESOTA POLLUTION CONTROL AGENCY (MPCA) ANNUALLY WITH ONE 2-DAY CONFERENCE FOR GENERAL DISCUSSIONS ON SOLID WASTE MANAGEMENT.

UPON FINALIZATION OF THE SOLID WASTE RULE AMENDMENTS, THE TRAINING PROGRAM WILL BE EXPANDED TO INCLUDE OTHER MANAGEMENT FACILITIES SUCH AS COMPOST AND REFUSE-DERIVED FUEL PROCESSING FACILITIES. ADDITIONALLY, AS THE RULES WILL

REQUIRE THE OPERATORS' INCREASED AWARENESS OF INDUSTRIAL WASTE MANAGEMENT AND SUCH DESIGN FEATURES AS GAS AND LEACHATE COLLECTION SYSTEMS, THESE AREAS OF THE EXISTING TRAINING COURSES WILL BE EXPANDED.

IOWA INVOLVEMENT:

THE MPCA HAS ASSISTED IN THE PRESENTATION OF TRAINING COURSES TWICE IN IOWA FOR OPERATORS AND INSPECTORS. APPROXIMATELY 100 PERSONS RECEIVED TRAINING AT THESE COURSES. ABOUT A HALF DOZEN HAVE ALSO TAKEN THE MINNESOTA CERTIFICATION EXAM AND ARE CERTIFIED TO OPERATE LANDFILLS IN MINNESOTA.

THE COURSES WERE HELD ON NOVEMBER 1-2, 1984 AND APRIL 15-16, 1986 AT FORT DODGE AND DES MOINES, IOWA, RESPECTIVELY.

THE MPCA EXPECTS TO CONTINUE TO WORK WITH THE IOWA SOCIETY OF SOLID WASTE OPERATORS IN THE DEVELOPMENT OF THEIR TRAINING PROGRAM.

APPENDIX XVIII.

THE MINNESOTA FORECASTING AND SIMULATION MODEL (MNFS-53)

FEATURE ARTICLE

THE MINNESOTA FORECASTING AND SIMULATION MODEL (MNFS53): A TOOL FOR POLICY ANALYSIS

Carolyn I. Allmon
Economics/Collections/Forecasting
Special Taxes Section

I. Introduction

The Department of Revenue purchased the Minnesota Forecasting and Simulation model (MNFS53) in 1981 from Regional Economic Models Incorporated of Amherst, Massachusetts, a firm headed by George I. Treyz, professor of Economics at the University of Massachusetts. The purpose of this article is to acquaint our readers with the model's theoretical base and its capability for policy analysis.

The model divides Minnesota's economic activity into 53 sectors, 49 of them industrial (based on Standard Industrial Classifications), three of them government, and the farm sector. See Table 1 on page 4.

The model produces annual calendar year baseline forecasts for key economic indicators including employment, personal income and gross state product to the year 1995. Then, through the use of more than 800 regular policy variables and 58 "translator" policy variables, it can simulate the effect of economic changes in the state. The difference between the control (baseline) forecast and the simulation forecast is the impact on the economy of the policy change. The control forecast, simulation forecast, or the difference between the two can be printed at the request of the person running the simulation.

Under the terms of the annual contract which the Department has with REMI, annual data updates, telephone consulting services and new model developments are received. New developments expected later this summer include a forecast extension to the year 2035 and a capability to model U.S policy changes. The effect of these changes on the national economy can in turn be input to the Minnesota portion of the model, thereby simulating the effect of a change in U.S. policy on Minnesota's economy.

The model currently is run interactively on the University of Minnesota's CYBER computer by Tax Research Division personnel, as well as by personnel in the Department of Trade and Economic Development, Department of Natural Resources, Pollution Control Agency, Housing Finance Agency and Senate Research.

In the following sections of this article, the model will be described in greater detail: its theoretical foundation and data base in Section II, its modeling and forecasting capabilities in Section III. Applications of the model in the Tax Research Division will be discussed in Section IV. An example will be presented in Section V.

II. MODEL DESCRIPTION: THEORETICAL FOUNDATION AND DATA BASE

All of the regional models built by George Treyz and his associates have as their basis the TFS modeling methodology (named after its developers, George I. Treyz, Ann F. Friedlaender and Benjamin H. Stevens). Treyz and Stevens explained the methodology in an article titled "The TFS Regional Modeling Methodology" which appeared in Regional Studies in 1985 (Vol. 19.6). Upcoming paragraphs in this section will draw from that article to summarize the methodology.

> The Treyz, Friedlaender, Stevens (TFS) regional (i.e. subnational) modeling approach represents an alternative to

Sectors Used in the Forecasting and Simulation Model

TABLE 1

MANUFACTURING

1. Durable Goods

(1) Lumber and wood products
(2) Furniture and fixtures
(3) Stone, clay, and glass products
(4) Primary metal industries
(5) Fabricated metal products
(6) Nonelectrical machinery
(7) Electric and electronic equipment
(8) Motor vehicles and equipment
(9) Transportation equipment except motor vehicles
(10) Instruments and related products
(11) Miscellaneous manufacturing industries

2. Nondurable Goods

(12) Food and kindred products
(13) Tobacco manufacturing
(14) Textile mill products
(15) Apparel and other textile products
(16) Paper and allied products
(17) Printing and publishing
(18) Chemicals and allied products
(19) Petroleum and coal products
(20) Rubber and miscellaneous plastics products
(21) Leather and leather products

PRIVATE NONMANUFACTURING

3. Mining

(22) Mining

4. Construction

(23) Construction

5. Transportation and Public Utilities

(24) Railroad transportation
(25) Trucking and warehousing
(26) Local and interurban passenger transit
(27) Air transportation
(28) Other transportation and transportation services
(29) Communication
(30) Electric, gas, and sanitary services

6. Finance, Insurance, and Real Estate

(31) Banking
(32) Insurance
(33) Brokers, credit, and other investment
(34) Real estate

7. Retail Trade

(35) Eating and drinking places
(36) Other retail trade

8. Wholesale Trade

(37) Wholesale trade

9. Services

(38) Hotels and other lodging places
(39) Personal and repair services
(40) Private households
(41) Auto repair, services, and garages
(42) Miscellaneous business services
(43) Amusement and recreation services
(44) Motion pictures
(45) Medical and other health services
(46) Legal and miscellaneous services
(47) Private educational services
(48) Nonprofit membership organizations and museums

10. Agricultural Services, Forestry, Fisheries, and Other

(49) Agricultural services, forestry, fisheries, and other

GOVERNMENT

11. State and Local

(50) State and local

12. Federal, Civilian

(51) Federal, civilian

13. Federal, Military

(52) Federal, military

FARM

14. Farm

(53) Farm

constructing regional models using traditional econometric procedures (TEP). In the TFS approach, a model structure based on economic theory is successively calibrated by using information from many sources and parameter estimates at each step from studies that encompass all regions. The use of a maintained structure and of large data sets yields econometric response parameters that are based on data for that region only. This makes the behaviorial characteristics of the model differ substantially from those of another region but it does not change the basic theoretical structure of the model from region to region.

The TFS methodology follows the tradition of Computable General Equilibrium models (models for which a solution can be calculated that simultaneously clears all of the product and labor markets) because it is a structural model with explicit demand and supply relationships for labor and product markets. It computes a simultaneous solution of over 1,000 equations to determine quantities and prices for all industries as well as wages and employment for all occupations and industries.

The major causal links in the model can be divided into three sets (depicted in Figures 1,2, and 3):

1. Demand and Supply Linkages
2. Cost Linkages
3. Wage Determination Linkages

In the diagrams, rectangles indicate exogenous variables (those whose values are generated outside the model), while ovals indicate endogenous variables (those whose values are determined by the model).

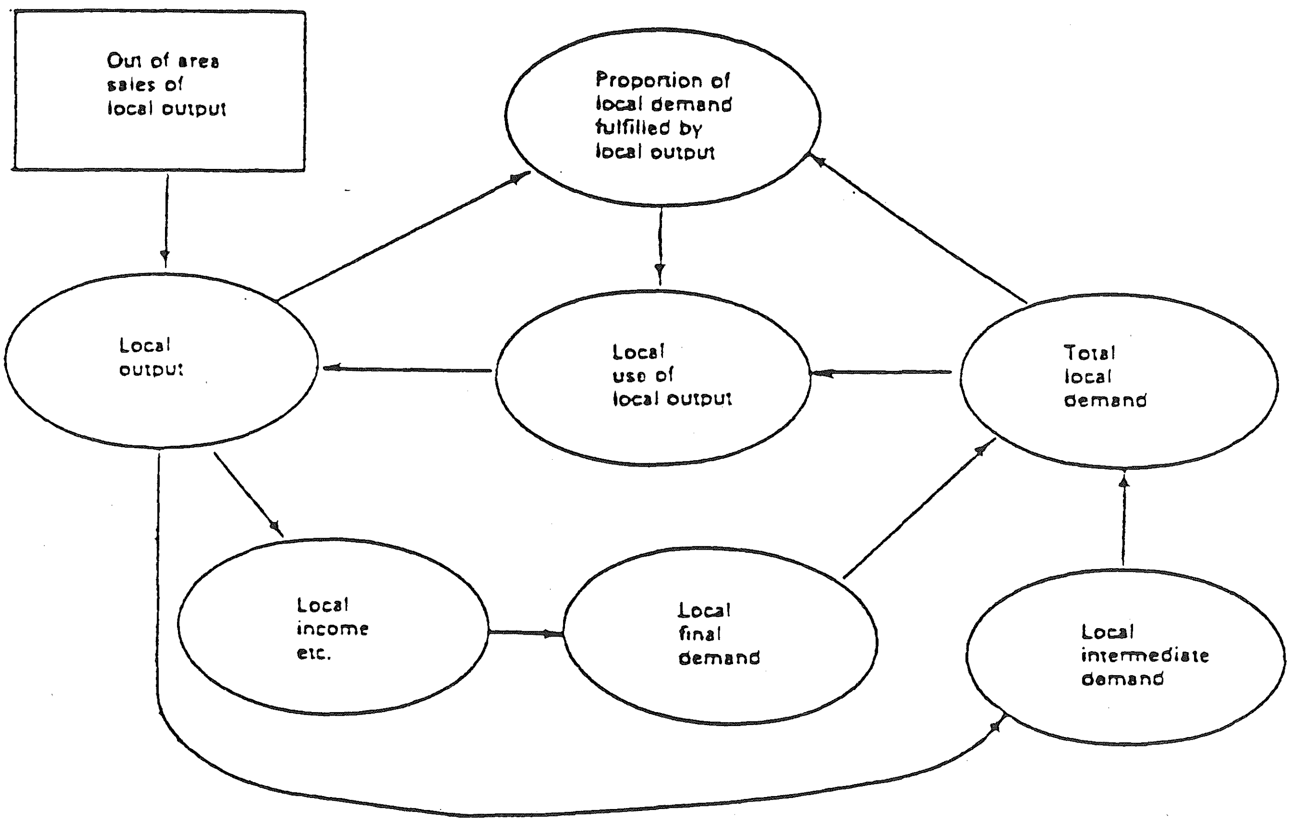


Fig. 1. Demand and supply linkages

Figure 1 presents the demand and supply linkages within the model. A change in SALES OF MINNESOTA PRODUCED PRODUCTS OUTSIDE OF MINNESOTA (represented by the rectangle in the upper left-hand corner) causes a change in LOCAL OUTPUT (local demand supplied locally + out-of-state demand supplied locally). The change in LOCAL OUTPUT leads to changes in INCOMES (which affect consumer spending), ECONOMIC ACTIVITY (which affects investment spending) and POPULATION (which will change government spending). These changes affect LOCAL FINAL DEMAND (comprised of demand for consumption, government spending and investment) and TOTAL LOCAL DEMAND (intermediate demand + final demand).

The change in LOCAL OUTPUT will stimulate production of the INTERMEDIATE inputs required to produce that output.

The oval labeled "PROPORTION OF LOC FINAL DEMAND FULFILLED BY LOCAL OUTPU indicates that changes in output for particular product will change th industry's penetration of local market that is, the proportion of local dema supplied locally. This proporti (called the REGIONAL PURCHAS COEFFICIENT) has been derived for ea industry using data from the 1977 Cens of Transportation on shipping and da from County Business Patterns employment and wages. The methodolo used to estimate RPCs for th non-manufacturing industries necessarily more subjective based assumptions regarding the proportion within-state shipments. The assumptio and procedures followed are described detail on page 555 of the TFS methodolo article cited above.

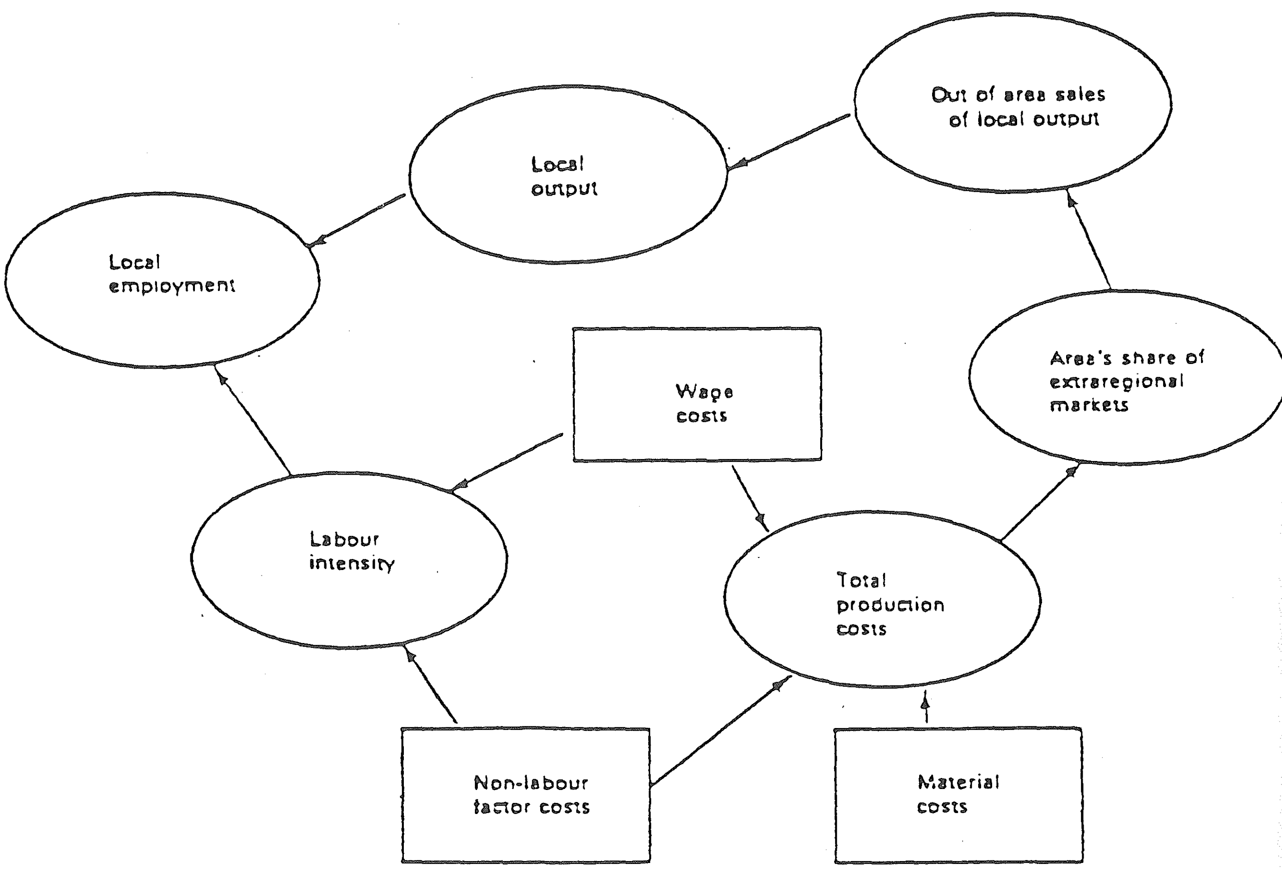


Fig. 2. Cost linkages

Some examples of RPCs for specific industries include the following.

* For Medical Services (SIC 80) the RPC = .940, meaning 94% of medical services demanded in Minnesota are supplied by Minnesota companies.

* For Lumber and Wood Products (SIC 24) the RPC = .167.

* For Food manufacturers (SIC 20) the RPC = .449.

* The highest RPC = .966, for the Credit and Finance sector (SIC 61,62 & 67).

* The lowest is for Mining at .000.

Figure 2 shows the cost linkages within the model. Again, a change in OUT-OF-MINNESOTA SALES OF MINNESOTA OUTPUT causes changes in LOCAL OUTPUT (as in Figure 1).

MINNESOTA EMPLOYMENT is affected by LOCAL OUTPUT required due to the change in sales. A change in WAGE or NON-LABOR factor costs (fuel or capital) leads to a substitution toward the factors of production that have experienced a drop in costs relative to other factors. This means that LABOR INTENSITY (labor used per unit of output) will change. A change in any cost will lead to a change in TOTAL PRODUCTION COSTS which in turn affect MINNESOTA'S SHARE OF EXTRA-REGIONAL MARKETS.

The following are examples of Minnesota's costs relative to the nation for the construction sector in the last year of history.

* Total production costs = .99755, 99.8% of the national average.

* Labor costs = 1.02064, 2.06% greater than the national average.

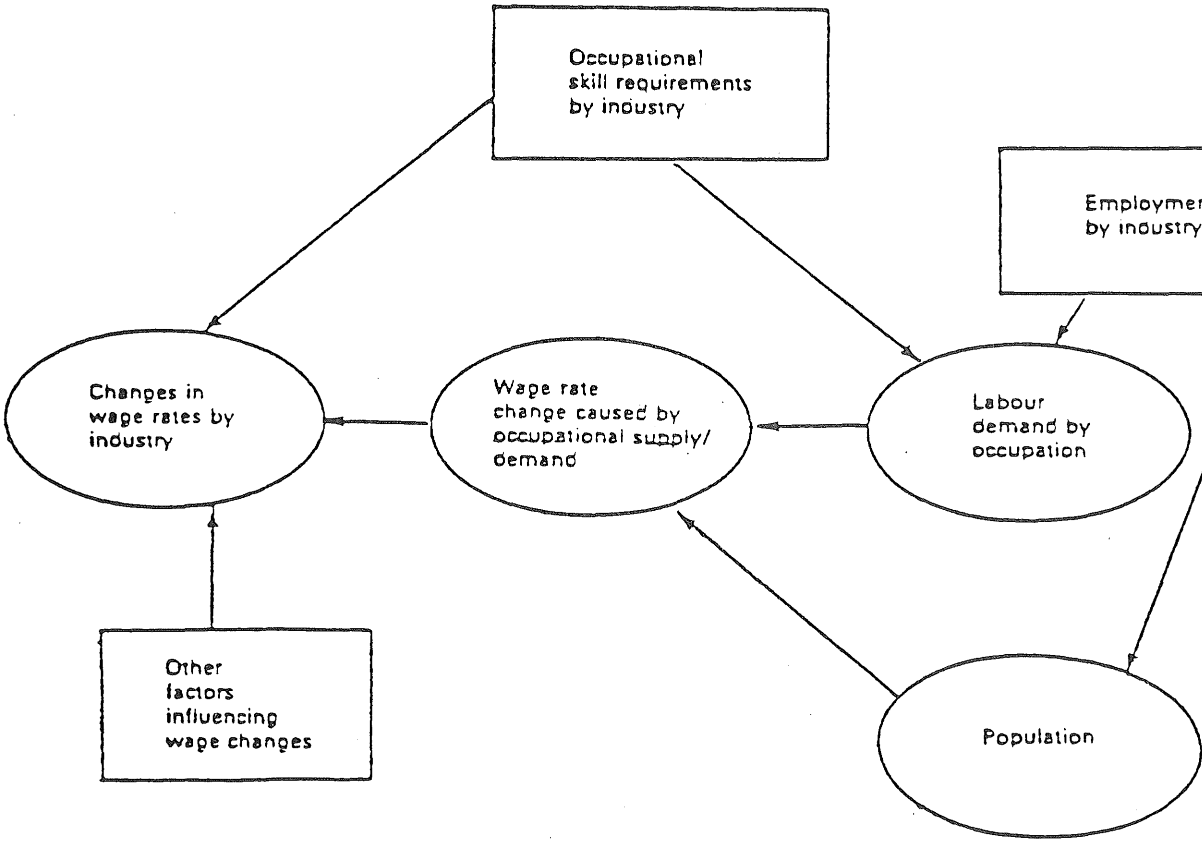


Fig. 3. Wage determination linkages

* Fuel costs = .83223, 83.2% of the national average.

* Capital costs = 1.00159, less than 1% above the national average.

* Intermediate input costs (from other industries) = .98356, 98.4% of the national average.

* Labor intensity = .98681, less labor required per unit of output than in the U.S. on average.

Figure 3 gives an overview of wage determination linkages in the model. A change in EMPLOYMENT BY INDUSTRY is converted to changes in LABOR DEMAND BY OCCUPATION using the "occupational skills by industry matrix" based on the 1978 Bureau of Labor Statistics' Occupational Employment System (OES) matrix. Changes in LABOR DEMAND BY OCCUPATION lead to CHANGES IN WAGE RATES BY OCCUPATION which are converted to CHANGES IN WAGE RATES BY INDUSTRY using the same matrix.

Another causal link, a change in POPULATION, is initiated when a change in EMPLOYMENT BY INDUSTRY occurs. Increased employment leads to an increase in population due to in-migration based on better economic conditions in Minnesota relative to the rest of the U.S. This, in turn, affects labor supply. A population increase dampens the effect of increased demand for labor on wage rates.

CHANGES IN WAGE RATES BY INDUSTRY are a function of the change in local wages for each occupation and the PROPORTION OF THAT OCCUPATION IN A PARTICULAR INDUSTRY plus OTHER FACTORS. Wage data in the model comes from the ES-202 data set released by the Bureau of Economic Analysis. The WAGE RATE CHANGE DUE TO SHIFTS IN SUPPLY AND DEMAND FOR EACH OCCUPATION is a function of POPULATION, past DEMAND FOR THE OCCUPATION, and DEMAND FOR low- and high-skilled OCCUPATIONS currently in the state.

The source of the model's employment, wage, personal income and population data is the Regional Economic Information System, Bureau of Economic Analysis.

Average annual wage rates by sector in 1984 ranged from a high of $37,175 for workers in "railroad transportation" to a low of $3,670 for workers in occupations usually considered domestic services. Workers in the real estate industry also earned less than $5,000 on average annually. Workers in "personal services and repair" as well as "agricultural services, forestry and fishing" earned less than $6,000. Sectors reporting wages in excess of $30,000 (in addition to "railroad transportation") include "motor vehicles," "paper," "petroleum" and "air transportation."

The state's largest occupational group in 1984 (except for workers "not elsewhere classified") was "food service workers" with 106,556. This was closely followed by "secretaries" with 94,921. The occupation with the least representation was "math technicians" with only 36.

III. MODELING & FORECASTING CAPABILITIES

A. Modeling

In preparing a policy simulation, the following categories of regular policy variables are available for use:

* Employment by industry

* Cost changes by industry

* Sales by industry

* Change in corporate profits tax rate by industry

* Final Demand personal consumption expenditures, 13 categories

* Final Demand agriculture, 5 categories

* Final Demand government, 7 categories

* Final Demand investment, 3 categories

* Percent change in Exports and Imports

* Change in business inventories

* Percent change in wage rates by industry

* Wage Bill adjustment by sector

* Percent change in Personal Income Components

* Occupational training by occupation, 94 categories

* Population changes in percentage points

* Employee productivity changes

* Unemployment compensation by sector

* Changes in equipment property tax rate, investment tax credit, personal taxes, property tax rate, equipment and structure life time

* Percent change in personal consumption price index

* Wage Rate adjustment by industry

* Change in purchasing power

Also, the analyst can impose certain model adjustments or restrictions such as those:

- for entering real or nominal dollars
- for assumptions regarding the effect of employment or sales on wage rates
- for assumptions regarding the effect of new employment (export or import substitution)
- for responses to inputs based on other assumptions
- to change wage and salary disbursements for government, farm, and total sectors without changing wage rates

In addition to regular policy variables, the model includes a number of "special translator" policy variables. Each translator represents a broad-based economic activity that is passed to the model through a combination of regular policy variables. These variables are useful when detail about the economic activity is not known. For example, if one desires to simulate the impact of a new construction project on Minnesota's economy and does not have data on the number of employees required or the expenditures by sector, the use of a translator variable (in this case a construction translator for a particular type of project) would be applicable. Basically, the translator provides a predetermined distribution of inputs to the various sectors based on the distribution of expenditures in the national input-output table. In the case of the tourism translators, the distribution is based on survey data. There are four major categories of translator variables available for use in policy simulations:

* Changes in production for agricultural sectors, 17 categories

* Levels of spending for construction projects, 33 categories

* Changes in tourism, 5 categories

* Changes in trucking costs, 3 categories

B. Forecasting

The model forecasts a wide variety of economic variables for the state of Minnesota. Currently historical data cover the period 1969 through 1984 while forecasts are made for the years 1985 through 1995. The update discussed earlier in this paper will include actual 1985 data and forecasts to the year 2035. Table 2 is a list of all the tables which can be printed out from the model control forecast, simulation forecast or difference between the two (the economic impact). Table 3 is a copy of the control forecast super summary table for the years 1991 through 1995. Note that the letters "GRP" stand for Gross Regional Product. In the case of the Minnesota model, the region is the state of Minnesota so the figures in the table are Gross State Product figures.

TABLE 2

TABLES AVAILABLE FROM MINNESOTA
FORECASTING AND SIMULATION MODEL

Output Table Number	
1	SUPER SUMMARY TABLE
2	SUMMARY TABLE FOR PRIVATE NONFARM SECTORS
3	EMPLOYMENT TABLE
4	PERSONAL INCOME TABLE
5	GRP BY FINAL DEMAND TABLE (1977 DOLLARS)
6	GRP BY FINAL DEMAND TABLE (AFTER 1973, NOMINAL DOLLARS)
7	10 SECTORS FOR: Private Nonfarm Employment
	Employment Generated by Demand for Intermediate Inputs
	Employment Induced by Local Consumption Demand
	Employment Induced by Government Demand
8	10 SECTORS FOR: Employment Induced by Investment Activity
	Employment Generated by Export to Rest of US/World
	Employment Depend on Export to Rest of Multi-Area Region
	Employment Caused by Exogenous Policy Stimulus
9	10 SECTORS FOR: Production Costs Relative to the U.S.
	Factor Costs Relative to the U.S.
	Labor Costs (Wage Rates & Other Costs) Relative to the U.S.
	Fuel Costs Relative to the U.S.
	Output of Local Industries (NOMINAL DOLLARS)
10	10 SECTORS FOR: Capital Costs Relative to the U.S.
	Intermediate Input Costs Relative to the U.S.
	Production Costs for Local Markets Relative to the U.S.
	Production Costs for Export Markets Relative to the U.S.
11	10 SECTORS FOR: Labor Intensity Relative to the U.S.
	Multiplicative Adjustments on Total Output & Employment
	Employment Generated by Export From Loc Reg, as A % of U.S. Emplyt.
	Regional Purchase COEFF(RPC)-Prop of Local Use Supplied Locally
12	10 SECTORS FOR: Average Annual Wage Rate
	Index of Effect of Relative Industrial Mix(3-DIG) on Employt. Change
	Demand(billions of $): Purchase by Local Area From All Sources
	Imports: Implicit Purchase Outside of Area For Local Use
13	10 SECTORS FOR: Self Supply: Local Production For Local Use
	Exports to the Rest of the U.S. and Rest of World
	Exports to Other Areas in Multi-Area Region
	Exogenous Production Stimulated by Policy Change

14 10 SECTORS FOR: Output of Local Industries (1977 DOLLARS)
Value Added: Output Excluding Intermediate Inputs (1977 DOLLARS)
Wage and Salary Disbursements
Output of Local Industries (NOMINAL DOLLARS)
15 OCCUPATIONAL EMPLOYMENT
16 OCCUPATIONAL WAGE RATE CHANGE
17 DETAILED/3RD LEVEL EMPLOYMENT (N/A SOME SIMS)
18 PRIVATE NONFARM EMPLOYMENT
19 EMPLOYMENT GENERATED BY DEMAND FOR INTERMEDIATE INPUTS
20 EMPLOYMENT INDUCED BY LOCAL CONSUMPTION DEMAND
21 EMPLOYMENT INDUCED BY GOVERNMENT DEMAND
22 EMPLOYMENT INDUCED BY INVESTMENT ACTIVITY
23 EMPLOYMENT GENERATED BY EXPORT TO REST OF US/WORLD
24 EMPLOYMENT DEPENDENT ON EXPORT TO REST OF MULTI-AREA REGION
25 EMPLOYMENT CAUSED BY EXOGENOUS POLICY STIMULUS
26 PRODUCTION COSTS RELATIVE TO THE U.S.
27 FACTOR COSTS RELATIVE TO THE U.S.
28 LABOR COSTS (WAGE RATES & OTHER LABOR COSTS) RELATIVE TO THE U.S.
29 FUEL COSTS RELATIVE TO THE U.S.
30 CAPITAL COSTS RELATIVE TO THE U.S.
31 INTERMEDIATE INPUT COSTS RELATIVE TO THE U.S.
32 PRODUCTION COSTS FOR LOCAL MARKETS RELATIVE TO THE U.S.
33 PRODUCTION COSTS FOR EXPORT MARKETS RELATIVE TO THE U.S.
34 LABOR INTENSITY RELATIVE TO THE U.S.
35 MULTIPLICATIVE ADJUSTMENTS ON TOTAL OUTPUT & EMPLOYMENT
36 EMPLOYMENT GENERATED BY EXPORT FROM LOC REG, AS A % OF U.S. EMPLOYT.
37 REGIONAL PURCHASE COEFF (RPC) - PROP OF LOC USE SUPPLIED LOCALLY
38 AVERAGE ANNUAL WAGE RATE
39 INDEX OF EFFECT OF RELATIVE INDUSTRIAL MIX(3-DIG) ON EMPLOYT. CHANGE
40 DEMAND(BILLIONS OF $): PURCHASE BY LOCAL AREA FROM ALL SOURCES
41 IMPORTS: IMPLICIT PURCHASE OUTSIDE OF AREA FOR LOCAL USE
42 SELF SUPPLY: LOCAL PRODUCTION FOR LOCAL USE
43 EXPORTS TO THE REST OF THE U.S. AND REST OF WORLD
44 EXPORTS TO OTHER AREAS IN MULTI-AREA REGION
45 EXOGENOUS PRODUCTION STIMULATED BY POLICY CHANGE
46 OUTPUT OF LOCAL INDUSTRIES (1977 DOLLARS)
47 VALUE ADDED: OUTPUT EXCLUDING INTERMEDIATE INPUTS (1977 DOLLARS)
48 WAGE AND SALARY DISBURSEMENTS
49 OUTPUT OF LOCAL INDUSTRIES (NOMINAL DOLLARS)

TABLE 3

CONTROL FORECAST

SUPER SUMMARY TABLE.
(TABLE # REFERENCES IN PARENTHESES)

	1991	1992	1993	1994	1995
TOTAL EMPLOYMENT (3)	2602.121	2633.966	2664.819	2697.754	2736.166
EMP % OF US	1.975	1.979	1.982	1.986	1.993
TOT PRIV NF EMPLYT(2)	2156.099	2187.816	2218.981	2252.237	2292.256
PR NF EMP % OF US	1.989	1.995	2.000	2.006	2.017
GRP 1977 $ (5)	55.831	57.570	59.336	61.147	62.929
GRP NOMINAL $ (6)	133.224	145.845	158.649	171.571	185.389
PERSONAL INCOME (4)	97.052	104.704	112.992	121.283	130.403
PERS INC % OF US	1.846	1.850	1.853	1.856	1.863
DISPOSABLE INCOME (4)	80.469	86.963	93.837	100.628	108.188
PCE-PRICE INDX-77 (4)	231.996	246.052	259.289	272.127	286.145
REAL DISP INCOME (4)	34.686	35.343	36.190	36.978	37.809
POPULATION (3)	4344.437	4362.044	4377.121	4389.707	4401.838
POP AS % OF US	1.715	1.708	1.701	1.693	1.686

(NOTE - FOR ALL TABLES: EMPLOYMENT & POPULATION IN THOUSANDS OF PEOPLE, DOLLAR CONCEPTS IN BILLIONS OF NOMINAL DOLLARS UNLESS OTHERWISE INDICATED.)

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IV. APPLICATIONS IN THE TAX RESEARCH DIVISION

The Minnesota Forecasting and Simulation model provides historical data and forecasts for a variety of projects completed by Research Division personnel. Analysts preparing studies for the Tax Expenditure Budget Document used tables on employment, personal income and output to assist them in preparing estimates. During the past legislative session, analysts estimating the revenue impact of the proposed sales tax on various services used forecasts of service industry output from the control forecast. Personal income forecasts are used in preparing the economic assumptions input to the Property Tax Refund model for regular forecasts of monies to be expended for that purpose. In addition, the model provides information to answer frequent questions posed by persons in State government and the general public on Minnesota's economy.

Examples of simulation analyses which have been done in the past include the following.

* The effect of specific employment changes in transportation, petroleum, and public utilities; requested by the Energy Conservation Division of the Dept. of Administration.
* The effect on Minnesota employment of the proposed "megamall"; requested by the Metro Council task force formed to prepare the metro significance study for the project.
* The economic impact of shifting to 100% sales for apportioning corporate income to Minnesota.
* The effect of reducing transfer payments in the state by $50 million.
* The economic impact on the state of the Lake Superior Paper construction project in Duluth.
* The impact of new construction and employee expansion in 1984 and 1985 at the International Language Villages near Bemidji; requested by Concordia College at Moorhead.

Section V describes the most recently completed simulation analysis.

V. AN EXAMPLE: THE HORSE RACING INDUSTRY STUDY

Earlier this summer, a policy simulation to estimate the economic impact on the state of the new horse racing industry in 1985 and 1986 was undertaken in the Tax Research Division at the request of the Minnesota Racing Commission. Data was furnished by the Minnesota Racing Commission and Canterbury Downs. The following policy variables were used for the simulation:

* regular policy variables for employment, sales by industry, final demand personal consumption expenditure adjustment (all categories), wage bill adjustment by sector, suppression of non-residential investment employment response to new construction;
* translator policy variables for construction of amusement and recreation buildings, new demand for agricultural feed grains, construction of new farm buildings, purchase of miscellaneous livestock.

The super summary table of the simulation impact (due to operation of Canterbury Downs) is shown in Table 4. The last column, for example, shows that the existence of the race track in 1986 resulted in an increase of 2,515 jobs in Minnesota over the baseline employment forecast. This information, as well as a detailed description of the simulation process, data and results, are contained in the simulation report: HORSE RACING IN MINNESOTA: WHAT IMPACT ON THE STATE'S ECONOMY? — available on request from the Tax Research Division at the address listed on page 2 of this publication.

TABLE 4

ECONOMIC IMPACT OF NEW RACING INDUSTRY ON MINNESOTA

SUPER SUMMARY TABLE.
(TABLE # REFERENCES IN PARENTHESES)

	1982	1983	1984	1985	1986
TOTAL EMPLOYMENT (3)	.000	.000	.000	1.464	2.515
EMP % OF US	.000	.000	.000	.001	.002
TOT PRIV NF EMPLYT(2)	.000	.000	.000	1.450	2.436
PR NF EMP % OF US	.000	.000	.000	.001	.002
GRP 1977 $ (5)	.000	.000	.000	.019	.032
GRP NOMINAL $ (6)	.000	.000	.000	.034	.065
PERSONAL INCOME (4)	.000	.000	.000	.023	.050
PERS INC % OF US	.000	.000	.000	.001	.001
DISPOSABLE INCOME (4)	.000	.000	.000	.018	.039
PCE-PRICE INDX-77 (4)	.000	.000	.000	.006	.017
REAL DISP INCOME (4)	.000	.000	.000	.010	.019
POPULATION (3)	.000	.000	.000	.000	.854
POP AS % OF US	.000	.000	.000	.000	.000

(NOTE - FOR ALL TABLES: EMPLOYMENT & POPULATION IN THOUSANDS OF PEOPLE, DOLLAR CONCEPTS IN BILLIONS OF NOMINAL DOLLARS UNLESS OTHERWISE INDICATED.)

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APPENDIX XIX.

MNFS-553 POLICY VARIABLES

AN ANNOTATED LIST OF REGULAR AND TRANSLATOR POLICY VARIABLES

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AN ANNOTATED LIST OF REGULAR AND TRANSLATOR POLICY VARIABLES

I. Regular Policy Variables

This list is organized alphabetically together. Some variables which share conceptual affinity are grouped together as well. In each entry below the policy variable name is given as it appears in the program, then an abbreviated description and the units of the policy variable are given in the same line. After this heading follows the FORTRAN equations in which the policy variable plays its role, and finally a brief explanation. The full sector specific policy variable list, which includes the policy variable identification numbers and may be produced while running the program, is appended. The reader may notice many variables in the actual equations here which are not in ~~his~~ glossary. We will produce an updated glossary soon; our documentation has not kept pace with our innovation.

NAME	DESCRIPTION	UNITS
AEPV	ENDOGENOUS INR FROM EPOL OR SALPOL	DEFAULT: YES=0. NO=1

```
AE = AE+(KWE(I)*E(I))-AEPV*EPX(I)*KWE(I)

AE = AE+((KWE(NM+2)*ECSD)-(AEPV*ECSD*KWE(NM+2))
```

If you enter a policy into the model that ends up affecting the economy through the EPX variable which is the general exogenous employment variable, the AEPV value can be set equal to 1 to suppress the endogenous non-residential investment (INR) response. Since many policies, such as sales and visitor day variables, work through EPX it becomes a general way to shut off the model's investment sector. This is necessary in cases when you put the investment component of the policy directly into the model. Whenever translator policy variables for construction (201-225) are used, the AEPV value must be set equal to one. This allows the ECSD value, the special demand for construction given by the translator variable, to remove the direct effect of construction on employment so that the vector for the special type of construction can be entered without double counting.

ALLEXP   EPOL/SALPOL AS EXP OR GEN EMPLMNT   DEFAULT: ALLEXP=0 WITH LOCAL=1.

```
EXPEMP = ((EPX(I)*(1.-ALLEXP))+EPX(I)*(EX(I)/E(I))*ALLEXP)*(1.-IMPSUB)
```

If ALLEXP is set at its default value of 0 all exogenous employment is considered as export. If it is set equal to 1 export employment is divided between export and local employment according to the export share (see the EPOL discussion above).

CAPV   CORP PROF TAX--EACH PRIVATE SECTOR   RATE CHANGE-AS A PERCENT

```
TCP(I) = (CA(I)+CAPV(I))*(XTCP+TCPPOL)
```

TCP(I) is the corporate tax rate for industry I. The CA(I) value is set equal to one for all states where the same corporate tax rate applies to all sectors. It is set equal to the proportion of each sector that is taxed or the proportion of the regular corporate profits tax rate that applies in states where different industries pay different rates. The XTCP variable is the corporate tax rate. CAPV(I) is changed in order to differentially change the corporate tax rate in particular sectors.- TCPPOL is used to change the corporat tax rate for all sectors simultaneously.

e

CPIPV   CPI MULTIPLICATIVE ADJ.   % CHANGE IN CPI

```
CPI = XCP*CPIU*CP*CPIPV
```

The CPIPV variable changes the consumer price index in the state multiplicatively. An increase in the CPI in turn reduces real disposable income.

CPOL   CHANGE IN PURCH. POWER   MILLIONS OF DOLLARS-SEE WPV

```
CPOL = WPV*CPOL*(CPI/XCPI) + (1.-WPV)*CPOL

XDR4 = XCI*((RYD+(CPOL/CPI))/RYDU)*CMPV
```

$$XDR4 = XCI * CMPV * \frac{RYD + (CPOL/CPI)}{RYPU}$$

When WPV is at its default value of 0 this variable should be put in nominal dollars of the year in question. When WPV equals 1 CPOL is translated from dollars of the last year of history into current year dollars. CPOL goes directly into the column that determines consumption demand using the special consumption patterns of the state adjustment (XCI) times the ratio of state income (RYDU).

CMPV RYD/RYDU MULTIPLICATIVE ADJ. % CHANGE IN CON. DEM.

$$XDR4 = XCI * CMPV * \frac{RYD + (CPOL/CPI)}{RYDU}$$

CMPV represents a change in the marginal propensity to consume (XCI).

CPV COSPOL: PERCENTAGE OR DOLLARS DEFAULT=%=0. 1.=DOLLARS.

```
IF( CPV.EQ.1.  ) COSPOL(I)=.1*COSPOL(I)

COSTCH = COSPOL(I)*(1.-CPV) + CPV* ((WPV * COSPOL(I) *
         (CPI/XCPI) + (1.-WPV) * COSPOL(I)/SALES(I))
```

If CPV is set equal to its default value of zero then the COSPOL variables below are entered in percent. Thus, an increase of cost to an industry of two percent is entered as 2. If CPV is set equal to one then COSPOL can be entered in current nominal millions of dollars (if WPV = 0) or in last historical year millions of dollars (if WPV = 1).

COSPOL REL. COST CHANGE-EACH PRIVATE SECTOR AS % OF COST OR IN $-CPV

```
IF( CPV.EQ.1.  ) COSPOL(I)=.1*COSPOL(I)

COSTCH = COSPOL(I)*(1.-CPV) + CPV *((WPV*COSPOL(I)*(CPI/XCPI) +
         (1.-WPV)*COSPOL(I))/ SALES(I))

P(I) = MC(I) + FC(I) + COSTCH
```

The combination of chosen cost change effects is entered into the production cost equation for the simultaneous solution of each year, thus increasing the relative production cost for the industry in question. See both the CPV and WPV annotations.

DEMPOL AMOUNT SALES- EACH PRIVATE SECTOR MILLIONS OF$ (SEE WPV)

```
FDEMP = (EPV*(WPV*DEMPOL(I)*R(I)*(CPI/XCPI)

ELF(I) = ELF(I)*R(I)*LI+FDEMP+(1.-WPV)*DEMPOL(I)*R(I)))

EPX(I) = EPX(I)+FDEMP+(EXPEMP-EPX(I)*(1.-IMPSUB)))
```

DEMPOL is used to represent increased spending in an area. This differs from SALPOL in that it is reduced by the regional purchase coefficient R(I). Thus, when you use DEMPOL you are spending that number of million dollars per year in the area but only the usual proportion of use supplied from within the area is supplied from within the area. The value you input can be in current year dollars (if WPV is at its default value of 0) or in dollars of the last year of history (if WPV=1). It is converted into EPX(I) which is discussed under EPOL(I) below.

EPOL EMPLOYMENT-EACH SECTOR EMPLOYEES (THOUSANDS)

```
GSLPOL = GSLPOL+EPOL(NP+1)

GFCPOL = GFCPOL+EPOL(NP+2)

EPX(I) = EPOL(I)

EPX(I)= EPOL(I)*(EPV/EPVX(I))*PRODPV*(CPI/XCPI)+
        +(EPV*(WPV*SALPOL(I)*(CPI/XCPI)+(1.-WPV)*SALPOL(I)))
        +EPOL(I)*(1.-PRODPV)
```

EPOL is the policy variable used to introduce exogenous employment into the model for purposes of policy simulations or for adjusting control forecasts. The program coverts this into EPX(I) for the private sectors and GSWPOL and GFCPOL for the state/local and federal government sectors respectively. The EPX(I) variable can also be activated by the DEMPOL and SALPOL policy variables. In the latter case, it is only entered after all calculations are made so that it will be printed out as exogenous employment. In the DEMPOL case, the conversion is made before the relevant equations using EXP(I) are encountered in the program. See DEMPOL discussion above. It should first be noted that the user must decide whether or not productivity changes are to be taken into account by PRODPV at its default value of zero or setting it equal to one. If it is left at its default value of 0, then the EPX(I) value remains constant in the simulation. If it is set equal to 1 then the EPX(I) direct employment is reduced as productivity increases. Productivity is measured as dollars of nominal output (EPV/EPVX(I)) times the growth in the CPI which is equivalent to the change in employees per constant dollar of output. The PRODPV variable should be set equal to one whenever employment is being used as a proxy for additional constant dollar output. In this case the simulation will appropriately reflect the fact that fewer employees will be required to produce the same output whenever labo productivity increases. At this point it is logical to give a general overview of the way that employment disturbances can be entered into the model. We will do this by considering the EXP(I) variable.

EXP(I): THE EMPLOYMENT DISTURBANCE TERM

```
EXPEMP = ((EPX(I)*(1.-ALLEXP))+EPX(I)*(EX(I)/E(I))*ALLEXP)* +
         (1.-IMPSUB)

EX(I) = EX(I)+EXPEMP

R(I) = R(I) + IMPSUB * (EPX/DEM(I))

EPX(I) = EPX(I)+FDEMP+(EXPEMP-(EPX(I)*(1.-IMPSUB)))
```

Employment disturbances whether entered directly through EPOL or whether entered as DEMANDPOL or SALPOL can be divided into various types as follows:

a) <u>All Export Employment</u>

In this case it is assumed that all of the new employees will be engaged in the production of exports from the state and that this increase in exports will not reduce the outside of state demand for other within-state firms exporting to the same market. It is accomplished by leaving Policy Variable 996 (All EXP) at its default value of zero.

b) <u>General Employment</u>

In this case it is assumed that the employment is distributed according to its usual proportions in the state economy. That portion usually going to exports is EX(I)/E(I). Most of the remainder of the employment will be lost as the good produced by new employees will compete with the goods produced by old employees for the same local markets. However, a small amount of new local employment will be generated as the increase in the supply demand ratio increases the RPC endogenously. For these effects ALLEXP is set to a value of one.

c) Import Substitution Employment

If IMPSUB is set equal to one instead of its default value of zero then all of the new employment will go into new intermediate and induced employment rather than export employment This is done by increasing the RPC exogenously by enough to absorb all of the new employees.

d) A Combination of:

(1) Import Substitution
(2) Exports, and
(3) No Net Gain in Employment

This is the case of an exogeneous shock assumed to create a certain number of new jobs through exports and import substitution. Then a certain number of jobs due to the exogenous shock are assumed to simply replace old local jobs, (as might the case of a new supermarket in a limited market). Thus,the only changes will be due to import substitution and exports. The import substitution value should be decided on first and IMPSUB should be set equal to the proportion of the new employment that will go towards import substitution. Next, the proportion going to exports must be set and the value of ALLEXP in the EXEMP equation must be decided on. With these two values set the simulation can then be carried out.

EGFMPV EMPLOYMENT-FED. GOVT. MILI. EMPLOYEES (THOUSANDS)

GFMPOL = GFMPOL+EGFMPV

This is used to increase Federal military employment in the state. Federal government spending is in units of thousands of employees in the model.

EFPV EMPLOYMENT-AGRICULTURE EMPLOYEES (THOUSANDS)

EF = XEF*EFU*MPVF+EFPV

This is used to exogenously increase farm employment in the state.

GSLPOL STATE & LOCAL GOVT SPENDING EMPLOYEES (THOUSANDS)

GSLPOL = GSLPOL+EPOL(NP+1)

D(1) = XDSL*DU(1)*(POP/POPU)+GSLPOL

This variable increases state and local spending. It works by adding employees directly to state and local government employment and by adding demand to the state and local government spending vector. See also the translator variables which should be used to add particular types of state and local government spending. An increase in transfer payments can be introduced through VPOL (ID=904) below.

GFCPOL FEDERAL GOVT. CIVI. SPENDING EMPLOYEES (THOUSANDS)

GFCPOL = GFCPOL+EPOL(NP+2)

D(2) = XDFC*DU(2)+GFCPOL

This variable is similar to GSLPOL except that it is for federal government civilian spending.

GFMPOL FEDERAL GOVT. MILI. SPENDING EMPLOYEES (THOUSANDS)

GFMPOL = GFMPOL+EGFMPV

D(3) = XDFM*DU(3)+GFMPOL

See GSPOL and GFCPOL above.

ICPOL IN STATE COSTS- EACH PRIVATE SECTOR COST CHANGE-% OF TOTAL COST

MC1 = MC1+(A(J)*XR(J)*P(J)) * (1.+ICPOL(J))

CCL(I) = (P(I)*(1.+ICPOL(I)))/(1.+MCPOL(I))

ICPOL can be used to increase or decrease the cost of within state deliveries. Thus if a new road is constructed from point

A to point B within the state the reduction in delivery costs expressed as a percentage change in the delivered total cost can be entered for each industry affected. This variable could also be used if the state introduced a policy of subsidizing in-state purchases ~~purchases~~ from a particular industry. If an investment series has been provided see variables 923-926 below.

IMPSUB EPOL OR SALPOL AS IMP SUB DEFAULT: NO=0. YES=1.

EXPEMP = ((EPX(I)*(1.-ALLEXP))+EPX(I)*(EX(I)/E(I))*ALLEXP)*
(1.-IMPSUB)

EX(I) = EX(I)+EXPEMP

EPX(I) = EPX(I)+FDEMP+(EXPEMP-(EPX(I)*(1.-IMPSUB)))

R(I) = R(I) + IMPSUB*(EPX/DEM(I))

See the EPOL discussion below.

INRC NON-RESIDENTIAL INVESTMENT MILLIONS OF CURRENT DOLLARS

INREPV See IREPV

INRRPV See INRC

INRRPV NON-RESIDENTIAL INVESTMENT MILLIONS OF 1972 DOLLARS

INRPV = INRCPV*(INRRU/INRU)+INRRPV

The appropriate non-residential investment policy variable is in 1972 dollars and so is the sum of any stimulus entered by the user in 1972 terms and any stimulus entered in current dollars which is then deflated by the program.

IRCPV RESIDENTIAL INVESTMENT MILLIONS OF CURRENT DOLLARS

IRRPV RESIDENTIAL INVESTMENT MILLIONS OF 1972 DOLLARS

IRPV = IRCPV*(IRRU/IRU)+IRRPV

As above the residential investment policy variable is the sum of the current value policy variable appropriately deflated and the 1972 value policy variable.

The values IRPV and INRPV are used in equations similar to those for IREPV and INREPV above to predict relative final demand for (5) Transportation and Public Utilities, and for (6) Finance, Insurance, and Real Estate. The most important difference is that employment ratios are no longer used as proxies for relative investment levels. Only when an investment series is provided will these variables be available. When using these variables directly in combination with direct EPOL inputs, AEPV (ID=901) should be set equal to 1 to shut off endogenous investment responses. Translator construction variables described below usually provide a superior way to introduce construction into the model.

IREPV RESIDENTIAL INVESTMENT (MODEL B) 1000'S OF CONST EMPLOYEES

INREPV NON-RESIDENTIAL INVESTMENT (MODEL B) 1000'S OF CONST EMPLOYEES

DR(6) = (XDR*(ARYD/ARYDU)*EMAJU(4)+IREPV)/EMAJU(4)

DR(5) = (XDNR*(1/ARC)*(AEF/AEFU)*EMAJU(4)+INREPV)/EMAJU(4)

Only these two investment variables are available with the standard model (model B). If an investment series has been provided see the four variables INRCPV-IRRPV, numbers 923-926 below. The relative demand equations here have to use employment in construction as proxies for relative final demand in finance,insurance and real estate. Similarly INREPV/EMAJU(4) is added to the relative nonresidential construction employment, to approximate the relative investment levels and therefore the relative final demand for transportation and public utilities.

MCPOL IMPORTING COST-EACH PRIVATE SECTOR COST CHANGE- % OF TOTAL COST

MC2 = MC2+(A(J)*(1.-XR(J))*(1.+ MCPOL(J)))

CCL(I) = (P(I)*(1.+ICPOL(I)))/(1.+MCPOL(I))

CP = CP+((XR(I)*P(I))+((1.+MCPOL(I))*(1.-XR(I))))*XWGHTS(I)

MCPOL is used to incorporate cost changes for goods imported into the state that result from policy actions. If a new road is constructed this will reduce import costs into the state. Decreasing an import cost with MCPOL(I) results in an increase in the comparative cost of local production and delivery relative to purchases outside of the state CCL(I). Such an increase will decrease the cost of material inputs imported into the state (MC2). It will also decrease the consumer price index adjustment (CP). In each case the appropriate weight must take into account the proportion imported (1.-XR(I)). Here XR(I), the regional purchase coefficient, is used at a fixed point so that changes in the index are caused only by changes in costs and not by shifts in XR(I).

MPVFM EXPORT ADJ.- FED. GOVT. MILI. MULT CHANGE-% OF EXPORTS

MPVF EXPORT ADJ.-AGRICULTURE MULT CHANGE-% OF EXPORTS

These two policy variables are equivalent to the MULTPV variables above and are for the Federal Military and Farm sectors respectively.

MRAPV See MVPV

MTWPPV See MVPV

MULTPV EXPORT ADJ.-EACH PRIVATE SECTOR MULT CHANGE-% OF EXPORT

```
MULT(I) = XMULT(I)*((1.+GRW(I))**TT)*MULTPV(I)

MULT(I) = XMULT(I)*(2.-(1.GRW)**TT)*MULTPV(I)

S(I)- = XS(I)*(XCCAA**XXSE(I))*MULT(I)

IF (MPVC(I).NE.0) MULTPV(I)=MPVC(I)
```

The MULTPV is used for two purposes in the 49 industries. First it may be used to adjust the exports here as in the first two equations above. Secondly it is the carrier of any adjustments that have been made to the simulation to account for extra but fragmentary employment data. These adjustments are calculated internally by the model as MPVC. Both adjustments can be made without any conflict; MULTPV is then simply the combination of the two adjustments.

MULTPV EXPORT ADJ.- ST/LOCAL GOVT. MULT CHANGE- % OF EXPORTS

MULTPV EXPORT ADJ.- FED. GOVT. CIVI. MULT CHANGE- % OF EXPORTS

```
E(NP+2) = XGFC*DR(2)*EU(NP+2)*MULTPV(NP+2)

E(NP+1) = XGSL*DR(1)*EU(NP+1)*MULTPV(NP+1)

IF(MPVC(NP+1).NE.O.) MULTPV(NP+1)=MPVC(NP+1)
```

```
IF(MPVC(NP+2).NE.O.)MULTPV(NP+2)=MPVC(NP+2)
```

These variables are not really changes in exports but do perform the same function in that they adjust for predicted or known (via MPVC) increases in activity.

MVPV	TRANSFER PAYMENT ADJUSTMENT	CHANGE IN PERCENTAGE POINTS
MWSDPV	WAGE BILL ADJUSTMENT	CHANGE IN PERCENTAGE POINTS
MYENPV	PROPIETORS INCOME ADJUSTMENT	CHANGE IN PERCENTAGE POINTS
MYOLPV	OTHER LABOR INCOME ADJUSTMENT	CHANGE IN PERCENTAGE POINTS
MTWPPV	CNTRBTNS TO SOC. ISN. ADJ.	CHANGE IN PERCENTAGE POINTS
MYPRPV	DIV + INT + RENT ADJUSTMENT	CHANGE IN PERCENTAGE POINTS
MRAPV	RESIDENCE ADJ. ADJUSTMENT	CHANGE IN PERCENTAGE POINTS

```
WSDF = WRF*EF*MWSDPV+FSD
WSD(I) = E(I)*WR(I)*MWSDPV+(WR(I)*WSDAPV(I))
WSD(NP+1) = MWSDPV*WR(NP+1)*E(NP+1)+GSLSD
WSD(NP+2) = MWSDPV*WR(NP+2)*E(NP+2)
YENT(14) = XYENT(14)*(YENTFU/EFU)*EF*MYENPV+XYENT(14)*YENTFU/EFU)*EFSD*FSDYA
YENT(I) = MYENPV*XYENT(I)*(YENNXU/EFWU)*EMAJ(I)
YENCSD = ECSD*(MYENPV*XYENT(4)*(YENNXU/EFWU)*CSDYA)
YOL(14) = XYOL(14)*(YOLFU/EFU)*EF*MYOLPV
YOL(I) = MYOLPV*XYOLY(I)*(YOLNXU/ENXU)*EMAJ(I)
YOLCSD = MYOLPV*XYOLY(I)*(YOLNXU/ENXU)*ECSD
YGSLSD = MYOPLV*XYOL(4)*(YOLNXU/ENXU)*EGSLSD
V=(XV*((POP-DEPSHR*ETOT)/(POPU-ETOTU))*VU*MVPV)+VPOL
TWPER = XTP*(TWPERU/ENFU)*ENF*MTWPPV
YPROP = XYPER*(YPROPU/POPU)*POP*MYPRPV
RA = XRA*(WSDNF+YOLNF+TWPER)*MRAPV
```

Each of these multiplicative adjustments makes an adjustment for the income concept named whenever it appears in the model. For instance, after the employment by industry has been calibrated to new partial employment data by the model,the user may calibrate the various income concepts to partial income data in the control forecast. These varia also be used when a policy changes an income payment such ~~as~~ transfer payments (MVPV) in a multiplicative way.

MWAPV	WAGE RATE ADJ.-EACH PRIVATE SECTOR	CHANGE IN % POINTS

```
WR(I) = (1. + CWR(I)*WRLJ(I)*MWA(I)*MWAPV(I)
```

These multiplicative wage rate changes are made in one year, but the changes then remain through the years unless they are explicitly removed. They are mostly used to adjust the control forecast.

CNTR.	ID.			
784	960	NAPV	NEW ADDITIVE POLICY VAR.	IN MODEL VARIABLE UNITS
785	961	NAPV	NEW ADDITIVE POLICY VAR.	IN MODEL VARIABLE UNITS
786	962	NAPV	NEW ADDITIVE POLICY VAR.	IN MODEL VARIABLE UNITS
787	963	NAPV	NEW ADDITIVE POLICY VAR.	IN MODEL VARIABLE UNITS
788	964	NAPV	NEW ADDITIVE POLICY VAR.	IN MODEL VARIABLE UNITS
789	965	NMPV	NEW MULTIPLICATIVE POLICY VAR.	RATE CHANGE-AS A PERCENT
790	966	NMPV	NEW MULTIPLICATIVE POLICY VAR.	RATE CHANGE-AS A PERCENT
791	967	NMPV	NEW MULTIPLICATIVE POLICY VAR.	RATE CHANGE-AS A PERCENT
792	968	NMPV	NEW MULTIPLICATIVE POLICY VAR.	RATE CHANGE-AS A PERCENT
793	969	NMPV	NEW MULTIPLICATIVE POLICY VAR.	RATE CHANGE-AS A PERCENT

These variables are not currently coded into the model. You may include them in any equation that you wish to in the FORTRAN program. Both are real arrays of length 5. Thus, policy variable 960 would be coded as NAPV(1), policy variable 961 as NAPV(2), etc.

OTRPV OCCPTNL TRAINING- EACH OCCUPATION EMPLOYEES (THOUSANDS)

$$\mathrm{COWR}(j) = \mathrm{UK} + (\mathrm{TRPOL}-\mathrm{TRPOLL}) + (\mathrm{ACTCPI}*[(\mathrm{RCPIL1}/\mathrm{RCPIL2})-1.]) + (\mathrm{OCCRES}(j)*\{\frac{[\mathrm{OD}(j)+0.01] - \mathrm{OTRPV}]}{\mathrm{ODA}(j)+0.01}\} -1.) + (0.15*[(\mathrm{EPR}/\mathrm{EPRA})-1.]$$

Increase in supply of employees in any occupation is introduced into the model as if it were a decrease in demand for that occupation. This approach in a sense assumes that a job opening is filled by each exogenously supplied person which then means that the number of jobs to be filled by the normal market process is reduced by that number of people thus putting a downward pressure on the wage rate for that occupation. The value you put in indicates the amount of supply. Thus, if you train 500 people per year you must see OTRPV equal to 500 the first year, 1000 the next, 1500 the third, etc. If you add supply and demand for jobs in an industry at the same time you can do it by setting WADJPV equal to 1.

POPPV POPULATION CHANGE IN PERCENTAGE POINTS

$$\mathrm{POP} = \mathrm{POPPV}*\mathrm{POPU}*[(G*[\mathrm{ERL}**.32]*\mathrm{EXP}(H*(10.+\mathrm{BFYR}-1967.+\mathrm{NTPS})/10.))]$$

This variable can be used to increase or decrease the population. The population size affects the local economy both through the wage determination equation and through its effect on state and local government demand.

PRODPV   PRODUCTIVITY CHANGES IN EPOL   DEFAULT:NO=0. YES=1.

```
EPX(I) = +EPOL(I)*(1.-PRODPV)+EPOL(I)*(EPV/EPVX(I))*PRODPV*(CPI/XCPI)+
         (EPV*(WPV*SALPOL(I)*(CPI/XCPI)+(1.-WPV)*SALPOL(I)))
```

When PRODPV is set equal to 1 any EPOL input is reduced as employment per dollar of output goes up less rapidly than the CPI.

PV10 # 960 (p. 16 of list)

PURPV   PURCHASING POWER POLICY VARIABLE   ~~PERCENTAGE POINTS~~ Nom $

```
CPI = XCP*CPIU*CP*CPIPV*[1.+(PURPV/YD)]
```

This purchasing power policy variable changes consumer demand, DR(4), by changing the consumer price index, CPI. The effect is to change real disposable income but not nominal disposable income. ~~Entered in percentage points of nominal disposable income.~~ The Michigan model currently used NAPV(1), ID no. 960, in place of PURPV.

REFPVC	REL. ELEC. FUEL COSTS-COMM.	REL. COST- AS A PERCENT
REFPVI	REL. ELEC. FUEL COSTS-IND.	REL. COST- AS A PERCENT
RGFPVC	REL. NATURAL GAS FUEL COSTS-COMM.	REL. COST- AS A PERCENT
RGFPVI	REL. NATURAL GAS FUEL COSTS-IND.	REL. COST- AS A PERCENT
RGFPVC	REL. RESIDUAL FUEL COSTS-COMM.	REL. COST- AS A PERCENT
RRFPVI	REL. RESIDUAL FUEL COSTS-IND.	REL. COST- AS A PERCENT

These policy variables change relative fuel cost for industrial and for commercial users. The functional form used assumes unitary price elasticity among fuels and between fuels and other factor inputs. An alternative version of the model is available which allows a different elasticity of substitution among fuels using a CES production function.

SALPOL   AMOUNT - SALES- EACH PRIVATE SECTOR   MILLIONS OF $ (SEE WPV)

```
EPX(I) = EPOL(I)*(1.-PRODPV)+EPOL(I)*(EPV(I)/EPVX(I))*PRODPV*(CPI/XCPI)+
         +(EPV(I)*(WPV*SALPOL(I)*(CPI/XCPI)+(1.-WPV)*SALPOL(I)))
```

SALPOL is used to represent an exogenous change in the sales of locally produced goods, as for example, when the government hires only local construction firms. This differs from DEMPOL which represents an across-the-board increase in demand for imported as well as locally produced goods. Note the regional purchase coefficient, R(I), in the equation where DEMPOL is used above. If WPV is at its default value of 0, SALPOL should be in nominal dollars, if WPV=1 then SALPOL should be in the constant dollars of the last year of data. If labor productivity is expected to grow normally in the industry the PRODPV (PVID=999) should be set equal to 1 instead of being left at its default value of 0.

TCPPOL	CORP. PROFIT TAX RATE	CHANGE IN PERCENTAGE POINTS
TEQPP	EQUIPMENT TAX RATE	CHANGE IN PERCENTAGE POINTS
TICPOL	INVESTMENT TAX CREDIT	CHANGE IN PERCENTAGE POINTS

TEQP = XTEQP + TEQPP

TIC = XTIC + TICPOL

TCP(I) = [CA(I) + CAPV(I)*[XTCP+TCPOL]

WM = TEQP - (TCPU*TEQP)

These policy variables change the relevant tax rate or credit from its control value for all industries. They then change the relative capital cost of equipment (CEQP), the relative cost of inventories CINV(I) or the relative cost of structures CSTR(I).

TELPV See TPROP

TPOL	PERSONAL TAXES	MILLIONS OF DOLLARS-SEE WPV

TPOL = WPV*TPOL*(CPI/XCPI) + (1.-WPV)*TPOL

TAXES = XTAX*((YPU-YDU)/(YPU-VU))*(YP-V)+TPOL

If WPV is equal to its default value of 1, TPOL should be entered in nominal dollars, if WPV is set equal to zero, TPOL can be entered in dollars of last year of history. TPOL simply changes the amount of income that is recieved as disposable income. If you also want to include an effect of the change in tax rates on the wage rate you must also use XTRPOL, the total personal tax rate policy variable.

TPROPP	PROPERTY TAX RATE	CHANGE IN PERCENTAGE POINTS
TELPV	EQUIPMENT LIFE TIME	YEARS OF LIFE
TSLPV	STRUCTURE LIFE TIME	YEARS OF LIFE

TPROP = XTPROP+TPROPP

TELM = XTELM+TELPV

TSLM = XTSLM+TSLPV

These variables enter the cost of capital variable. See the equations under the TCPPOL policy variable set above. The TELPV and TSLPV variables refer to state allowed tax lifetime for equipment. The default state equipment lifetimes usually correspond with federal allowed lifetimes.

UECPV UNEMP COMP-EACH PRIVATE SECTOR % CHANGE OF TOTAL WAGE RATE

RWR(I) = (WR(I)*(1.+UECPV(I)+WCPV(I)))/WRU(I)

RWR(I) = (WR(I)*(1.+UECPV(I)+WCPV(I)))/WRU(I)

These variables affect the wage rate whether exogenous or endogenous wages are being used (thus, two equations). The effect is to increase the cost of labor by industry but not to increase take home wages. If the new high tax rates are combined with new higher payments then VPOL should be changed accordingly.

VPOL TRANSFER PAYMENTS MILLIONS OF DOLLARS-SEE WPV

VPOL = WPV*VPOL*(CPI/XCPI) + (1.-WPV)*VPOL

V = (XV*((POP-DEPSHR*ETOT)/(POPU-ETOTU))*VU*MVPV)+VPOL

This variable works in much the same way as the TPOL variable above. However an increase in VPOL will increase disposable income while an increase in TPOL will decrease disposable income.

WADJPV EPOL OR SALPOL EFFECT ON WAGE RATES DEFAULT: YES=0. NO=1.

TE = TE+E(I)-WADJPV*EPX(I)

TE = TE+(1.-WADJPV)*(ECSD+EGSLSD)

E(NM+2) = E(NM+2)+(1.-WADJPV)*ECSD

E(NP+1) = E(NP+1)+(1.-WADJPV)*EGSLSD

OD(J) = OD(J)+OCC(I,J)*(E(I)-EPX(I)*WADJPV)

E(NM+2) = E(NM+2)-(1.-WADJPV)*ECSD

E(NP+1) = E(NP+1)O(1.-WADJPV)*EGSLSD

For WADJPV's default value of 0 exogenously introduced employment will affect wage rates if the endogenous wage rate version of the model is being used. If WADJPV is set equal to one and the endogenous wage rate version of the model is used then the exogenous direct employment or sales will not affect wage rates but all other employment changes will affect wage rates. This might be desired in a case where the direct exogeneous change is brief and will have little time to work its way into wage rates.

WCP WORKM COMP-EACH PRIVATE SECTOR % CHANGE OF TOTAL WAGE RATE

These variable affect the wage rate and cost of labor by industry in the same manner as the UECPV variables. See the equations and explanation for UECPV above. Changes in spending due to changes in WCPV must be introduced through transfer payments (VPOL).

WPV REAL (T-1) OR NOMINAL DOLLARS DEFAULT: NOMINAL=0. 1=REAL.

When WPV equals its default value of zero then you must input policy variables in nominal dollars. Thus, if your dollar input does not grow as fast as the CPI your exogenous demand will decrease as prices increase. If WPV=1 then your variable must be in the dollars of the last historical year (when XCPI was set).

WSDAPV WAGE BILL ADJ.-EACH PRIVATE SECTOR EMPLOYEES(THOUSANDS)

WSD(I) = E(I)*WR(I)*MWSDPV+(WR(I)*WSDAPV(I))

This variable is used to change the wage payment for a sector without changing the wage rate. It is expressed in employee units. Suppose you were making an exogenous addition of 10 employees to the lumber industry and it was known that these 10 employees had special skills and would be paid at 50 percent above the industry average wage. Then rather than changing the average wage we add the 10 employees to industry employment E(I) through EPOL and account for the extra wage disbursements by adding an effect of 5 extra employees with a WSDAPV for the lumber industry equal to .005. WSDAPV adjustments are made for all industries by the conjoining program and for the special translator variables below to reflect different average wage rates in the 3-digit industries that make up each 2-digit industry. When some 3-digit industries are stimulated more than others, the effect is to alter the industrial mix at the 2-digit level. This means that the conceptual industry-wide rate will change, but it would be a mistake to change the model's industry wage rate because it would make the local industry less competitive—something an industrial mix change should not do.

XCPOL EXPORT COSTS-EACH PRIVATE SECTOR COST CHANGE-% OF TOTAL COST

CCX(I) = P(I)+XCPOL(I)

This increases the comparative cost of exports only from the state. It is most often used in transportation simulations where a new transportation facility reduces export cost. It could also be used if a state subsidized or taxed all export sales.

XMNRPV NON-RESID. INV. ADJUSTMENT % OF NON-RESID. INV.

MULINR = XMULNR*XMNRPV

This variable is used to increase or decrease non-residential investment spending.

XTRPOL TOTAL TAX RATE ON WAGES CHANGE IN PERCENTAGE POINTS

TRPOL = XTRPOL

$$\mathrm{COWR}(j) = \mathrm{UK} + (\mathrm{TRPOL}-\mathrm{TRPOLL})+\mathrm{ACTCPI}*[(\mathrm{RCPIL1}/\mathrm{RCPIL2})-1.) + (\mathrm{OCCRES}(j)*\frac{\{[\mathrm{OD}(j)+.01]-\mathrm{OTRPV}]\}}{\mathrm{ODA}(j)+0.01} - 1.)+(0.15*[(\mathrm{EPR}/\mathrm{EPRA})-1.]$$

TRPOLL = TRPOL

This variable can be used to pass a tax rate increase into the nominal wage on the theory that the wage is set by supply and demand and that an increase in taxes shifts supply enough to maintain a constant real wage (if 100% is passed on).

II. Special Translator Policy Variables .

The REMI FS Model System includes a number of 'special translator' policy variables. Each translator represents a broad based economic activity that is passed to the FS model through a combination of regular policy variables by the 'SINT532' program. There are five major categories of special translators:

	Description	Translator ID Number	Units	Regular Policy Variables Affected
1)	Changes in production for agricultural sectors	101-117	millions of dollars	DEMPOL
2)	Levels of spending for construction projects	201-225	millions of dollars	DEMPOL
3)	Changes in State/Local Government activity	301-304	millions of dollars	DEMPOL
4)	Changes in tourism	401-406	thousands of visitor days	DEMPOL,SALPOL
5)	Changes in trucking costs	501-503	percentage points	MCPOL,ICPOL,XCPOL

See the Annotated Policy Variable List for a discussion of : DEMPOL , SALPOL , MCPOL , ICPOL , and XCPOL.

AGRICULTURE

There are 17 agriculture translator policy variables :

PVID	NAME/DESCRIPTION
101	DAIRY FARM PRODUCTS
102	POULTRY AND EGGS
103	MEAT ANIMALS
104	MISCELLANEOUS LIVESTOCK
105	COTTON
106	FOOD GRAINS
107	FEED GRAINS
108	GRASS SEEDS
109	TOBACCO
110	FRUITS
111	TREE NUTS
112	VEGETABLES
113	SUGAR CROPS
114	MISC. CROPS
115	OIL BEARING CROPS
116	FOREST PRODUCTS
117	GREENHSE & NURSERY PRODS

The change in production for a specific type of agriculture is entered in millions of dollars (see regular policy variable WPV), but is passed to the model as the dollar levels of output from the rest of the economy demanded by that change in production - the first round indirect effects in Input/Output terms.

DEMPOL(j) = VALUES(i) * ASD(i,j)   j=1-49

where,

VALUES(i) is the dollar value of increased production for the i'th type of agriculture

ASD(i,j) is the cents worth of the j'th sector used per dollar of the i'th agriculture sector - an input/output coefficient

The wage bill for this increase in agricultural production (FSD) is passed to the model

FSD(i) = VALUES(i) * ASD(i,50) * ASD(i,54)

where,

ASD(i,50) is the value added per dollar of production for the i'th agricultural sector

ASD(i,54) is the proportion of value added that is wages

In the model the additional agricultural employment (EFSD) implied by the change is calculated :

EFSD = FSD / (WRF * FSDWA)

where,

WRF is the average wage rate for agriculture

FSDWA is an adjustment for differential wage rates - the specific agricultural wage rate relative the the average agricultural wage rate (RWR)

The level of agricultural proprietor's income - YENT(14) - in the model is incremente by the additional agricultural employment times the average agricultural worker's proprietor's income rate, with an adjustment - FSDYA - for a sector specific rate differential (RYR).

This additional employment is NOT directly added to agricultural employment in order NOT to double count the indirect demands of the increased agricultural production.

REMI FS53 SPECIAL TRANSLATOR POLICY VARIABLES : AGRICULTURE
CENTS OF JTH SECTOR PER DOLLAR OF ITH TRANSLATOR (DOWN A COLUMN)

	101	102	103	104	105	106	107
SIC 24	.000373	.000015	.000208	.000028	.000049	.000029	.000123
SIC 25	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 32	.000439	.000012	.000056	.000052	.000049	.000029	.000304
SIC 33	.000041	.000001	.000188	0.000000	0.000000	0.000000	.000093
SIC 34	.002842	.001106	.002309	.004271	.001121	.001192	.002433
SIC 35	.005553	.002864	.007624	.002095	.009131	.008214	.009880
SIC 36	.000354	.000005	.000650	.000132	.001101	.001028	.001314
SIC 371	.000734	.000306	.000862	.000050	.000679	.000541	.000529
SIC R37	.000011	.000009	.000037	.003321	.000035	.000020	.000025
SIC 38	.000002	.000002	.000012	.000463	.000006	.000004	.000005
SIC 39	.000005	.000005	.000075	.000481	.000016	.000010	.000012
SIC 20	.177822	.466693	.157057	.267587	.000092	.000053	.000065
SIC 21	0.000000	0.000000	0.000000	.000007	0.000000	0.000000	0.000000
SIC 22	.001018	.000027	.000114	.002360	.000107	.000060	.003454
SIC 23	.000044	.000010	.000044	.000970	.000034	.000026	.000028
SIC 26	.012065	.013140	.000517	.000236	.000406	.000241	.000450
SIC 27	.000055	.000014	.000326	.000343	.000047	.000038	.000128
SIC 28	.007455	.007167	.005242	.007403	.214717	.092527	.141327
SIC 29	.010881	.010772	.014555	.022229	.050859	.061556	.065810
SIC 30	.005748	.001956	.005236	.000314	.005722	.004930	.006168
SIC 31	.000005	.000005	.000020	.025498	.000016	.000009	.000011
MINING	.000070	.000002	.000014	.000005	.004847	.006072	.009401
CONST	.007685	.005201	.006825	.002854	.010318	.009699	.008657
R-ROAD	.003811	.008335	.004684	.004226	.006396	.003993	.004795
TRUCKING	.031666	.005552	.007528	.006339	.005691	.003570	.007939
LOC-INTER	.000018	.000014	.000060	.000219	.000056	.000032	.000040
AIR	.000288	.000069	.000285	.000475	.000268	.000154	.000189
OTH-TRANS	.000676	.001207	.001246	.000196	.002551	.002392	.003043
COMM	.002807	.002489	.004426	.002901	.002344	.002718	.002463
UTILS	.010301	.009454	.015589	.009606	.014471	.007228	.010309
BANKING	.007267	.003452	.010879	.002126	.006837	.004568	.004521
INSURANCE	.005102	.002891	.006840	.002480	.007744	.007837	.006361
CRED+FIN	.000642	.000429	.000090	.000051	.000079	.000400	.000368
REAL-EST	.023193	.012622	.030803	.025239	.128342	.134081	.087206
EAT+DRINK	.000881	.000383	.000736	.000381	.000136	.000408	.000382
R-RETAIL	.000982	.011925	.001796	.004877	.000100	.000138	.000123
WHLSALE	.025134	.040521	.054770	.033217	.035190	.025285	.037293
HOTELS	.000019	.000016	.000065	.000343	.000061	.000035	.000043
PERSONAL	.000115	.000010	.000034	.000091	.000024	.000019	.000020
PRIV HH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
AUTO-REP	.003989	.001571	.004533	.001326	.003682	.002651	.002675
MISC-BUSI	.005885	.001712	.005670	.003421	.012569	.011967	.015842
AMUS+RECR	.000018	.000029	.000110	.000109	.000056	.000029	.000036
MOT PICT	.000024	0.000000	.000001	0.000000	0.000000	0.000000	0.000000
MEDICAL	.001268	.020251	.002920	.007701	.000009	.000005	.000006
MISC PROF	.002482	.001563	.002758	.000668	.001411	.001633	.001520
EDUCATION	0.000000	0.000000	0.000000	.000068	0.000000	0.000000	0.000000
NON-PROF	.000480	.000328	.000579	.000044	.000048	.000355	.000317
AFF	.027935	.134975	.031299	.011042	.194602	.020594	.020356
VAL ADDED	.393213	.089997	.235858	.319411	.266592	.557191	.495848
RWR	1.634000	1.311000	.499000	.395000	2.348000	.953000	.987000
RYR	1.956000	.236000	.354000	.160000	.766000	3.289000	2.798000
W / VA	.124000	.484000	.192000	.295000	.341000	.047000	.056000

REMI FS53 SPECIAL TRANSLATOR POLICY VARIABLES : AGRICULTURE
CENTS OF JTH SECTOR PER DOLLAR OF ITH TRANSLATOR (DOWN A COLUMN)

	108	109	110	111	112	113	114
SIC 24	.000169	.000030	.029428	.000031	.000543	.000054	.000051
SIC 25	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 32	.000169	.000030	.000044	.000031	.000024	.000071	.000051
SIC 33	0.000000	0.000000	0.000000	0.000000	0.000000	.000003	0.000000
SIC 34	.000379	.001195	.001722	.000071	.001226	.000862	.000115
SIC 35	.015265	.009973	.004337	.000097	.005230	.006343	.000157
SIC 36	.000063	.000011	.000519	.000012	.000578	.000041	.000019
SIC 371	.000267	.001001	.000070	.000050	.000406	.000086	.000081
SIC R37	.000120	.000021	.000031	.000022	.000017	.000619	.000036
SIC 38	.000022	.000004	.000006	.000004	.000003	.000088	.000007
SIC 39	.000057	.000010	.000013	.000009	.000007	.000099	.000015
SIC 20	.000319	.000057	.008973	.000058	.000045	.001256	.000095
SIC 21	.000001	0.000000	0.000000	0.000000	0.000000	.000001	0.000000
SIC 22	.000369	.007519	.000096	.000068	.000052	.000521	.000111
SIC 23	.000118	.000021	.002093	.000021	.002511	.000205	.000035
SIC 26	.001397	.000250	.007309	.000260	.002660	.000468	.000422
SIC 27	.000163	.000029	.000903	.000028	.000022	.000103	.000045
SIC 28	.111843	.025644	.223491	.196408	.106609	.196269	.367831
SIC 29	.064509	.035061	.063569	.056735	.025561	.040503	.025337
SIC 30	.045025	.010193	.003402	.000011	.003490	.004101	.000017
SIC 31	.000056	.000010	.000012	.000009	.000007	.000016	.000014
MINING	.000030	.002302	.002146	.000006	.003721	.003237	.007554
CONST	.000722	.012650	.006144	.009427	.006093	.009010	.000209
R-ROAD	.000140	.000762	.006102	.004675	.003485	.005662	.012521
TRUCKING	.016214	.002318	.005793	.000067	.006932	.004346	.006784
LOC-INTER	.000194	.000035	.000050	.000036	.000028	.000097	.000058
AIR	.000921	.000165	.000379	.000171	.000131	.000351	.000278
OTH-TRANS	.000083	.000015	.002084	.000015	.001183	.000057	.000024
COMM	.000371	.002881	.002166	.000062	.002510	.002484	.000101
UTILS	.000682	.000121	.004364	.000122	.002589	.000291	.000198
BANKING	.011963	.005056	.003362	.003605	.004493	.006779	.005562
INSURANCE	.010632	.011841	.003975	.004703	.004060	.009556	.000088
CRED+FIN	.000273	.000049	.000071	.000051	.000407	.000089	.000082
REAL-EST	.068559	.109320	.014368	.015806	.034951	.085087	.046260
EAT+DRINK	.000480	.000084	.000199	.000080	.000381	.000191	.000129
R-RETAIL	.000347	.000062	.004492	.000064	.007348	.000129	.000103
WHLSALE	.037037	.053677	.046086	.037850	.050053	.029677	.054178
HOTELS	.000210	.000038	.000055	.000039	.000030	.000123	.000063
PERSONAL	.000087	.000015	.000017	.000012	.000010	.000035	.000020
PRIV HH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
AUTO-REP	.000909	.005189	.001820	.000168	.002372	.002913	.000273
MISC-BUSI	.017894	.007558	.009949	.008500	.006583	.011085	.009153
AMUS+RECR	.000220	.000033	.000021	.000015	.000017	.000039	.000025
MOT PICT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MEDICAL	.000030	.000005	.000008	.000006	.000004	.000010	.000009
MISC PROF	.000799	.001659	.001432	.000146	.001535	.000353	.000237
EDUCATION	.000001	0.000000	0.000000	0.000000	0.000000	.000012	0.000000
NON-PROF	.000167	.000030	.000042	.000030	.000324	.000054	.000048
AFF	.058758	.024535	.068014	.069028	.053451	.048846	.044129
VAL ADDED	.519453	.658358	.455502	.585589	.638637	.519067	.416472
RWR	2.141000	3.364000	3.390000	3.457000	2.016000	2.009000	2.178000
RYR	1.450000	4.017000	1.134000	1.304000	1.534000	.914000	.632000
W / VA	.200000	.124000	.336000	.309000	.182000	.271000	.368000

REMI FS53 SPECIAL TRANSLATOR POLICY VARIABLES : AGRICULTURE
CENTS OF JTH SECTOR PER DOLLAR OF ITH TRANSLATOR (DOWN A COLUMN)

	115	116	117
SIC 24	.000024	.001127	.000045
SIC 25	0.000000	0.000000	0.000000
SIC 32	.000024	.000836	.004556
SIC 33	0.000000	.001777	0.000000
SIC 34	.001224	.045660	.001064
SIC 35	.010153	.013446	.006883
SIC 36	.001293	.001331	.000018
SIC 371	.000639	.001885	.000071
SIC R37	.000017	.016440	.000034
SIC 38	.000003	.002277	.000007
SIC 39	.000008	.002553	.000029
SIC 20	.000045	.010799	.000096
SIC 21	0.000000	.000033	.000001
SIC 22	.000052	.012011	.002281
SIC 23	.000017	.005129	.000038
SIC 26	.000199	.000407	.003415
SIC 27	.000022	.001555	.000066
SIC 28	.081534	.015302	.006271
SIC 29	.054022	.052615	.022047
SIC 30	.005892	.004677	.019482
SIC 31	.000007	.000199	.000031
MINING	.002097	.001057	.003708
CONST	.011557	.001213	.006326
R-ROAD	.002330	.002144	.001307
TRUCKING	.003946	.014359	.008368
LOC-INTER	.000028	.001201	.000053
AIR	.000131	.002444	.000250
OTH-TRANS	.082342	.001900	.000030
COMM	.002733	.001491	.003103
UTILS	.001276	.000954	.022074
BANKING	.005130	.003078	.004372
INSURANCE	.006941	.004906	.005493
CRED+FIN	.000546	.000447	.000073
REAL-EST	.092212	.007926	.017608
EAT+DRINK	.000396	.002064	.000221
R-RETAIL	.000049	.001347	.032033
WHLSALE	.021063	.029687	.064264
HOTELS	.000030	.001709	.000059
PERSONAL	.000011	.000456	.000063
PRIV HH	0.000000	0.000000	0.000000
AUTO-REP	.002863	.009520	.003144
MISC-BUSI	.015584	.017175	.022950
AMUS+RECR	.000022	.000093	.000301
MOT PICT	0.000000	0.000000	0.000000
MEDICAL	.000004	.000003	.000008
MISC PROF	.001635	.003370	.001812
EDUCATION	0.000000	.000548	.000001
NON-PROF	.000344	.000238	.000057
AFF	.025328	.177202	.018462
VAL ADDED	.629370	.521954	.713463
RWR	.864000	2.088000	2.215000
RYR	2.113000	3.482000	.799000
W / VA	.065000	.092000	.319000

CONSTRUCTION

There are 25 construction translator policy variables :

PVID	NAME/DESCRIPTION
201	NEW RES 1 UNIT STRUC, NONF
202	NEW RES GARDEN APTS. (1101
203	NEW RES ADDS & ALTER., NON
204	NEW HOTELS AND MOTELS (110
205	NEW INDUSTRIAL BUILDINGS
206	NEW OFFICE BUILDINGS
207	NEW STORES & RESTAURANTS
208	NEW RELIGIOUS BUILDINGS
209	NEW EDUCATIONAL BUILDINGS
210	NEW HOSPITAL & INST BLDGS
211	NEW OTHER NONFARM BUILDING
212	NEW TELEPHONE & TELEGR FAC
213	NEW RAILROADS
214	NEW ELECTRIC UTIL FACILITI
215	NEW GAS UTILITY FACILITIES
216	NEW PETRO. PIPELINES
217	NEW WATER SUPPLY FACILITIE
218	NEW SEWER SYSTEM FACILITIE
219	NEW HIGHWAYS & STREETS
220	NEW FARM RESID, INCL ADDS
221	NEW FARM SERVICE FACILITIE
222	NEW PETRO-NAT GAS WELL DRI
223	NEW MILITARY FACILITIES
224	NEW CONSERV & DEVELOP FAC
225	OTHER NEW NONBLDG FACIL (1

The spending level for a specific type of construction is entered in millions of dollars (see regular policy variable WPV), but is passed to the model as the dollar levels of output from the rest of the economy demanded by that change in spending - the first round indirect effects in Input/Output terms.

$$DEMPOL(j) = VALUES(i) * ASD(i,j) \qquad j=1-49$$

where,

VALUES(i) is the dollar value of increased spending for the i'th type of construction

ASD(i,j) is the cents worth of the j'th sector used per dollar of the i'th construction sector - an input/output coefficient

The spending level for this construction project is adjusted for sector specific productivity and passed to the model :

$$CSD(i) = VALUES(i) * ASD(i,56)$$

where,

CSD(i) is the dollars spent on i'th construction project

ASD(i,56) is the ratio of the specific employee per dollar output to the average employee per dollar output (REPV)

In the model the additional construction employment (ECSD) implied by the change is calculated as the spending times the employee per dollar of output (sales) times the regional purchase coefficient :

$$ECSD = CSD * (E(nm+2) / (WSD(nm+2)/ALPHA(nm+2))) * R(nm+2)$$

where,

E(nm+2) is the employment in the construction industry

WSD(nm+2) is the wage bill in the construction industry

ALPHA(nm+2) is the wage per dollar of sales for the construction industry

R(nm+2) is the regional purchase coefficient for construction

The level of construction wages - WSD(nm+2) - in the model is incremented by the additional construction employment times the average construction worker's wage rate, with an adjustment - CSDWA - for a sector specific rate differential (RWR).

The level of construction proprietor's income - YENT(nm+2) - in the model is incremented by the additional construction employment times the average construction worker's proprietor's income rate, with an adjustment - CSDYA - for a sector specific rate differential (RYR).

This additional employment is NOT directly added to construction employment in order NOT to double count the indirect demands of the increased construction spending.

REMI FS53 SPECIAL TRANSLATOR POLICY VARIABLES : CONSTRUCTION
CENTS OF JTH SECTOR PER DOLLAR OF ITH TRANSLATOR (DOWN A COLUMN)

	201	202	203	204	205	206	207
SIC 24	.174284	.086925	.178286	.043330	.007936	.019534	.023195
SIC 25	.002502	.002932	.005688	.006720	.000948	.003819	.002920
SIC 32	.083502	.070786	.061867	.095888	.055555	.093162	.089086
SIC 33	.012671	.017432	.025188	.023671	.012401	.024801	.028115
SIC 34	.057519	.082549	.097397	.108325	.341905	.194504	.171243
SIC 35	.014318	.017424	.012467	.017954	.038392	.026923	.021227
SIC 36	.012312	.015143	.030442	.020662	.016684	.030318	.031244
SIC 371	.000277	.000176	.000195	0.000000	0.000000	0.000000	0.000000
SIC R37	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 38	.001425	.001867	.001250	.002407	.002455	.004404	.004239
SIC 39	.001852	.000792	.001229	0.000000	0.000000	.000219	.000618
SIC 20	.000187	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 21	.000066	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 22	.010802	.008672	.002645	.001805	.000171	.002180	0.000000
SIC 23	.000097	.000070	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 26	.004590	.003082	.005522	.001103	.000377	.001141	.001246
SIC 27	.000303	.000062	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 28	.004441	.009007	.012308	.009829	.006075	.005633	.009305
SIC 29	.010193	.008901	.004322	.014544	.008016	.009540	.020327
SIC 30	.013591	.011481	.021747	.009428	.003403	.009467	.009557
SIC 31	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MINING	.003780	.005872	.002486	.008927	.003905	.008165	.011043
CONST	.000442	.000141	0.000000	0.000000	0.000000	.000307	.000272
R-ROAD	.007799	.004455	.006671	.002909	.003517	.003043	.003632
TRUCKING	.012910	.014307	.010198	.014142	.010780	.014559	.020223
LOC-INTER	.000138	.000044	0.000000	0.000000	0.000000	0.000000	.000084
AIR	.000881	.000387	.000325	.000702	0.000000	.000615	.000419
OTH-TRANS	.001728	.000801	.000903	0.000000	.000594	.000819	.000796
COMM	.004145	.001303	.000976	.002808	0.000000	.003029	.002701
UTILS	.001891	.000563	.000419	.001204	0.000000	.001332	.001151
BANKING	.003327	.001039	.000781	.002207	0.000000	.002444	.002177
INSURANCE	.002989	.001514	.001373	.001805	.000354	.001961	.001769
CRED+FIN	.000382	.000158	.000145	0.000000	0.000000	.000190	.000167
REAL-EST	.007344	.002307	.001735	.004915	0.000000	.005370	.004783
EAT+DRINK	.006356	.001999	.001496	.004313	0.000000	.004638	.004145
R-RETAIL	.053010	.034029	.060053	.021364	.016649	.023616	.023049
WHLSALE	.040527	.031062	.043849	.026580	.032191	.031796	.030250
HOTELS	.000206	.000062	0.000000	0.000000	0.000000	.000146	.000136
PERSONAL	.000108	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
PRIV HH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
AUTO-REP	.003470	.001664	.001684	.001505	.000514	.001536	.001287
MISC-BUSI	.012534	.006137	.006273	.005617	.002250	.005824	.004752
AMUS+RECR	.000132	.000044	0.000000	0.000000	0.000000	0.000000	0.000000
MOT PICT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MEDICAL	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MISC PROF	.032945	.059913	.003570	.071414	.028994	.071507	.068047
EDUCATION	.000044	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NON-PROF	.000692	.000220	.000159	.000502	0.000000	.000541	.000440
AFF	.001191	.001726	0.000000	0.000000	.000206	.000776	.000440
VAL ADDED	.396095	.492952	.396352	.473420	.405728	.392140	.405916
RWR	.743000	1.114000	.801000	1.151000	1.139000	1.151000	1.150000
RYR	1.080000	.743000	1.034000	.821000	.870000	.910000	.824000
W / VA	.601000	.767000	.629000	.754000	.741000	.735000	.753000
REPV	1.111560	1.159551	1.078585	.920148	.912746	.900801	.924728

REMI FS53 SPECIAL TRANSLATOR POLICY VARIABLES : CONSTRUCTION
CENTS OF JTH SECTOR PER DOLLAR OF ITH TRANSLATOR (DOWN A COLUMN)

	215	216	217	218	219	220	221
SIC 24	0.000000	0.000000	0.000000	.005459	.006229	.161830	.092303
SIC 25	0.000000	0.000000	0.000000	0.000000	0.000000	.001739	0.000000
SIC 32	.025938	.004012	.052254	.142823	.120406	.063662	.129487
SIC 33	.078203	.180610	.191228	.088992	.010068	.016317	.035195
SIC 34	.229019	.177100	.228955	.060315	.073188	.073760	.243222
SIC 35	.004420	0.000000	0.000000	.040303	.001739	.010833	.001923
SIC 36	.014887	.017551	.007236	.011012	.006975	.019326	.009787
SIC 371	0.000000	0.000000	0.000000	0.000000	.000405	0.000000	0.000000
SIC R37	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 38	.035559	.009110	.009943	.004845	0.000000	0.000000	.000634
SIC 39	0.000000	0.000000	0.000000	0.000000	.003093	0.000000	0.000000
SIC 20	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 21	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 22	0.000000	0.000000	0.000000	0.000000	0.000000	.005350	0.000000
SIC 23	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 26	0.000000	0.000000	0.000000	0.000000	.000160	.001739	.002775
SIC 27	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 28	.008646	.014459	0.000000	.002981	.007381	.009028	.005353
SIC 29	.113307	.107898	.008451	.011385	.113121	.006821	.017368
SIC 30	.008711	0.000000	.012373	.005851	.001376	.016250	.016822
SIC 31	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MINING	.014367	.013874	.002430	.020515	.057552	.003477	.015686
CONST	0.000000	0.000000	0.000000	0.000000	.000085	0.000000	0.000000
R-ROAD	.002925	.003427	.001933	.002832	.005525	.005417	.005527
TRUCKING	.010271	.009026	.007402	.015969	.021758	.007423	.013196
LOC-INTER	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
AIR	.000130	0.000000	0.000000	0.000000	.000352	0.000000	.001049
OTH-TRANS	.003120	0.000000	0.000000	.000913	.003029	0.000000	.001158
COMM	.001820	0.000000	0.000000	.002236	.000875	.001538	.000677
UTILS	.000455	0.000000	0.000000	.000578	.000373	0.000000	0.000000
BANKING	.001430	0.000000	0.000000	.001807	.000693	.001204	.000568
INSURANCE	.002015	0.000000	.005579	.004267	.002442	.001872	.002075
CRED+FIN	0.000000	0.000000	0.000000	0.000000	.000245	0.000000	0.000000
REAL-EST	.003250	0.000000	.001049	.003987	.001536	.002742	.001223
EAT+DRINK	.002795	0.000000	.000994	.003447	.001333	.002407	.001092
R-RETAIL	.022167	.016548	.025354	.010248	.013418	.050020	.043475
WHLSALE	.050900	.048809	.033252	.035813	.034578	.036378	.040308
HOTELS	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
PERSONAL	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
PRIV HH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
AUTO-REP	.003315	.004597	.001326	.003820	.003424	.002742	.001835
MISC-BUSI	.011051	.016465	.014196	.015615	.011882	.009563	.006598
AMUS+RECR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MOT PICT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MEDICAL	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MISC PROF	.013261	.010447	.021542	.026403	.020628	.029825	.005462
EDUCATION	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NON-PROF	0.000000	0.000000	0.000000	0.000000	.000149	0.000000	0.000000
AFF	0.000000	0.000000	0.000000	.000950	.000288	0.000000	0.000000
VAL ADDED	.338035	.366068	.374503	.476634	.475693	.458740	.305202
RWR	1.093000	1.100000	1.089000	1.137000	1.125000	.817000	.816000
RYR	1.336000	1.784000	.809000	1.440000	1.287000	1.140000	.982000
W / VA	.642000	.574000	.747000	.634000	.657000	.611000	.645000
REPV	.677659	.600157	.864896	.893941	.953797	1.077116	.837940

REMI FS53 SPECIAL TRANSLATOR POLICY VARIABLES : CONSTRUCTION
CENTS OF JTH SECTOR PER DOLLAR OF ITH TRANSLATOR (DOWN A COLUMN)

	208	209	210	211	212	213	214
SIC 24	.371557	.024137	.031269	.029786	.012998	.035835	.032690
SIC 25	.003826	.002784	.001109	.018811	.000818	0.000000	0.000000
SIC 32	.024292	.075423	.074044	.097055	.040840	.020225	.060655
SIC 33	.006312	.022974	.029749	.027119	.259906	.147550	.067603
SIC 34	.033569	.167859	.123659	.137677	.090259	.181485	.280507
SIC 35	.004686	.015507	.029667	.029091	.007714	0.000000	.003320
SIC 36	.007651	.031129	.035214	.027702	.035931	.058233	.038407
SIC 371	0.000000	.000196	0.000000	0.000000	.000327	0.000000	.000260
SIC R37	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 38	.001339	.003488	.005937	.005140	.000912	0.000000	.006128
SIC 39	0.000000	.000147	.000288	0.000000	0.000000	0.000000	0.000000
SIC 20	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 21	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 22	0.000000	.008204	.000966	.001750	.000397	0.000000	0.000000
SIC 23	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 26	0.000000	.001392	.001520	.001111	.000327	0.000000	.000686
SIC 27	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SIC 28	.002774	.006321	.006944	.006252	.001800	0.000000	.001238
SIC 29	.005069	.022958	.007396	.009086	.026299	.014524	.003391
SIC 30	.002104	.009416	.011464	.010420	.003062	0.000000	.001640
SIC 31	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MINING	.002391	.011905	.007396	.008808	.008018	.021311	.001877
CONST	0.000000	.000246	.000226	.000306	0.000000	0.000000	0.000000
R-ROAD	.001339	.003652	.003102	.002890	.002361	.003394	.002950
TRUCKING	.004973	.017292	.015655	.013476	.014657	.021311	.007547
LOC-INTER	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
AIR	0.000000	.000540	.000349	.000417	0.000000	0.000000	.000189
OTH-TRANS	0.000000	.000966	.000534	.000917	.000842	0.000000	.000994
COMM	0.000000	.002522	.002239	.003056	.000958	0.000000	.000568
UTILS	0.000000	.001097	.000945	.001306	.000234	0.000000	.000142
BANKING	0.000000	.002030	.001787	.002445	.000771	0.000000	.000457
INSURANCE	0.000000	.001981	.001418	.001834	.001426	0.000000	.001230
CRED+FIN	0.000000	.000196	0.000000	0.000000	0.000000	0.000000	.000181
REAL-EST	.001148	.004470	.003924	.005418	.001730	0.000000	.001009
EAT+DRINK	.001052	.003848	.003410	.004696	.001520	0.000000	.000875
R-RETAIL	.014537	.022499	.021695	.020978	.011502	.005701	.013912
WHLSALE	.023527	.029655	.028578	.031425	.031676	.039772	.035773
HOTELS	0.000000	.000131	0.000000	0.000000	0.000000	0.000000	0.000000
PERSONAL	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
PRIV HH	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
AUTO-REP	0.000000	.001736	.000966	.001639	.002758	0.000000	.002177
MISC-BUSI	.001626	.006190	.003904	.005918	.009421	.006244	.007539
AMUS+RECR	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MOT PICT	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MEDICAL	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MISC PROF	.034813	.107993	.107018	.095082	.017696	.010045	.032043
EDUCATION	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NON-PROF	0.000000	.000426	.000349	.000500	0.000000	0.000000	0.000000
AFF	0.000000	.000933	.000288	0.000000	0.000000	0.000000	0.000000
VAL ADDED	.451415	.387758	.436989	.397888	.412839	.434369	.394009
RWR	1.152000	1.153000	1.152000	1.150000	1.077000	1.081000	1.108000
RYR	.879000	.968000	.888000	.979000	.632000	.888000	.931000
W / VA	.742000	.723000	.740000	.720000	.789000	.727000	.723000
REPV	.953198	.836174	.958242	.852517	1.029518	.930562	.887949

REMI FS53 SPECIAL TRANSLATOR POLICY VARIABLES : CONSTRUCTION
CENTS OF JTH SECTOR PER DOLLAR OF ITH TRANSLATOR (DOWN A COLUMN)

	222	223	224	225
SIC 24	.001718	.016513	.011807	.028535
SIC 25	0.000000	.004832	0.000000	.000378
SIC 32	.045207	.082808	.036716	.065874
SIC 33	.121654	.034065	.022837	.014413
SIC 34	.012397	.151795	.079542	.133114
SIC 35	.049150	.019693	.005023	.009269
SIC 36	.006725	.026910	.007069	.010664
SIC 371	.001480	0.000000	.000647	.000407
SIC R37	0.000000	0.000000	0.000000	0.000000
SIC 38	0.000000	.004526	.001683	.001656
SIC 39	0.000000	.000673	0.000000	.000901
SIC 20	0.000000	0.000000	0.000000	0.000000
SIC 21	0.000000	0.000000	0.000000	0.000000
SIC 22	0.000000	.001345	0.000000	0.000000
SIC 23	0.000000	0.000000	0.000000	0.000000
SIC 26	0.000000	0.000000	0.000000	0.000000
SIC 27	0.000000	0.000000	0.000000	0.000000
SIC 28	.034657	.008684	.004169	.002121
SIC 29	.031389	.029050	.064913	.050503
SIC 30	.005374	.008623	.007664	.004417
SIC 31	0.000000	0.000000	0.000000	0.000000
MINING	.004182	.016696	.023148	.028012
CONST	0.000000	0.000000	0.000000	0.000000
R-ROAD	.011642	.002507	.002978	.003225
TRUCKING	.013480	.014617	.010823	.025891
LOC-INTER	0.000000	0.000000	0.000000	0.000000
AIR	0.000000	0.000000	0.000000	0.000000
OTH-TRANS	.004569	.000795	.002279	.001104
COMM	.000765	.001712	.000803	.000959
UTILS	0.000000	0.000000	0.000000	0.000000
BANKING	.000626	.001407	.000647	.000726
INSURANCE	.004669	.002079	.002097	.002179
CRED+FIN	.001113	0.000000	0.000000	0.000000
REAL-EST	.001351	.002997	.001398	.001627
EAT+DRINK	.001192	.002630	.001217	.001482
R-RETAIL	.006169	.019754	.009373	.010141
WHLSALE	.031250	.030090	.024909	.023769
HOTELS	0.000000	0.000000	0.000000	0.000000
PERSONAL	0.000000	0.000000	0.000000	0.000000
PRIV HH	0.000000	0.000000	0.000000	0.000000
AUTO-REP	.012496	.003670	.005437	.003603
MISC-BUSI	.043170	.013638	.018824	.013890
AMUS+RECR	0.000000	0.000000	0.000000	0.000000
MOT PICT	0.000000	0.000000	0.000000	0.000000
MEDICAL	0.000000	0.000000	0.000000	0.000000
MISC PROF	.001281	.074674	.028689	.058436
EDUCATION	0.000000	0.000000	0.000000	0.000000
NON-PROF	0.000000	0.000000	0.000000	0.000000
AFF	0.000000	.001223	0.000000	.000581
VAL ADDED	.552294	.421993	.625307	.502121
RWR	1.365000	1.145000	1.117000	1.126000
RYR	1.014000	1.157000	1.233000	1.417000
W / VA	.747000	.684000	.665000	.635000
REPV	.929433	.834191	1.246161	.948379

STATE/LOCAL GOVERNMENT

There are four state/local government translator policy variables :

PVID	NAME/DESCRIPTION
301	EDUCATION PURCHASES BY STATE/LOCAL GOVERNMENT
302	HEALTH,WELFARE,SANITATION PURCHASES BY STATE/LOCAL GOVERNMENT
303	SAFETY PURCHASES BY STATE/LOCAL GOVERNMENT
304	OTHER GEN PURCHASES BY STATE/LOCAL GOVERNMENT

The change in a specific type of activity is entered in millions of dollars (see regular policy variable WPV), but is passed to the model as dollar levels of production across specific sectors needed to support that level of activity - the first round indirect effects in Input/Output terms.

$$DEMPOL(j) = VALUES(i) * ASD(i,j) \qquad j = 1\text{-}49$$

where,

VALUES(i) is the dollar value of increased activity for the i'th type of state/local government.

ASD(i,j) is the cents worth of the j'th sector used per dollar of the i'th state/local government activity - an input/output coefficient.

Further, the wage bill paid to the state/local government workers (GSLSD) , associated with this increased activity, is calculated and passed to the model :

$$GSLSD(i) = VALUES(i) * ASD(i,50)$$

where,

ASD(i,50) is the cents worth of labor per dollar of activity (for government all of value added is considered labor)

In the model the additional state/local government employment (EGSLSD) implied by the change is calculated as :

$$EGSLSD = GSLSD / WR(np+1)$$

where,

WR(np+1) is the wage rate for state/local government workers

This additional employment is NOT directly added to state/local government employment in order NOT to double count it's indirect demand across the rest of the economy.

REMI FS53 SPECIAL TRANSLATOR POLICY VARIABLES : STATE/LOCAL GOVT.
CENTS OF JTH SECTOR PER DOLLAR OF ITH TRANSLATOR (DOWN A COLUMN)

	301	302	303	304
SIC 24	.000655	0.000000	.000097	0.000000
SIC 25	.004908	.001098	.002027	.002650
SIC 32	.001085	.004024	.001158	.000179
SIC 33	.000039	0.000000	.000338	.000033
SIC 34	.002268	.000573	.001786	.000276
SIC 35	.009698	.003627	.002172	.008731
SIC 36	.004223	.002243	.004778	.004130
SIC 371	.004370	.003181	.017665	.018485
SIC R37	.000117	0.000000	.003427	.001967
SIC 38	.003412	.012534	.002124	.003544
SIC 39	.006247	.001432	.000579	.002569
SIC 20	.025497	.026611	.008398	.000114
SIC 21	0.000000	0.000000	0.000000	0.000000
SIC 22	.000284	.001813	.000483	.000065
SIC 23	.000225	.002450	.004633	.000325
SIC 26	.005230	.004979	.001979	.004406
SIC 27	.022584	.003849	.001062	.013218
SIC 28	.005846	.038955	.000965	.004682
SIC 29	.007029	.005217	.007191	.006715
SIC 30	.000948	.003977	.005357	.000439
SIC 31	0.000000	.000080	.000676	0.000000
MINING	.000205	.000143	0.000000	.001138
CONST	.093698	.042534	.041701	.480555
R-ROAD	.000987	.001018	.000531	.001203
TRUCKING	.004077	.009067	.002992	.004942
LOC-INTER	.009141	.001209	.000483	.001951
AIR	.001740	.001527	.001014	.003902
OTH-TRANS	.000372	.000986	.000338	.000537
COMM	.006325	.006076	.005550	.019737
UTILS	.031207	.007206	.007722	.024322
BANKING	0.000000	0.000000	0.000000	.038076
INSURANCE	.003920	.005010	.000676	.002699
CRED+FIN	0.000000	0.000000	.001738	.003219
REAL-EST	.005455	.013345	.002799	.020583
EAT+DRINK	-.041022	.002672	.000821	.004520
R-RETAIL	-.003578	.010339	0.000000	.000602
WHLSALE	.014186	.018579	.007288	.007560
HOTELS	-.005866	.004406	.001738	.006373
PERSONAL	.003070	.012518	0.000000	0.000000
PRIV HH	0.000000	0.000000	0.000000	0.000000
AUTO-REP	.001232	.000859	.005164	.005674
MISC-BUSI	.018566	.024766	.006226	.021558
AMUS+RECR	-.006316	.000048	.000097	-.001333
MOT PICT	.000254	.000032	.000145	.000049
MEDICAL	-.006316	.247026	0.000000	0.000000
MISC PROF	.012729	.029284	.002462	.024728
EDUCATION	-.000684	.000095	.000917	.000325
NON-PROF	0.000000	0.000000	0.000000	0.000000
AFF	.000626	.000159	0.000000	.000537
VAL ADDED	.751325	.444455	.842705	.254016

TOURISM

There are six tourism translator policy variables :

PVID	NAME/DESCRIPTION
401	VISITORS-COMMERCIAL LODGING
402	RENTALS, MISC. ACCOM
403	LODG W/FRIEND OR RELATIVE
404	CAMPING
405	TOURIST-DAY TRIPS
406	TOTAL TOURISTS

The change in a particular type of tourism is entered in thousands of tourist visitor days per year, but is passed to the model as tourist dollars spent across specific sectors:.

DEMPOL(j) = VALUES(i) * TUREXP(i,j)   j = 1-37 ; j = 39-49

SALPOL(j) = VALUES(i) * TUREXP(i,j)   j = 38   (HOTELS)

where,

VALUES(i) - is the number of tourist visitor days for the i'th type of tourist.

TUREXP(i,j) is the dollars spent per i'th tourist visitor day in the j'th sector.

STATE/LOCAL GOVERNMENT

There are four state/local government translator policy variables :

PVID	NAME/DESCRIPTION
301	EDUCATION PURCHASES BY STATE/LOCAL GOVERNMENT
302	HEALTH,WELFARE,SANITATION PURCHASES BY STATE/LOCAL GOVERNMENT
303	SAFETY PURCHASES BY STATE/LOCAL GOVERNMENT
304	OTHER GEN PURCHASES BY STATE/LOCAL GOVERNMENT

The change in a specific type of activity is entered in millions of dollars (see regular policy variable WPV), but is passed to the model as dollar levels of production across specific sectors needed to support that level of activity - the first round indirect effects in Input/Output terms.

DEMPOL(j) = VALUES(i) * ASD(i,j)   j = 1-49

where,

VALUES(i) is the dollar value of increased activity for the i'th type of state/local government.

ASD(i,j) is the cents worth of the j'th sector used per dollar of the i'th state/local government activity - an input/output coefficient.

Further, the wage bill paid to the state/local government workers (GSLSD) , associated with this increased activity, is calculated and passed to the model :

GSLSD(i) = VALUES(i) * ASD(i,50)

where,

ASD(i,50) is the cents worth of labor per dollar of activity (for government all of value added is considered labor)

In the model the additional state/local government employment (EGSLSD) implied by the change is calculated as :

EGSLSD = GSLSD / WR(np+1)

where,

WR(np+1) is the wage rate for state/local government workers

This additional employment is NOT directly added to state/local government employment in order NOT to double count it's indirect demand across the rest of the economy.

TRUCKING COSTS

There are three trucking cost translator policy variables :

PVID	NAME/DESCRIPTION
501	TRUCKING COSTS FOR IMPORTED GOODS AND SERVICES
502	TRUCKING COSTS FOR EXPORTED GOODS AND SERVICES
503	TRUCKING COSTS FOR GOODS AND SERVICES SHIPPED WITHIN-STATE

The change in a particular type of trucking cost is entered as the percent change in the cost of truck transport, but is passed to the model as a percent change in the appropriate total cost of doing business across specific sectors :

MCPOL(j) = VALUES(i) * TRKCOS(1,j)   j = 1-49

XCPOL(j) = VALUES(i) * TRKCOS(2,j)   j = 1-49

ICPOL(j) = VALUES(i) * TRKCOS(3,j)   j = 1-49

where,

VALUES(i)   is the percent change in trucking cost for the i'th type.

TRKCOS(i,j)   is the i'th trucking cost as a proportion of the j'th sector's total cost of doing business.

REMI FS53 SPECIAL TRANSLATOR POLICY VARIABLES : TRUCK COSTS

TRUCKING COSTS AS A PERCENT OF TOTAL COST PER SECTOR (DOWN A COLUMN)

	501	502	503
SIC 24	.012000	.012000	.012000
SIC 25	.002000	.002000	.002000
SIC 32	.030000	.030000	.030000
SIC 33	.011000	.011000	.011000
SIC 34	.017000	.017000	.017000
SIC 35	.004000	.004000	.004000
SIC 36	.003000	.003000	.003000
SIC 371	.001000	.001000	.001000
SIC R37	.001000	.001000	.001000
SIC 38	.003000	.003000	.003000
SIC 39	.014000	.014000	.014000
SIC 20	.008000	.008000	.008000
SIC 21	.020000	.020000	.020000
SIC 22	.025000	.025000	.025000
SIC 23	.003000	.003000	.003000
SIC 26	.047000	.047000	.047000
SIC 27	.004000	.004000	.004000
SIC 28	.020000	.020000	.020000
SIC 29	.150000	.150000	.150000
SIC 30	.022000	.022000	.022000
SIC 31	.001000	.001000	.001000
MINING	.070000	.070000	.070000
CONST	0.000000	0.000000	0.000000
R-ROAD	0.000000	0.000000	0.000000
TRUCKING	0.000000	0.000000	0.000000
LOC-INTER	0.000000	0.000000	0.000000
AIR	0.000000	0.000000	0.000000
OTH-TRANS	0.000000	0.000000	0.000000
COMM	0.000000	0.000000	0.000000
UTILS	0.000000	0.000000	0.000000
BANKING	0.000000	0.000000	0.000000
INSURANCE	0.000000	0.000000	0.000000
CRED+FIN	0.000000	0.000000	0.000000
REAL-EST	0.000000	0.000000	0.000000
EAT+DRINK	.001000	.001000	.001000
R-RETAIL	.001000	.001000	.001000
WHLSALE	.010000	.010000	.010000
HOTELS	0.000000	0.000000	0.000000
PERSONAL	0.000000	0.000000	0.000000
PRIV HH	0.000000	0.000000	0.000000
AUTO-REP	0.000000	0.000000	0.000000
MISC-BUSI	0.000000	0.000000	0.000000
AMUS+RECR	0.000000	0.000000	0.000000
MOT PICT	0.000000	0.000000	0.000000
MEDICAL	0.000000	0.000000	0.000000
MISC PROF	0.000000	0.000000	0.000000
EDUCATION	0.000000	0.000000	0.000000
NON-PROF	0.000000	0.000000	0.000000
AFF	0.000000	0.000000	0.000000

APPENDIX XX.

THE MASSACHUSETS ECONOMIC POLICY ANALYSIS MODEL TRACK RECORD: 1977-1983

Final Comments

The Northeastern United States has been viewed as having a strong, high-quality health care system. Yet, quality is also evident in other parts of the country. In fact, changes among providers, consumers, and corporations that have affected the delivery and cost of health care have been more pronounced outside the Northeast. The next few years in Massachusetts may see similar upheavals and hopefully benefits, as health care becomes increasingly competitive.

Footnotes

1. Robert Teitelman, "Taking the Cure," *Forbes* (June 4, 1984), 82.91
2. *New York Times* (March 29, 1982).
3. *Medical Economics* (May 30, 1983).

The Massachusetts Economic Policy Analysis Model Track Record: 1977 — 1983

John Lanzillo
Margaret Larson
George I. Treyz
Roy E. Williams

The Massachusetts Economic Policy Analysis (MEPA) model has been used to make forecasts of the state economy extending out for three years quarterly for the last seven years. Since mid-1978 these forecasts have been published quarterly in the Massachusetts Business and Economic Report. Table 1 shows the mean absolute percentage error for the forecasts made in January in each of those years.

The MEPA mean absolute percentage errors for the major concepts predicted by the model are shown in the first column of Table 1. The errors for the comparable variables in the U.S. forecasts by Data Resources, Inc. (DRI) on which the MEPA Massachusetts forecasts were based are shown in the second column. The MEPA forecasts were made at a much more detailed level and then aggregated. The DRI inputs actually used were also on a much more detailed level than these aggregate variables. For each MEPA forecast, 94 U.S. variables were used including employment forecasts for each of 28 U.S. industries. However, the forecast errors are given for MEPA and DRI aggregate forecast variables to provide a summary basis for evaluating the size of the error. Surprisingly, the error in the state forecasts was usually *smaller* than the error in the U.S. forecasts used as inputs. This result is difficult to explain because the state forecast was made conditional on the U.S. forecast.

In Table 2, the first three variables are employment variables. Here we note that the MEPA average absolute error (Table 1) in predicting employment in manufacturing was two percent in the first year and about five percent in the second and third years while the error in predicting non-manufacturing was slightly more than half this amount. Despite the relatively good performance of the Massachusetts economy relative to the U.S. when compared with the period preceding 1977, we still note by looking at the percent error (Table 2) an upward bias in the MEPA forecasts after the first year of forecast.

Our hypothesis is that this bias as well as a substantial proportion of the error in the MEPA forecast was due to the forecast's conditionality on a U.S. forecast that itself was in error. To test this definitively, we could reproduce each of the MEPA forecasts from 1977-1983 with all inputs to the model the same except for the U.S. forecast. Instead, we examined the errors in each of the individual MEPA and DRI forecasts. We found that the correlation between the employment forecast errors was .91. This high correlation indicates that a high proportion of the MEPA error is probably due to the error in the DRI forecast.

The consumer price index forecast is a prediction of the Boston area All-Urban Consumer Price Index. This forecast is closely related to the DRI forecast of the U.S. Consumer Price Index. Therefore, it is not surprising to find very close forecast records. An examination of the individual forecasts shows underpredictions of inflation in the earlier forecasts and overpredictions in the later forecasts.

The MEPA forecasts of personal income and personal disposable income are outcomes of a full simultaneous solution of the MEPA model. Thus, they are not directly related to the DRI income forecasts. Here, we find MEPA errors of about one percent in the first year, three percent in the second year and four percent in the third year. Table 2 shows a slight tendency by both MEPA and by DRI to overpredict the level of personal income. The correlation between the errors in the MEPA and DRI personal income forecasts was .92. Comparing MEPA and DRI forecasts, we find that the DRI forecast error is again slightly higher. This is hard to explain since one would expect that errors made in the national forecast would be incorporated into the state forecast and that, then, additional error would arise from errors introduced by the MEPA model. Our only explanation, is that judgmental fine tuning adjustments of the MEPA forecast may have offset, in part, errors in the national forecast inputs used by the model.

In summary, there is evidence that any error that might have been inherent in the MEPA model was more than offset by fine tuning of the MEPA forecast in the presence of errors in the U.S. forecast. This forecast record provides important indirect evidence validating the structural relationships incorporated into the MEPA model and in other current state models that incorporate the same modeling approach.

Table 1

Mean Absolute Percentage Error for Ex Ante Forecasts 1977-1983

	MEPA Massachusetts Forecasts	DRI U.S. Forecasts
Total Employment		
One Year Ahead	1.4	1.1
Two Years Ahead	3.2	2.3
Three Years Ahead	3.4	3.1
Manufacturing Employment		
One Year Ahead	2.2	2.9
Two Years Ahead	4.9	6.1
Three Years Ahead	5.0	5.3
Non-Manufacturing Employment		
One Year Ahead	1.4	0.8
Two Years Ahead	2.6	1.8
Three Years Ahead	3.1	2.6
Consumer Price Index		
One Year Ahead	1.3	2.0
Two Years Ahead	4.6	5.4
Three Years Ahead	8.2	9.6
Personal Income		
One Year Ahead	1.1	1.4
Two Years Ahead	3.2	3.9
Three Years Ahead	4.1	6.1
Disposable Income		
One Year Ahead	1.2	1.2
Two Years Ahead	2.8	3.7
Three Years Ahead	3.7	5.6

Table 2

Mean Percent Error for Ex Ante Forecasts 1977-1983

	MEPA Massachusetts Forecasts	DRI U.S. Forecasts
Total Employment		
One Year Ahead	-0.6	-0.5
Two Years Ahead	0.4	0.4
Three Years Ahead	1.6	1.6
Manufacturing Employment		
One Year Ahead	-0.8	-1.3
Two Years Ahead	2.4	0.9
Three Years Ahead	4.7	1.9
Non-Manufacturing Employment		
One Year Ahead	-0.5	-0.5
Two Years Ahead	-0.2	-0.3
Three Years Ahead	0.7	0.5
Consumer Price Index		
One Year Ahead	0.1	-0.7
Two Years Ahead	-0.3	-1.5
Three Years Ahead	-2.2	-4.4
Personal Income		
One Year Ahead	-0.1	-0.3
Two Years Ahead	0.6	0.7
Three Years Ahead	1.3	1.0
Disposable Income		
One Year Ahead	0.4	0.1
Two Years Ahead	1.6	1.4
Three Years Ahead	2.2	1.5

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APPENDIX XXI.

SCALE ECONOMICS AT LAND DISPOSAL FACILITIES

Landfill

Disposal Costs Are Based On Daily Tonnage

By Kevin D. Grant
and
Douglas W. Cooper, Ph.D.

COST considerations, as anyone who has studied the subject knows, play a major role in selecting alternatives for disposing of solid wastes. This paper presents an itemized analysis of municipal landfill disposal costs, from which an estimating model for average landfill costs was formulated. Not surprisingly, the analysis demonstrates that daily disposal tonnage is the most significant factor affecting average landfill costs.

Generally, the study concludes, lower costs per ton are realized as a landfill's operating capacity increases. In addition, it was noted that environmental protection regulations, while imposing relatively small cost increases on large capacity landfills (as low as $1.47/ton for a 1,750-ton-per-week facility), might very well impose increases on small facilities (those handling less than 350 tons per week) approaching $20 a ton.

This analysis is separated into two components: operational and regulatory costs. Operational costs were taken as the capital and variable costs of daily landfill operation, such as labor, equipment and fill material. The opportunity cost of resources were owned by the community or purchased for use. Capital costs were amortized; inflation was accounted for and an additional 6% discount rate was applied.

Capacity, as measured in tons per day, was derived by dividing yearly tonnage by 365 days. It was assumed that the landfills operated on a five-day week (a three-day week for the 10 TPD landfill). Therefore, a landfill would actually handle seven-fifths of the daily tonnage given.

A refuse-to-fill-ratio of 2:1 was used for all capacities, with the exception of the 250-TPD landfill for which a 3:1 refuse-to-fill ratio was used.

Cost Data

Tables 1 and 2 present results of analyses of landfill disposal costs for five hypothetical facilities.[1] Table 1 presents data for costs that would be incurred from a typical, well-operated landfill. The data given in Table 2 are the additional costs that could be incurred from groundwater, surface water and safety requirements.

The analysis shows that the average cost of landfill disposal ($/ton) decreases as a landfill's daily tonnage increases. The relationship found from our cost estimates was that total cost was proportional to capacity (in TPD) to the 0.6 power. This relationship is similar to other cost/capacity relationships observed in major engineering projects.[2] (Bridgwater and Mumford[3] summarized many such relationships for processes and equipment related to waste management and listed landfill as proportional to the 0.9 power of capacity.)

Increasing returns to scale were noted within the range of landfill capacities analyzed. The relationship in terms of average cost was:

$$C_A/C_B = (Q_B/Q_A)^{0.4}$$

where C_A is the average cost per ton for landfill A of capacity Q_A (in TPD) and C_B is the average cost per ton for landfill B (assumed to be known) of capacity; the closer the capacities are, the more accurate the estimate (Q_A and Q_B should be within an order of magnitude of each other). This relationship can be employed to estimate landfill costs in the following manner: Q_B, an existing landfill of 100 TPD has C_B = $12; the estimate for C_A for Q_A = 25 TPD is:

$$C_A = (\$12)(100/25)^{0.4} = \$21$$

The largest cost factors (excluding regulatory costs) for all landfill capacities analyzed were those for equipment and labor. (Equipment plus labor was $19.16/ton for a 10-TPD landfill and $3.87/ton for a 250-TPD landfill). The average cost of equipment and labor for small facilities was estimated to exceed total operational and regulatory induced cost for a large operation.

Economies of scale were observed for operational and environmental regulatory costs. Groundwater protection requirements could result in a maximum $3/ton cost increase at 250-TPD landfill while a 10-TPD or 25-TPD landfill could be expected to have additional increases of $12/ton and $9/ton, respectively.

Points to Consider

There are three points about landfill disposal of refuse that require discussion. First, there appears to be an abundance of small landfill operations. According to one industry survey, more than 80% of municipal landfills are operating under 50 TPD, and more than 95% are under 100 TPD.[3] In view of our analysis, landfills operating at less than 50 TPD are in general uneconomical. The increasing returns to scale offered by larger landfills may not have been considered by communities.

Second, we found that communities often underestimate their disposal cost. In a recent analysis prepared by the Mitre Corp. and the Massachusetts Bureau of Solid Waste Disposal, communities reported their average landfill cost to be $7/ton.[4] An analysis of actual cost incurred at these same landfills indicated that costs were more than $11/ton.[5] We estimate that the average landfill cost for these landfills should have been more than $18/ton for a proper facility operation. Communities may underestimate cost by not counting all costs and/or operate landfills in an unsound manner. Such underestimation of landfill costs by communities will result in suboptimal solutions for solid waste disposal problems.

Third, consider the problem of enforcing landfill regulations. It is difficult to inspect and enforce regulations on a large number of small landfills. According to the Massachusetts Open Dump Inventory, almost 70% of the 273 operating landfills in the Commonwealth were out of compliance with one or more of the landfill regulations.

OCT 1983

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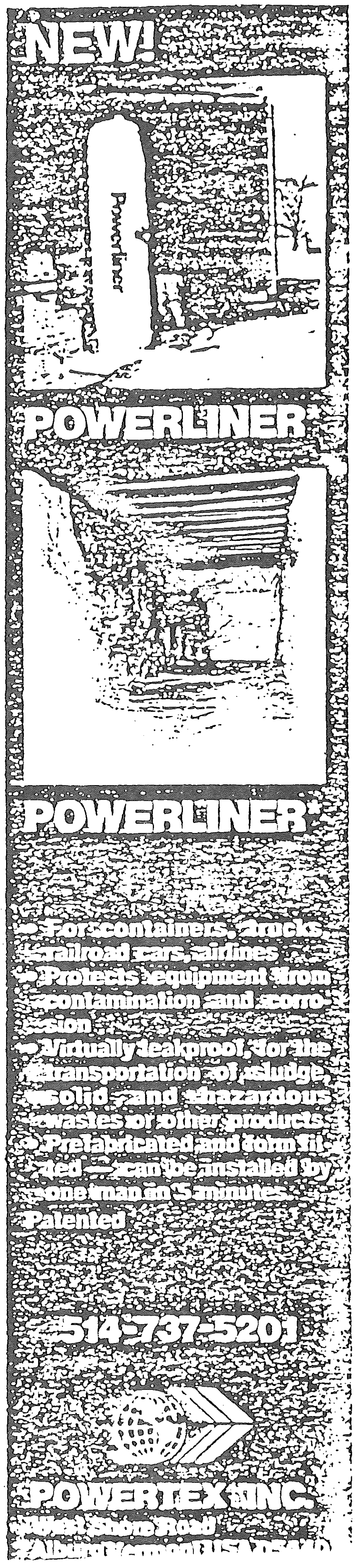

Table 1: Landfill Cost — Typical Operation

	Annualized operational cost ($/ton) Facility Size (TPD)				
	10	25	50	100	250
1. Preliminary studies	.73	.30	.15	.09	.03
2. Land	.24	.19	.16	.15	.06
3. Site preparation	.84	.66	.57	.53	.21
4. Fill material	1.27	1.10	1.10	1.10	.75
5. Utilities	.28	.20	.17	.14	.06
6. Roadways	1.30	1.09	.97	1.08	.43
7. Fencing	.55	.31	.21	.28	.11
8. Equipment	10.02	7.29	5.43	3.76	2.38
9. Buildings	1.49	.60	.45	.30	.12
10. Labor	9.14	4.40	3.55	2.62	1.49
11. Miscellaneous	.21	.11	.08	.08	.03
12. Final cover	1.26	1.13	1.08	1.08	.43
13. Engineering	1.26	.93	.80	.78	.41
Total Cost/Ton	28.59	18.31	15.71	11.99	6.51

Economic Sense

Landfill disposal of solid waste seems likely to continue to be an economical solution. However, the current distribution of landfill capacities indicates instances in which refuse is probably being disposed of in an uneconomical manner. Single-community solutions for waste disposal are often uneconomical, imposing unnecessary costs upon taxpayers. It is also more difficult and more costly to regulate a large number of small landfills. Environmental and safety regulations impose a substantially lower cost per ton on large facilities and on their regulators than on smaller landfills and their regulators.

Community officials should join together and investigate methods to reduce their solid waste costs while improving their current disposal practices. When considering regional solutions, hauling costs (based on haul time) become an important economic consideration. Even so, regional disposal alternatives are likely to be cost-effective for a large majority of communities.[1]

More options are available for siting a regional landfill than are available to a single community. A regional or multi-community facility can be sited away from environmentally-sensitive areas, and a larger total amount of money can be spent on environmental safety. □

[1]Detailed Cost Analysis of Municipal Waste Disposal Alternatives. K. D. Grant, Harvard School of Public Health, Boston MA, May 1981.
[2]de Neufuille, R. and Stafford, J. H. Systems Analysis for Engineers and Managers, McGraw-Hill, New York, 1971, pp. 192-194.
[3]Survey of U.S Disposal Practices. *Waste Age*, January 1978, pp. 40–41.
[4]Detailed Feasibility Study Report for the Central Massachusetts Resource Recovery Project. Mitre Technical Report, MTR 80 W00070, Mitre Corp., Bedford MA, 1980, p. 33.
[5]Analysis of Landfill Costs. T. Lynch, Massachusetts Bureau of Solid Waste Disposal, Boston MA, 1980
[6]Massachusetts Open Dump Inventory, an Intradepartmental Report of the DEQE. K. Morton, Massachusetts Division of Environmental Quality Engineering, Boston MA, 1981.
[7]Bridgewater, A. V. and Mumford, C. J. Waste Recycling and Pollution Control Handbook, van Nostrand Reinhold, New York, pp. 632-635.

Table 2: Estimated Additional Cost of Environmental Regulations

	Annualized Cost ($/ton) Facility Size (TPD)				
	10	25	50	100	250
1. Base material					
A. Sand only	1.29	.93	.87	.81	.33
B. Clay base	3.91	3.00	2.65	2.46	.99
C. Synthetic base	10.54	8.12	7.15	6.63	2.66
2. Leachate collection	2.03	1.25	1.01	.84	.39
3. Leachate treatment and storage	.36	.20	.23	19	.08
4. Leachate monitoring	1.37	55	.41	.27	.22
5. Gas venting and monitoring	2.65	1.50	1.00	.69	.27
6 Engineering	1.47	66	51	.39	.18
Total cost/ton					
Sand base	8.87	5.21	4.03	3.19	1.47
Clay base	12.78	8.21	6.68	5.65	2.46
Synthetic base	19.71	13.33	11.18	9.82	4.13
7 Flood plain or wetlands protection	[illegible]	[illegible]			

APPENDIX XXII.

ECONOMIC SIMULATION OF PROPOSED RULES: INPUT VALUES

TABLE I

SWM SYSTEM DEVELOPMENT & 02:08:53 PM
PCA RULE-IMPOSED COSTS: 01/28/88
1988 - 1995

YEAR / CATEGORY	Units	Line #	Unit costs	# of units	Total costs
				1984	
I. CAPITAL ELEMENTS					
Number of sites closed				3	
COSTS	Units	Line #	Unit costs	# of units	Total costs
Upgrade monitoring syst.:					
Water	wells	1	$5,500	20	$110,000
Gas	acres	2	$3,000	0	$0
Install final cover	acres	3	$32,000	75	$2,400,000
Sub-total		4	$40,500		$2,510,000
Engineering cost	15%	5	$6,075		$376,500
Total		6	$46,575		$2,886,500
Number of sites operating		7		110	
COSTS		8			
Begin hydro studies	lump sum	9	$155,000	3	$465,000
Install liners	acres	10	$120,000	10	$1,200,000
Install monitoring syst.	wells	11	$5,500	30	$165,000
Corrective actions	lump sum	12	$1,438,000		$0
Land	acres	13	$500		$0
Sub-total		14	$1,719,000		$1,830,000
Engineering cost	15%	15	$257,850		$274,500
Engineering studies	lump sum	16	$15,000	3	$45,000
Total		17	$1,991,850		$2,149,500
Total capital costs		18	$2,038,425		$5,036,000
		19			
II. ANNUAL ELEMENTS		20			
Number of sites closed		21		3	
COSTS		22			
Post-closure care	acres	23	$6,000	75	$450,000
Accum. annual P-C costs:		24			
1984		25			$450,000
1985		26			
1986		27			
1987		28			
1988		29			
1989		30			
1990		31			
1991		32			
1992		33			
1993		34			
1994		35			
1995		36			
Total annual P-C costs		37			$450,000
Number of sites operating		38		110	
COSTS		39			
Operational changes:		40			
sampling (groundwater)	wells X 3/yr	41	$550	440	$242,000
sampling (gas)	acres	42	$200		$0
cover	acres	43	$24,000	1,100	$26,400,000
training	lump sum	44	$1,000	110	$110,000
industrial waste mgmt.	lump sum	45	$6,000		$0
leachate treatment	gallons	46	$0.09		$0
liner maintenance	hours	47	$100		$0
leachate testing	samples	48	$200		$0
Financial assurance:		49			
reserve accumulations	C + PC + CA	50	$513,927		$0
service charges	2% of above	51	2.00%		$0
		52			
Corrective actions	lump sum	53	$69,000		$0
Accum. annual CA costs:		54			
1988		55			
1989		56			
1990		57			
1991		58			
1992		59			
1993		60			
1994		61			
1995		62			
Total annual C. A.		63			$0
Total: operating		64			$26,752,000
		65			
SWM - alternative sites		66			
Accumulated annual costs:	lump sum	67	$10,300		
Transportation costs	tons/mile	68			
		69			
Total: operating		70			
		71			
MPCA admin. costs	lump sum	72	$444,000		
		73			
		74			
		75			
Total annual costs		76			$27,202,000
Total capital costs		77			$5,036,000
		78			
GRAND TOTAL		79			$32,238,000

	1985		1986	
	1		3	
Line #	# of units	Total costs	# of units	Total costs
1	8	$44,000	20	$110,000
2	0	$0	0	$0
3	25	$800,000	75	$2,400,000
4		$844,000		$2,510,000
5		$126,600		$376,500
6		$970,600		$2,886,500
7			105	
8				
9	6	$930,000	10	$1,550,000
10		$0	20	$2,400,000
11	60	$330,000	100	$550,000
12		$0		$0
13		$0		$0
14		$1,260,000		$4,500,000
15		$189,000		$675,000
16	6	$90,000	10	$150,000
17		$1,539,000		$5,325,000
18		$2,509,600		$8,211,500
19				
20				
21	1		3	
22				
23	25	$150,000	75	$450,000
24				
25		$450,000		$450,000
26		$150,000		$150,000
27				$450,000
28				
29				
30				
31				
32				
33				
34				
35				
36				
37		$600,000		$1,050,000
38	107		105	
39				
40				
41	428	$235,400	420	$231,000
42		$0		$0
43	1,070	$25,680,000	1,050	$25,200,000
44	107	$107,000	105	$105,000
45		$0		$0
46		$0		$0
47		$0		$0
48		$0		$0
49				
50		$0		$0
51		$0		$0
52				
53		$0		$0
54				
55				
56				
57				
58				
59				
60				
61				
62				
63		$0		$0
64		$26,022,400		$25,536,000
65				
66				
67				
68				
69				
70				
71				
72				
73				
74				
75				
76		$26,622,400		$26,586,000
77		$2,509,600		$8,211,500
78				
79		$29,132,000		$34,797,500

	1987		1988	
	4		32	
Line #	# of units	Total costs	# of units	Total costs
1	32	$176,000	307	$1,688,500
2	0	$0	615	$1,845,000
3	100	$3,200,000	615	$19,680,000
4		$3,376,000		$23,213,500
5		$506,400		$3,482,025
6		$3,882,400		$26,695,525
7	101		82	
8				
9	6	$930,000	15	$2,325,000
10	20	$2,400,000	197	$23,640,000
11	60	$330,000	156	$858,000
12		$0	6	$8,628,000
13	20	$10,000	150	$75,000
14		$3,670,000		$35,526,000
15		$550,500		$5,328,900
16	6	$90,000	82	$1,230,000
17		$4,310,500		$42,084,900
18		$8,192,900		$68,780,425
19				
20				
21	4		32	
22				
23	100	$600,000	615	$3,690,000
24				
25		$450,000		$450,000
26		$150,000		$150,000
27		$450,000		$450,000
28		$600,000		$600,000
29				$3,690,000
30				
31				
32				
33				
34				
35				
36				
37		$1,650,000		$5,340,000
38	101		82	
39				
40				
41	404	$222,200	331	$182,050
42	20	$4,000	165	$33,000
43	1,010	$24,240,000	165	$3,960,000
44	101	$101,000	82	$82,000
45		$0	82	$492,000
46	2,000	$180	10,250,000	$922,500
47	20	$2,000	1,600	$160,000
48	12	$2,400	82	$16,400
49				
50		$0	82	
51		$0		
52				
53		$0	6	$414,000
54				
55				$414,000
56				
57				
58				
59				
60				
61				
62				
63		$0		$414,000
64		$24,571,780		$6,261,950
65				
66			15	
67				$154,500
68				
69				
70				$154,500
71				
72				$444,000
73				
74				
75				
76		$26,221,780		$12,200,450
77		$8,192,900		$68,780,425
78				
79		$34,414,680		$80,980,875

	1989		1990	
	12		4	
Line #	# of units	Total costs	# of units	Total costs
1	93	$511,500	28	$154,000
2	377	$1,131,000	120	$360,000
3	377	$12,064,000	120	$3,840,000
4		$13,706,500		$4,354,000
5		$2,055,975		$653,100
6		$15,762,475		$5,007,100
7	70		66	
8				
9	15	$2,325,000	15	$2,325,000
10	210	$25,200,000	198	$23,760,000
11	156	$858,000	105	$577,500
12	6	$8,628,000	6	$8,628,000
13	200	$100,000	200	$100,000
14		$37,111,000		$35,390,500
15		$5,566,650		$5,308,575
16		$0		$0
17		$42,677,650		$40,699,075
18		$58,440,125		$45,706,175
19				
20				
21	12		4	
22				
23	377	$2,262,000	120	$720,000
24				
25		$450,000		$450,000
26		$150,000		$150,000
27		$450,000		$450,000
28		$600,000		$600,000
29		$3,690,000		$3,690,000
30		$2,262,000		$2,262,000
31				$720,000
32				
33				
34				
35				
36				
37		$7,602,000		$8,322,000
38	70		66	
39				
40				
41	358	$196,900	236	$129,800
42	140	$28,000	132	$26,400
43	140	$3,360,000	132	$3,168,000
44	70	$70,000	66	$66,000
45	70	$420,000	66	$396,000
46	11,400,000	$1,026,000	10,500,000	$945,000
47	1,700	$170,000	1,575	$157,500
48	75	$15,000	70	$14,000
49				
50	70	$35,974,890	66	$33,919,182
51		$719,498		$678,384
52				
53	6	$414,000	6	$414,000
54				
55		$414,000		$414,000
56		$414,000		$414,000
57				$414,000
58				
59				
60				
61				
62				
63		$828,000		$1,242,000
64		$42,808,288		$40,742,266
65				
66	17		18	
67		$175,100		$185,400
68				
69				
70		$175,100		$185,400
71				
72		$444,000		$444,000
73				
74				
75				
76		$51,029,388		$49,693,666
77		$58,440,125		$45,706,175
78				
79		$109,469,513		$95,399,841

	1991		1992	
	6		5	
Line #	# of units	Total costs	# of units	Total costs
1	38	$209,000	48	$264,000
2	110	$330,000	112	$336,000
3	110	$3,520,000	112	$3,584,000
4		$4,059,000		$4,184,000
5		$608,850		$627,600
6		$4,667,850		$4,811,600
7	60		55	
8				
9	0	$0	0	$0
10	180	$21,600,000	165	$19,800,000
11	105	$577,500	105	$577,500
12	6	$8,628,000	6	$8,628,000
13	200	$100,000	150	$75,000
14		$30,905,500		$29,080,500
15		$4,635,825		$4,362,075
16		$0		$0
17		$35,541,325		$33,442,575
18		$40,209,175		$38,254,175
19				
20				
21	6		5	
22				
23	110	$660,000	112	$672,000
24				
25		$450,000		$450,000
26		$150,000		$150,000
27		$450,000		$450,000
28		$600,000		$600,000
29		$3,690,000		$3,690,000
30		$2,262,000		$2,262,000
31		$720,000		$720,000
32		$660,000		$660,000
33				$672,000
34				
35				
36				
37		$8,982,000		$9,654,000
38	60		55	
39				
40				
41	230	$126,500	225	$123,750
42	120	$24,000	110	$22,000
43	120	$2,880,000	110	$2,640,000
44	60	$60,000	55	$55,000
45	60	$360,000	55	$330,000
46	9,500,000	$855,000	8,600,000	$774,000
47	1,465	$146,500	1,285	$128,500
48	65	$13,000	60	$12,000
49				
50	60	$30,835,620	55	$28,265,985
51		$616,712		$565,320
52				
53	6	$414,000	6	$414,000
54				
55		$414,000		$414,000
56		$414,000		$414,000
57		$414,000		$414,000
58		$414,000		$414,000
59				$414,000
60				
61				
62				
63		$1,656,000		$2,070,000
64		$37,573,332		$34,986,555
65				
66	18		18	
67		$185,400		$185,400
68				
69				
70		$185,400		$185,400
71				
72		$444,000		$444,000
73				
74				
75				
76		$47,184,732		$45,269,955
77		$40,209,175		$38,254,175
78				
79		$87,393,907		$83,524,130

	1993		1994	
	11		0	
Line #	# of units	Total costs	# of units	Total costs
1	93	$513,386		$0
2	210	$628,886		$0
3	253	$8,090,971		$0
4		$9,233,243		$0
5		$1,384,986		$0
6		$10,618,229		$0
7	44		44	
8				
9	0	$0	0	$0
10	132	$15,840,000	132	$15,840,000
11	0	$0	0	$0
12	6	$8,628,000	6	$8,628,000
13	100	$50,000	100	$50,000
14		$24,518,000		$24,518,000
15		$3,677,700		$3,677,700
16		$0		$0
17		$28,195,700		$28,195,700
18		$38,813,929		$28,195,700
19				
20				
21	11		0	
22				
23	253	$1,517,057		$0
24				
25		$450,000		$450,000
26		$150,000		$150,000
27		$450,000		$450,000
28		$600,000		$600,000
29		$3,690,000		$3,690,000
30		$2,262,000		$2,262,000
31		$720,000		$720,000
32		$660,000		$660,000
33		$672,000		$672,000
34		$1,517,057		$1,517,057
35				
36				
37		$11,171,057		$11,171,057
38	44		44	
39				
40				
41	179	$98,337	179	$98,337
42	88	$17,600	88	$17,600
43	88	$2,112,000	88	$2,112,000
44	44	$44,000	44	$44,000
45	44	$264,000	44	$264,000
46	6,600,000	$594,000	6,600,000	$594,000
47	1,012	$101,200	1,012	$101,200
48	50	$10,000	50	$10,000
49				
50	44	$22,612,788	44	$22,612,788
51		$452,256		$452,256
52				
53	6	$414,000	6	$414,000
54				
55		$414,000		$414,000
56		$414,000		$414,000
57		$414,000		$414,000
58		$414,000		$414,000
59		$414,000		$414,000
60		$414,000		$414,000
61				$414,000
62				
63		$2,484,000		$2,898,000
64		$28,790,180		$29,204,180
65				
66	21		21	
67		$216,300		$216,300
68		$737,615		$737,615
69				
70		$953,915		$953,915
71				
72		$444,000		$444,000
73				
74				
75				
76		$41,359,152		$41,773,152
77		$38,813,929		$28,195,700
78				
79		$80,173,082		$69,968,852

1995

Line #	0 # of units	Total costs
1		$0
2		$0
3		$0
4		$0
5		$0
6		$0
7	44	
8		
9	0	$0
10	132	$15,840,000
11	0	$0
12	6	$8,628,000
13	100	$50,000
14		$24,518,000
15		$3,677,700
16		$0
17		$28,195,700
18		$28,195,700
19		
20		
21	0	
22		
23		$0
24		
25		$450,000
26		$150,000
27		$450,000
28		$600,000
29		$3,690,000
30		$2,262,000
31		$720,000
32		$660,000
33		$672,000
34		$1,517,057
35		
36		
37		$11,171,057
38	44	
39		
40		
41	179	$98,337
42	88	$17,600
43	88	$2,112,000
44	44	$44,000
45	44	$264,000
46	6,600,000	$594,000
47	1,012	$101,200
48	50	$10,000
49		
50	44	$22,612,788
51		$452,256
52		
53	6	$414,000
54		
55		$414,000
56		$414,000
57		$414,000
58		$414,000
59		$414,000
60		$414,000
61		$414,000
62		$414,000
63		$3,312,000
64		$29,618,180
65		
66	21	
67		$216,300
68		$737,615
69		
70		$953,915
71		
72		$444,000
73		
74		
75		
76		$42,187,152
77		$28,195,700
78		
79		$70,382,852

APPENDIX XXII

NOTES FOR TABLE 1

NO.	COST ELEMENT	UNIT COST
1	Upgrade ground water monitoring systems	$ 5,500/well
	60-foot well depth and $90 per foot construction cost; $150 per well protection system cost	
2	Upgrade gas monitoring systems	$ 3,000/A
	Five wells per acre, 40 feet deep, $15 per foot construction cost	
3	Install final cover	$ 32,000/A
	10-mile hauling distance; 5-foot clay liner, $4.90/c.y.; hauling and compaction cost; 0.5-foot sand drainage layer ($6.50/c.y. cost); 1.5-foot topsoil layer ($3.00/c.y. cost); seeding, (1,000 per acre; grading, ($2,700 per acre)	
4	Engineering costs	15% of capital
	Engineering costs cover such items as the development of final plans and specifications, indirect and direct overhead costs, and profit. Convention dictates that this cost is estimated as a percentage of the total capital costs. The percentage used in this estimating process is based on engineering consultant figures for Minnesota.	
5	Begin hydrogeologic studies	$155,000 sum

- 28 soil borings, 50 feet deep, $25 per foot cost
- 10 wells, 50 feet deep, $90 foot cost
- well protection, $150 per well
- laboratory tests:

Type:	Unit cost	Number	Total
Falling head permeability	$160	6	$ 960
Constant head permeability	$150	6	$ 900
Hydrometer analysis	$ 57	6	$ 342
Shelby tubes	$ 15	6	$ 90
Grain size distribution	$100	6	$ 600
			$2,892

- background sampling and analysis:
  - 3 sampling events at 2 upgradient and 2 downgradient wells
  - Analysis cost = 4 wells x 3 events x $420 unit cost = $5,000
  - Sampling cost = 3 events x $500 unit cost = $1,500
  - Total costs = $5,000 + $1,500/4 wells/3 events = $540/well/event
- mobilization; $3,600 lump sum cost
- data compilation, analysis and feasibility report; $60,000 lump sum cost

6	Liner installation	$ 120,000/A
	5-foot liner depth required; 10-mile haul assumed for clay at $3.75 per cubic yard, land cost = $.12 per cubic yard; compaction cost = $1.00 per cubic yard	
7	Install ground water monitoring systems	$ 5,500/well
	(see #1 above)	
8	Corrective actions	$1,438,000 sum
	Ground water:	
	RI/FS	$ 400,000
	Corrective action capital cost:	
	engineer design	$ 50,000
	3-well ground water pumpout & spray irrigation system	$ 300,000
	purchase 15 acres for spraying	$ 22,500
	Spill:	
	replace leachate collection tank (6,000 gal.)	$ 14,000
	excavate/replace contaminated soil (750 c.y.)	$ 3,000
	additional monitoring wells (5-50 ft.)	$ 22,500
	sampling and analysis (15 VOC analyses)	$ 4,500
	corrective action (wells, pipes, pumps, etc.)	$ 50,000
	Liner repair:	
	50 x 100 foot area (920 c.y. clay, 185 c.y. sand)	$ 5,200
	collection pipe repair	$ 400
	inspection	900
	Cover erosion:	
	200 x 300 foot area (18,000 c.y.)	$ 90,000
	seeding	$ 3,700
	Cover settlement:	
	extinguish fire	$ 40,000
	waste/cover excavation (40,000 c.y.)	$ 80,000
	replace cover:	
	clay (12,000 c.y.)	$ 60,000
	sand (3,000 c.y.)	$ 9,000
	topsoil (9,000 c.y.)	$ 45,000
	seeding	$ 4,000
	inspection	$ 30,000
	Collection pipe collapse:	
	excavate (2,500 c.y.)	$ 5,000
	material (4,500 ft.)	$ 22,500
	waste replacement (2,500 c.y.)	$ 5,000
	cover:	
	clay (300 c.y.)	$ 1,500
	sand (148 c.y.)	450
	topsoil (444 c.y.)	$ 2,200
	seeding	200

	Control gas migration:	
	vegetative stress repair	$ 10,000
	probe monitoring system	$ 20,000
	passive ventilation (45 acres)	$ 135,000
9	Purchase land	$ 500/A

Purchase agricultural land, not prime

10	Engineering costs	15% of capital

Engineering costs cover such items as the development of final plans and specifications, indirect and direct overhead costs, and profit. Convention dictates that this cost is estimated as a percentage of the total capital costs. The percentage used in this estimating process is based on engineering consultant figures for Minnesota.

11	Engineering studies	$ 150,000 sum

150 hours at $100 per hour

12	Postclosure care and maintenance	$ 6,000/A

Type:	Unit cost	Units/A/yr.	Total
ground water sampling	$550/sample	1	$ 550
gas sampling	$200/sample	1	200
leachate sampling	$200/sample	1	200
leachate hauling and treatment	$0.09/gallon	55,000	4,950
site maintenance	$100/hour	1	100

13	Ground water sampling	$ 550/sample

- organic analysis = $420/sample
- inorganic analysis = $130/sample

14	Gas sampling	$ 200/sample
15	Intermittent cover	$ 2,400/A

assumes 3 acres are filled each year
labor and associated benefits = $10,000/A/yr.
equipment, maintenance and fuel = $14,000/A/yr.

16	Training	$ 1,000 sum

Assumes development of training manual, recordkeeping system on personnel training and attending training courses provided by outside groups or equipment vendors.

17	Industrial waste management	$ 6,000 sum
	Assumes development of policy manual, contacting industrial waste generators and haulers, increased recordkeeping and inspecting incoming wastes.	
18	Leachate treatment	$ 0.09/gallon
	assumes 2 inches of infiltration per acre per year = 54,305 gallons of leachate per acre per year	
19	Leachate testing	$ 200/sample
20	Accumulated reserves for financial assurance	$ 513,927 sum
	- unit costs equal values in items 3, 8, 12 & 22 - average site is 19 acres in area - 20-year period of postclosure care and maintenance - 3 percent inflation - 8 percent earnings on reserve balances	
21	Financial service charges for reserves	2% of balances
	Average charge rate quoted by representatives of banking, legal, trust company and surety communities.	
22	Corrective action: operations and maintenance	$ 69,000 sum
	- ground water pump out irrigation and sampling	$ 38,000
	- spill spray and sampling	$ 11,000
	- gas monitoring	$ 20,000
23	Costs incurred by nonlandfill waste facilities	$ 10,300 sum
	- ground water sampling	$ 3,300
	- training	$ 1,000
	- industrial waste management	$ 6,000
24	Transport costs incurred by waste consolidation	$ 737,615 sum
	- 184,404 tons of waste diverted from present disposal sites - new distances covered by transfer trailers - average distance = 40 miles - unit cost = $0.10/ton/mile - mixed municipal solid waste weighs 600 pounds per cubic yard	
25	Cost to State of administering proposed rules	$ 444,000 sum
	New positions on professional staff: 6 engineers and 3 hydrogeologists at a cost of $36,000 each (salary plus benefits); 4 pollution control specialists at a cost of $30,000 each	

TABLE II

DISTRIBUTION OF RULES'
COSTS TO ECON. SECTORS

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COST CATEGORIES	SECTORS	1984 SHARES	1984 TC	1985 SHARES	1985 TC
Water	MPS	$55,000		$22,000	
Water	Construction	$55,000	$110,000	$22,000	$44,
Gas	Construction	$0		$0	
Gas	Landfills	$0	$0	$0	
Install final cover	Construction	$1,200,000		$400,000	
Install final cover	Landfills	$1,200,000	$2,400,000	$400,000	$800,
Sub-total			$2,510,000		$844,
Engineering cost	Misc. Pro Svcs.	$376,500	$376,500	$126,600	$126,
Total			$2,886,500		$970,
Begin hydro studies	Misc. Pro Svcs.	$465,000	$465,000	$930,000	$930,
Install liners	Construction	$600,000		$0	
Install liners	Landfills	$600,000	$1,200,000	$0	
Install monitoring syst.	Construction	$82,500		$165,000	
Install monitoring syst.	Landfills	$82,500	$165,000	$165,000	$330,
Corrective actions	Construction	$0		$0	
Corrective actions	Landfills	$0		$0	
Corrective actions	MPS	$0	$0	$0	
Land	Landfills	$0	$0	$0	
Sub-total			$1,830,000		$1,260,
Engineering cost	MPS	$274,500	$274,500	$189,000	$189,
Engineering studies	MPS	$45,000	$45,000	$90,000	$90,
Total			$2,149,500		$1,539,
Total capital costs			$5,036,000		$2,509,
II. ANNUAL ELEMENTS					
Current operating costs:					
sampling (groundwater)	MPS	$242,000	$242,000	$235,400	$235,
sampling (gas)	Landfills	$0	$0	$0	
cover	Landfills	$26,400,000	$26,400,000	$25,680,000	$25,680,
training	Landfills	$110,000	$110,000	$107,000	$107,
industrial waste mgmt.	Landfills	$0		$0	
industrial waste mgmt.	MPS	$0	$0	$0	
leachate treatment	Landfills	$0		$0	
leachate treatment	Water utilities	$0	$0	$0	
liner maintenance	Landfills	$0	$0	$0	
leachate testing	MPS	$0	$0	$0	
Financial assurance:					
reserve accumulations	Banking	$0	$0	$0	
service charges	Banking	$0	$0	$0	
Corrective actions	Construction	$0		$0	
Corrective actions	Landfills	$0		$0	
Corrective actions	MPS	$0	$0	$0	
Total: operating			$26,752,000		$26,022,
Total P-C care	Landfills	$225,000		$300,000	
Total P-C care	MPS	$225,000	$450,000	$300,000	$600,
Alternative site costs	Alt. sites				
MPCA admin. costs	Government				
Total annual costs			$27,202,000		$26,622,
Total capital costs			$5,036,000		$2,509,
GRAND TOTAL		$32,238,000	$32,238,000	$29,132,000	$29,132,

DISTRIBUTION OF RULES'
COSTS TO ECON. SECTORS

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COST CATEGORIES	SECTORS	1986 SHARES	1986 TC	1987 SHARES	1987 TC
Water	MPS	$55,000		$88,000	
Water	Construction	$55,000	$110,000	$88,000	$176,00
Gas	Construction	$0		$0	
Gas	Landfills	$0	$0	$0	$
Install final cover	Construction	$1,200,000		$1,600,000	
Install final cover	Landfills	$1,200,000	$2,400,000	$1,600,000	$3,200,00
Sub-total			$2,510,000		$3,376,00
Engineering cost	Misc. Pro Svcs.	$376,500	$376,500	$506,400	$506,40
Total			$2,886,500		$3,882,40
Begin hydro studies	Misc. Pro Svcs.	$1,550,000	$1,550,000	$930,000	$930,00
Install liners	Construction	$1,200,000		$1,200,000	
Install liners	Landfills	$1,200,000	$2,400,000	$1,200,000	$2,400,00
Install monitoring syst.	Construction	$275,000		$165,000	
Install monitoring syst.	Landfills	$275,000	$550,000	$165,000	$330,00
Corrective actions	Construction	$0		$0	
Corrective actions	Landfills	$0		$0	
Corrective actions	MPS	$0	$0	$0	$
Land	Landfills	$0	$0	$10,000	$10,0
Sub-total			$4,500,000		$3,670,0
Engineering cost	MPS	$675,000	$675,000	$550,500	$550,5
Engineering studies	MPS	$150,000	$150,000	$90,000	$90,0
Total			$5,325,000		$4,310,5
Total capital costs			$8,211,500		$8,192,9
II. ANNUAL ELEMENTS					
Current operating costs:					
sampling (groundwater)	MPS	$231,000	$231,000	$222,200	$222,2
sampling (gas)	Landfills	$0	$0	$4,000	$4,0
cover	Landfills	$25,200,000	$25,200,000	$24,240,000	$24,240,00
training	Landfills	$105,000	$105,000	$101,000	$101,00
industrial waste mgmt.	Landfills	$0		$0	
industrial waste mgmt.	MPS	$0	$0	$0	$
leachate treatment	Landfills	$0		$90	
leachate treatment	Water utilities	$0	$0	$90	$1
liner maintenance	Landfills	$0	$0	$2,000	$2,0
leachate testing	MPS	$0	$0	$2,400	$2,4
Financial assurance:					
reserve accumulations	Banking	$0	$0	$0	
service charges	Banking	$0	$0	$0	
Corrective actions	Construction	$0		$0	
Corrective actions	Landfills	$0		$0	
Corrective actions	MPS	$0	$0	$0	
Total: operating			$25,536,000		$24,571,7
Total P-C care	Landfills	$525,000		$825,000	
Total P-C care	MPS	$525,000	$1,050,000	$825,000	$1,650,0
Alternative site costs	Alt. sites				
MPCA admin. costs	Government				
Total annual costs			$26,586,000		$26,221,7
Total capital costs			$8,211,500		$8,192,9
GRAND TOTAL		$34,797,500	$34,797,500	$34,414,680	$34,414,6

DISTRIBUTION OF RULES'
COSTS TO ECON. SECTORS

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		1988		1989	
COST CATEGORIES	SECTORS	SHARES	TC	SHARES	TC
Water	MPS	$844,250		$255,750	
Water	Construction	$844,250	$1,688,500	$255,750	$511,
Gas	Construction	$922,500		$565,500	
Gas	Landfills	$922,500	$1,845,000	$565,500	$1,131,
Install final cover	Construction	$9,840,000		$6,032,000	
Install final cover	Landfills	$9,840,000	$19,680,000	$6,032,000	$12,064,
Sub-total			$23,213,500		$13,706,
Engineering cost	Misc. Pro Svcs.	$3,482,025	$3,482,025	$2,055,975	$2,055,
Total			$26,695,525		$15,762,
Begin hydro studies	Misc. Pro Svcs.	$2,325,000	$2,325,000	$2,325,000	$2,325,
Install liners	Construction	$11,820,000		$12,600,000	
Install liners	Landfills	$11,820,000	$23,640,000	$12,600,000	$25,200,
Install monitoring syst.	Construction	$429,000		$429,000	
Install monitoring syst.	Landfills	$429,000	$858,000	$429,000	$858,
Corrective actions	Construction	$2,876,000		$2,876,000	
Corrective actions	Landfills	$2,876,000		$2,876,000	
Corrective actions	MPS	$2,876,000	$8,628,000	$2,876,000	$8,628,
Land	Landfills	$75,000	$75,000	$100,000	$100,
Sub-total			$35,526,000		$37,111,
Engineering cost	MPS	$5,328,900	$5,328,900	$5,566,650	$5,566,
Engineering studies	MPS	$1,230,000	$1,230,000	$0	
Total			$42,084,900		$42,677,
Total capital costs			$68,780,425		$58,440,
II. ANNUAL ELEMENTS					
Current operating costs:					
sampling (groundwater)	MPS	$182,050	$182,050	$196,900	$196,
sampling (gas)	Landfills	$33,000	$33,000	$28,000	$28,
cover	Landfills	$3,960,000	$3,960,000	$3,360,000	$3,360,
training	Landfills	$82,000	$82,000	$70,000	$70,
industrial waste mgmt.	Landfills	$246,000		$210,000	
industrial waste mgmt.	MPS	$246,000	$492,000	$210,000	$420,
leachate treatment	Landfills	$461,250		$513,000	
leachate treatment	Water utilities	$461,250	$922,500	$513,000	$1,026,
liner maintenance	Landfills	$160,000	$160,000	$170,000	$170,
leachate testing	MPS	$16,400	$16,400	$15,000	$15,
Financial assurance:					
reserve accumulations	Banking	$0	$0	$35,974,890	$35,974,
service charges	Banking	$0	$0	$719,498	$719,
Corrective actions	Construction	$138,000		$276,000	
Corrective actions	Landfills	$138,000		$276,000	
Corrective actions	MPS	$138,000	$414,000	$276,000	$828,
Total: operating			$6,261,950		$42,808,
Total P-C care	Landfills	$2,670,000		$3,801,000	
Total P-C care	MPS	$2,670,000	$5,340,000	$3,801,000	$7,602.
Alternative site costs	Alt. sites	$154,500	$154,500	$175,100	$175.
MPCA admin. costs	Government	$444,000	$444,000	$444,000	$444.
Total annual costs			$12,200,450		$51,029.
Total capital costs			$68,780,425		$58,440.
GRAND TOTAL		$80,980,875	$80,980,875	$109,469,513	$109,469.

DISTRIBUTION OF RULES'
COSTS TO ECON. SECTORS

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COST CATEGORIES	SECTORS	1990 SHARES	1990 TC	1991 SHARES	1991 TC
Water	MPS	$77,000		$104,500	
Water	Construction	$77,000	$154,000	$104,500	$209,0
Gas	Construction	$180,000		$165,000	
Gas	Landfills	$180,000	$360,000	$165,000	$330,0
Install final cover	Construction	$1,920,000		$1,760,000	
Install final cover	Landfills	$1,920,000	$3,840,000	$1,760,000	$3,520,0
Sub-total			$4,354,000		$4,059,0
Engineering cost	Misc. Pro Svcs.	$653,100	$653,100	$608,850	$608,8
Total			$5,007,100		$4,667,8
Begin hydro studies	Misc. Pro Svcs.	$2,325,000	$2,325,000	$0	
Install liners	Construction	$11,880,000		$10,800,000	
Install liners	Landfills	$11,880,000	$23,760,000	$10,800,000	$21,600,0
Install monitoring syst.	Construction	$288,750		$288,750	
Install monitoring syst.	Landfills	$288,750	$577,500	$288,750	$577,5
Corrective actions	Construction	$2,876,000		$2,876,000	
Corrective actions	Landfills	$2,876,000		$2,876,000	
Corrective actions	MPS	$2,876,000	$8,628,000	$2,876,000	$8,628,0
Land	Landfills	$100,000	$100,000	$100,000	$100,0
Sub-total			$35,390,500		$30,905,5
Engineering cost	MPS	$5,308,575	$5,308,575	$4,635,825	$4,635,8
Engineering studies	MPS	$0	$0	$0	
Total			$40,699,075		$35,541,3
Total capital costs			$45,706,175		$40,209,1
II. ANNUAL ELEMENTS					
Current operating costs:					
sampling (groundwater)	MPS	$129,800	$129,800	$126,500	$126,5
sampling (gas)	Landfills	$26,400	$26,400	$24,000	$24,0
cover	Landfills	$3,168,000	$3,168,000	$2,880,000	$2,880,0
training	Landfills	$66,000	$66,000	$60,000	$60,0
industrial waste mgmt.	Landfills	$198,000		$180,000	
industrial waste mgmt.	MPS	$198,000	$396,000	$180,000	$360,0
leachate treatment	Landfills	$472,500		$427,500	
leachate treatment	Water utilities	$472,500	$945,000	$427,500	$855,0
liner maintenance	Landfills	$157,500	$157,500	$146,500	$146,5
leachate testing	MPS	$14,000	$14,000	$13,000	$13,0
Financial assurance:					
reserve accumulations	Banking	$33,919,182	$33,919,182	$30,835,620	$30,835,6
service charges	Banking	$678,384	$678,384	$616,712	$616,7
Corrective actions	Construction	$414,000		$552,000	
Corrective actions	Landfills	$414,000		$552,000	
Corrective actions	MPS	$414,000	$1,242,000	$552,000	$1,656,0
Total: operating			$40,742,266		$37,573,3
Total P-C care	Landfills	$4,161,000		$4,491,000	
Total P-C care	MPS	$4,161,000	$8,322,000	$4,491,000	$8,982,0
Alternative site costs	Alt. sites	$185,400	$185,400	$185,400	$185,4
MPCA admin. costs	Government	$444,000	$444,000	$444,000	$444,0
Total annual costs			$49,693,666		$47,184,7
Total capital costs			$45,706,175		$40,209,1
GRAND TOTAL		$95,399,841	$95,399,841	$87,393,907	$87,393,9

DISTRIBUTION OF RULES'
COSTS TO ECON. SECTORS

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COST CATEGORIES	SECTORS	1992 SHARES	1992 TC	1993 SHARES	1993 TC
Water	MPS	$132,000		$256,693	
Water	Construction	$132,000	$264,000	$256,693	$513,38
Gas	Construction	$168,000		$314,443	
Gas	Landfills	$168,000	$336,000	$314,443	$628,88
Install final cover	Construction	$1,792,000		$4,045,486	
Install final cover	Landfills	$1,792,000	$3,584,000	$4,045,486	$8,090,97
Sub-total			$4,184,000		$9,233,24
Engineering cost	Misc. Pro Svcs.	$627,600	$627,600	$1,384,986	$1,384,98
Total			$4,811,600		$10,618,22
Begin hydro studies	Misc. Pro Svcs.	$0	$0	$0	$
Install liners	Construction	$9,900,000		$7,920,000	
Install liners	Landfills	$9,900,000	$19,800,000	$7,920,000	$15,840,00
Install monitoring syst.	Construction	$288,750		$0	
Install monitoring syst.	Landfills	$288,750	$577,500	$0	$
Corrective actions	Construction	$2,876,000		$2,876,000	
Corrective actions	Landfills	$2,876,000		$2,876,000	
Corrective actions	MPS	$2,876,000	$8,628,000	$2,876,000	$8,628,00
Land	Landfills	$75,000	$75,000	$50,000	$50,00
Sub-total			$29,080,500		$24,518,00
Engineering cost	MPS	$4,362,075	$4,362,075	$3,677,700	$3,677,70
Engineering studies	MPS	$0	$0	$0	$
Total			$33,442,575		$28,195,70
Total capital costs			$38,254,175		$38,813,90
II. ANNUAL ELEMENTS					
Current operating costs:					
sampling (groundwater)	MPS	$123,750	$123,750	$98,337	$98,33
sampling (gas)	Landfills	$22,000	$22,000	$17,600	$17,60
cover	Landfills	$2,640,000	$2,640,000	$2,112,000	$2,112,00
training	Landfills	$55,000	$55,000	$44,000	$44,00
industrial waste mgmt.	Landfills	$165,000		$132,000	
industrial waste mgmt.	MPS	$165,000	$330,000	$132,000	$264,00
leachate treatment	Landfills	$387,000		$297,000	
leachate treatment	Water utilities	$387,000	$774,000	$297,000	$594,00
liner maintenance	Landfills	$128,500	$128,500	$101,200	$101,20
leachate testing	MPS	$12,000	$12,000	$10,000	$10,00
Financial assurance:					
reserve accumulations	Banking	$28,265,985	$28,265,985	$22,612,788	$22,612,7
service charges	Banking	$565,320	$565,320	$452,256	$452,2
Corrective actions	Construction	$690,000		$828,000	
Corrective actions	Landfills	$690,000		$828,000	
Corrective actions	MPS	$690,000	$2,070,000	$828,000	$2,484,00
Total: operating			$34,986,555		$28,790,1
Total P-C care	Landfills	$4,827,000		$5,585,529	
Total P-C care	MPS	$4,827,000	$9,654,000	$5,585,529	$11,171,0
Alternative site costs	Alt. sites	$185,400	$185,400	$953,915	$953,9
MPCA admin. costs	Government	$444,000	$444,000	$444,000	$444,0
Total annual costs			$45,269,955		$41,359,1
Total capital costs			$38,254,175		$38,813,9
GRAND TOTAL		$83,524,130	$83,524,130	$80,173,082	$80,173,0

DISTRIBUTION OF RULES'
COSTS TO ECON. SECTORS

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COST CATEGORIES	SECTORS	1994 SHARES	1994 TC	1995 SHARES	1995 TC
Water	MPS	$0		$0	
Water	Construction	$0	$0	$0	$
Gas	Construction	$0		$0	
Gas	Landfills	$0	$0	$0	$
Install final cover	Construction	$0		$0	
Install final cover	Landfills	$0	$0	$0	$
Sub-total			$0		$
Engineering cost	Misc. Pro Svcs.	$0	$0	$0	$
Total			$0		$
Begin hydro studies	Misc. Pro Svcs.	$0	$0	$0	$
Install liners	Construction	$7,920,000		$7,920,000	
Install liners	Landfills	$7,920,000	$15,840,000	$7,920,000	$15,840,00
Install monitoring syst.	Construction	$0		$0	
Install monitoring syst.	Landfills	$0	$0	$0	$
Corrective actions	Construction	$2,876,000		$2,876,000	
Corrective actions	Landfills	$2,876,000		$2,876,000	
Corrective actions	MPS	$2,876,000	$8,628,000	$2,876,000	$8,628,00
Land	Landfills	$50,000	$50,000	$50,000	$50,00
Sub-total			$24,518,000		$24,518,00
Engineering cost	MPS	$3,677,700	$3,677,700	$3,677,700	$3,677,70
Engineering studies	MPS	$0	$0	$0	$
Total			$28,195,700		$28,195,70
Total capital costs			$28,195,700		$28,195,70
II. ANNUAL ELEMENTS					
Current operating costs:					
sampling (groundwater)	MPS	$98,337	$98,337	$98,337	$98,33
sampling (gas)	Landfills	$17,600	$17,600	$17,600	$17,60
cover	Landfills	$2,112,000	$2,112,000	$2,112,000	$2,112,00
training	Landfills	$44,000	$44,000	$44,000	$44,00
industrial waste mgmt.	Landfills	$132,000		$132,000	
industrial waste mgmt.	MPS	$132,000	$264,000	$132,000	$264,00
leachate treatment	Landfills	$297,000		$297,000	
leachate treatment	Water utilities	$297,000	$594,000	$297,000	$594,00
liner maintenance	Landfills	$101,200	$101,200	$101,200	$101,20
leachate testing	MPS	$10,000	$10,000	$10,000	$10,00
Financial assurance:					
reserve accumulations	Banking	$22,612,788	$22,612,788	$22,612,788	$22,612,7
service charges	Banking	$452,256	$452,256	$452,256	$452,2
Corrective actions	Construction	$966,000		$1,104,000	
Corrective actions	Landfills	$966,000		$1,104,000	
Corrective actions	MPS	$966,000	$2,898,000	$1,104,000	$3,312,0
Total: operating			$29,204,180		$29,618,1
Total P-C care	Landfills	$5,585,529		$5,585,529	
Total P-C care	MPS	$5,585,529	$11,171,057	$5,585,529	$11,171,0
Alternative site costs	Alt. sites	$953,915	$953,915	$953,915	$953,9
MPCA admin. costs	Government	$444,000	$444,000	$444,000	$444,0
Total annual costs			$41,773,152		$42,187,1
Total capital costs			$28,195,700		$28,195,7
GRAND TOTAL		$69,968,852	$69,968,852	$70,382,852	$70,382,8

TABLE III

VALUES ONLY:

CNTR/ID	SECTOR	1984	1985	1986
REVENUES				
599/681	Banking	$0	$0	$0
(DEMPOL)	Banking	$0	$0	$0
Sub-total		$0	$0	$0
591/623	Construction	$1,200,000	$400,000	$1,200,000
	Construction	$0	$0	$0
	Construction	$82,500	$165,000	$275,000
	Construction	$55,000	$22,000	$55,000
	Construction	$0	$0	$0
	Construction	$0	$0	$0
	Construction	$600,000	$0	$1,200,000
Sub-total		$1,937,500	$587,000	$2,730,000
598/630	Landfills	$0	$0	$0
	Landfills	$110,000	$107,000	$105,000
	Landfills	$0	$0	$0
	Landfills	$26,400,000	$25,680,000	$25,200,000
	Landfills	$0	$0	$0
	Landfills	$0	$0	$0
	Landfills	$225,000	$300,000	$525,000
	Landfills	$0	$0	$0
	Landfills	$0	$0	$0
	Landfills	$600,000	$0	$1,200,000
	Landfills	$0	$0	$0
	Landfills	$0	$0	$0
	Landfills	$1,200,000	$400,000	$1,200,000
	Landfills	$82,500	$165,000	$275,000
Sub-total		$28,617,500	$26,652,000	$28,505,000
614/646	Misc. Pro Svcs.	$465,000	$930,000	$1,550,000
	Misc. Pro Svcs.	$376,500	$126,600	$376,500
	MPS	$45,000	$90,000	$150,000
	MPS	$242,000	$235,400	$231,000
	MPS	$55,000	$22,000	$55,000
	MPS	$274,500	$189,000	$675,000
	MPS	$0	$0	$0
MPS	MPS	$0	$0	$0
	MPS	$225,000	$300,000	$525,000
	MPS	$0	$0	$0
	MPS	$0	$0	$0
Sub-total		$1,683,000	$1,893,000	$3,562,500
598/630	Water utilities	$0	$0	$0
598/630	Alt. sites	$0	$0	$0
Sector 630: combined		$28,617,500	$26,652,000	$28,505,000
TOTAL	(COSPOL, 480)	$32,238,000	$29,132,000	$34,797,500
223/180	Gov't. demand	$0	$0	$0
621/954	Tax increase			
GRAND TOTAL		$32,238,000	$29,132,000	$34,797,500

VALUES ONLY: CNTR/ID	SECTOR	1987	1988	1989
REVENUES				
599/681	Banking	$0	$0	$35,974,890
(DEMPOL)	Banking	$0	$0	$719,498
Sub-total		$0	$0	$36,694,388
591/623	Construction	$1,600,000	$9,840,000	$6,032,000
	Construction	$0	$2,876,000	$2,876,000
	Construction	$165,000	$429,000	$429,000
	Construction	$88,000	$844,250	$255,750
	Construction	$0	$138,000	$276,000
	Construction	$0	$922,500	$565,500
	Construction	$1,200,000	$11,820,000	$12,600,000
Sub-total		$3,053,000	$26,869,750	$23,034,250
598/630	Landfills	$4,000	$33,000	$28,000
	Landfills	$101,000	$82,000	$70,000
	Landfills	$0	$2,876,000	$2,876,000
	Landfills	$24,240,000	$3,960,000	$3,360,000
	Landfills	$0	$922,500	$565,500
	Landfills	$90	$461,250	$513,000
	Landfills	$825,000	$2,670,000	$3,801,000
	Landfills	$0	$138,000	$276,000
	Landfills	$10,000	$75,000	$100,000
	Landfills	$1,200,000	$11,820,000	$12,600,000
	Landfills	$2,000	$160,000	$170,000
	Landfills	$0	$246,000	$210,000
	Landfills	$1,600,000	$9,840,000	$6,032,000
	Landfills	$165,000	$429,000	$429,000
Sub-total		$28,147,090	$33,712,750	$31,030,500
614/646	Misc. Pro Svcs.	$930,000	$2,325,000	$2,325,000
	Misc. Pro Svcs.	$506,400	$3,482,025	$2,055,975
	MPS	$90,000	$1,230,000	$0
	MPS	$222,200	$182,050	$196,900
	MPS	$88,000	$844,250	$255,750
	MPS	$550,500	$5,328,900	$5,566,650
	MPS	$0	$246,000	$210,000
MPS	MPS	$2,400	$16,400	$15,000
	MPS	$825,000	$2,670,000	$3,801,000
	MPS	$0	$2,876,000	$2,876,000
	MPS	$0	$138,000	$276,000
Sub-total		$3,214,500	$19,338,625	$17,578,275
598/630	Water utilities	$90	$461,250	$513,000
598/630	Alt. sites	$0	$154,500	$175,100
Sector 630: combined		$28,147,180	$34,328,500	$31,718,600
TOTAL	(COSPOL, 480)	$34,414,680	$80,536,875	$109,025,513
223/180	Gov't. demand	$0	$444,000	$444,000
621/954	Tax increase			
GRAND TOTAL		$34,414,680	$80,980,875	$109,469,513

VALUES ONLY: CNTR/ID	SECTOR	1990	1991	1992
REVENUES				
599/681	Banking	$33,919,182	$30,835,620	$28,265,985
(DEMPOL)	Banking	$678,384	$616,712	$565,320
Sub-total		$34,597,566	$31,452,332	$28,831,305
591/623	Construction	$1,920,000	$1,760,000	$1,792,000
	Construction	$2,876,000	$2,876,000	$2,876,000
	Construction	$288,750	$288,750	$288,750
	Construction	$77,000	$104,500	$132,000
	Construction	$414,000	$552,000	$690,000
	Construction	$180,000	$165,000	$168,000
	Construction	$11,880,000	$10,800,000	$9,900,000
Sub-total		$17,635,750	$16,546,250	$15,846,750
598/630	Landfills	$26,400	$24,000	$22,000
	Landfills	$66,000	$60,000	$55,000
	Landfills	$2,876,000	$2,876,000	$2,876,000
	Landfills	$3,168,000	$2,880,000	$2,640,000
	Landfills	$180,000	$165,000	$168,000
	Landfills	$472,500	$427,500	$387,000
	Landfills	$4,161,000	$4,491,000	$4,827,000
	Landfills	$414,000	$552,000	$690,000
	Landfills	$100,000	$100,000	$75,000
	Landfills	$11,880,000	$10,800,000	$9,900,000
	Landfills	$157,500	$146,500	$128,500
	Landfills	$198,000	$180,000	$165,000
	Landfills	$1,920,000	$1,760,000	$1,792,000
	Landfills	$288,750	$288,750	$288,750
Sub-total		$25,908,150	$24,750,750	$24,014,250
614/646	Misc. Pro Svcs.	$2,325,000	$0	$0
	Misc. Pro Svcs.	$653,100	$608,850	$627,600
	MPS	$0	$0	$0
	MPS	$129,800	$126,500	$123,750
	MPS	$77,000	$104,500	$132,000
	MPS	$5,308,575	$4,635,825	$4,362,075
	MPS	$198,000	$180,000	$165,000
MPS	MPS	$14,000	$13,000	$12,000
	MPS	$4,161,000	$4,491,000	$4,827,000
	MPS	$2,876,000	$2,876,000	$2,876,000
	MPS	$414,000	$552,000	$690,000
Sub-total		$16,156,475	$13,587,675	$13,815,425
598/630	Water utilities	$472,500	$427,500	$387,000
598/630	Alt. sites	$185,400	$185,400	$185,400
Sector 630: combined		$26,566,050	$25,363,650	$24,586,650
TOTAL	(COSPOL, 480)	$94,955,841	$86,949,907	$83,080,130
223/180	Gov't. demand	$444,000	$444,000	$444,000
621/954	Tax increase			
GRAND TOTAL		$95,399,841	$87,393,907	$83,524,130

VALUES ONLY: CNTR/ID	SECTOR	1993	1994	1995
REVENUES				
599/661	Banking	$22,612,788	$22,612,788	$22,612,788
(DEMPOL)	Banking	$452,256	$452,256	$452,256
Sub-total		$23,065,044	$23,065,044	$23,065,044
591/623	Construction	$4,045,486	$0	$0
	Construction	$2,876,000	$2,876,000	$2,876,000
	Construction	$0	$0	$0
	Construction	$256,693	$0	$0
	Construction	$828,000	$966,000	$1,104,000
	Construction	$314,443	$0	$0
	Construction	$7,920,000	$7,920,000	$7,920,000
Sub-total		$16,240,621	$11,762,000	$11,900,000
598/630	Landfills	$17,600	$17,600	$17,600
	Landfills	$44,000	$44,000	$44,000
	Landfills	$2,876,000	$2,876,000	$2,876,000
	Landfills	$2,112,000	$2,112,000	$2,112,000
	Landfills	$314,443	$0	$0
	Landfills	$297,000	$297,000	$297,000
	Landfills	$5,585,529	$5,585,529	$5,585,529
	Landfills	$828,000	$966,000	$1,104,000
	Landfills	$50,000	$50,000	$50,000
	Landfills	$7,920,000	$7,920,000	$7,920,000
	Landfills	$101,200	$101,200	$101,200
	Landfills	$132,000	$132,000	$132,000
	Landfills	$4,045,486	$0	$0
	Landfills	$0	$0	$0
Sub-total		$24,323,257	$20,101,329	$20,239,329
614/646	Misc. Pro Svcs.	$0	$0	$0
	Misc. Pro Svcs.	$1,384,986	$0	$0
	MPS	$0	$0	$0
	MPS	$98,337	$98,337	$98,337
	MPS	$256,693	$0	$0
	MPS	$3,677,700	$3,677,700	$3,677,700
	MPS	$132,000	$132,000	$132,000
MPS	MPS	$10,000	$10,000	$10,000
	MPS	$5,585,529	$5,585,529	$5,585,529
	MPS	$2,876,000	$2,876,000	$2,876,000
	MPS	$828,000	$966,000	$1,104,000
Sub-total		$14,849,244	$13,345,565	$13,483,565
598/630	Water utilities	$297,000	$297,000	$297,000
598/630	Alt. sites	$953,915	$953,915	$953,915
Sector 630: combined		$25,574,172	$21,352,244	$21,490,244
TOTAL	(COSPOL, 480)	$79,729,082	$69,524,852	$69,938,852
223/180	Gov't. demand	$444,000	$444,000	$444,000
621/954	Tax increase			
GRAND TOTAL		$80,173,082	$69,968,852	$70,382,852

APPENDIX XXIII.

ECONOMIC SIMULATION OF PROPOSED RULES: FINDINGS

This appendix presents the results of the simulation of the proposed rules' economic impacts. The Agency relied on the Minnesota Forecasting and Simulation (MNFS-53) model for this simulation. The first set of tables is labelled "Solid Waste Rules, Control Forecast." These tables are included for comparative purposes. They provide the MNFS-53 estimate of selected economic values that would result if no change is imposed by the rules. These values can be considered as a status quo against which the effects of the rules can be measured.

The next set of tables is labelled "Solid Waste Rules, Economic Impact - Simulation Forecast." These tables provide the measures of the rules' impacts. They consist of the differences between the control forecast values and the simulation forecast values.

The final set of tables is labelled "Solid Waste Rules, Simulation Forecast + Consolidation." These tables provide the same information as the second set of tables up until 1993. These tables also simulate the impacts of the changes referred to in the text of this statement as the consolidation of regional solid waste steams.

Each set of tables has the same three components. The first component is a summary table which provides estimated values for aggregate factors of common concern. (The MNFS-53 can generate disaggregated tables for most of the values reported in these tables.) The second component is an employment table which provides job and population estimates. The third table is an income table which consists of selected income estimates.

The tables are read in the following manner. Go to the Control Forecast's Summary table. The entry for total employment in 1993 shows that the MNFS-53 estimates there will be 1,885,716 jobs in the State in that year. Now consider the Simulation Forecast's Summary table. That table shows that the MNFS-53 estimates there will be 95 more jobs in 1993 if the proposed rules are adopted and implemented. Finally, consider the Simulation + Consolidation Forecast's Summary table. This table shows that the MNFS-53 estimates an increase of 87 jobs in 1993 if the rules are adopted and the waste stream consolidation occurs.

The rest of the tables can be read in the same manner.

SOLID WASTE RULES, CONTROL FORECAST

SUMMARY TABLE FOR PRIVATE NONFARM SECTORS.

	1984	1985	1986	1987	1988	1989
PRIVATE NONFARM EMPLOYMENT (IN THOUSANDS OF JOBS)						
TOTAL	1561.421	1613.040	1651.133	1693.795	1741.278	1786.822
INTERMEDIATE	302.476	311.900	319.215	327.136	335.135	342.710
INDUCED	636.446	658.784	675.626	690.660	709.826	729.582
EXPORT	622.500	642.356	656.291	675.999	696.318	714.530
EXOGENOUS	0	0	0	0	0	0
COSTS RELATIVE TO THE U.S.						
PRODUCTION	.98147	.98212	.98324	.98470	.98628	.98787
FACTOR INPUTS	.97378	.97463	.97610	.97800	.98008	.98220
LABOR	.99008	.99243	.99560	.99885	1.00234	1.00618
FUEL	.83870	.83870	.83870	.83870	.83870	.83870
CAPITAL	1.00781	1.00745	1.00711	1.00769	1.00817	1.00805
INTERMED. INPUTS	.99379	.99414	.99469	.99544	.99623	.99697
PROD FOR LOCAL MKT	.97420	.97475	.97583	.97730	.97892	.98056
PROD. FOR EXPORT	.99340	.99425	.99544	.99687	.99839	.99989
OTHER VARIABLES:						
LABOR INTENSITY	1.01605	1.01517	1.01428	1.01341	1.01254	1.01164
MULT ADJ. INDEX	1.21400	1.22720	1.23990	1.25211	1.26231	1.27166
EXP. SHARE OF US-	2.17	2.20	2.23	2.25	2.27	2.29
EXP EMP-PCT OF EMP	39.87	39.82	39.75	39.91	39.99	39.99
EMP. AS PCT OF US	1.94	1.96	1.98	1.99	1.99	2.00
DEMAND (BILLIONS)	95.321	101.966	109.935	119.651	130.394	142.262
SELF SUPPLY (SS)	55.164	59.119	63.880	69.530	75.858	82.955
IMPORTS	40.157	42.848	46.055	50.121	54.536	59.307
OUTPUT (SUP-BIL)	99.325	106.150	114.265	124.392	135.650	148.149
SUP/DEM RATIO	1.04	1.04	1.04	1.04	1.04	1.04
PS= SS/SUPPLY	.56	.56	.56	.56	.56	.56
RPC= SS/DEMAND	.58	.58	.58	.58	.58	.58
AVERAGE WAGE RATE	17.543	18.193	19.175	20.377	21.657	23.132
EMPLOYMENT INDEX	1.021677	1.022210	1.022684	1.022711	1.022844	1.023912

SOLID WASTE RULES, CONTROL FORECAST

SUMMARY TABLE FOR PRIVATE NONFARM SECTORS.

	1990	1991	1992	1993	1994	1995
PRIVATE NONFARM EMPLOYMENT (IN THOUSANDS OF JOBS)						
TOTAL	1817.388	1842.028	1865.776	1885.716	1904.603	1923.795
INTERMEDIATE	347.599	350.307	354.838	359.355	364.207	369.697
INDUCED	742.868	754.740	764.489	772.456	779.560	786.017
EXPORT	726.920	736.981	746.449	753.904	760.836	768.080
EXOGENOUS	0	0	0	0	0	0
COSTS RELATIVE TO THE U.S.						
PRODUCTION	.98961	.99145	.99311	.99462	.99598	.99730
FACTOR INPUTS	.98451	.98695	.98915	.99115	.99297	.99473
LABOR	1.01014	1.01417	1.01787	1.02118	1.02423	1.02713
FUEL	.83870	.83870	.83870	.83870	.83870	.83870
CAPITAL	1.00824	1.00865	1.00881	1.00907	1.00909	1.00926
INTERMED. INPUTS	.99778	.99867	.99946	1.00017	1.00081	1.00143
PROD FOR LOCAL MKT	.98236	.98428	.98602	.98760	.98904	.99043
PROD. FOR EXPORT	1.00152	1.00324	1.00477	1.00615	1.00740	1.00860
OTHER VARIABLES:						
LABOR INTENSITY	1.01072	1.00978	1.00883	1.00787	1.00690	1.00594
MULT ADJ. INDEX	1.28041	1.28868	1.29653	1.30402	1.31118	1.31804
EXP. SHARE OF US-	2.31	2.33	2.35	2.36	2.38	2.39
EXP EMP-PCT OF EMP	40.00	40.01	40.01	39.98	39.95	39.93
EMP. AS PCT OF US	2.01	2.02	2.03	2.03	2.03	2.04
DEMAND (BILLIONS)	154.646	168.709	184.040	200.028	217.136	235.229
SELF SUPPLY (SS)	90.365	98.871	108.173	117.914	128.390	139.435
IMPORTS	64.281	69.839	75.867	82.114	88.746	95.794
OUTPUT (SUP-BIL)	161.271	176.123	192.110	208.765	226.660	245.699
SUP/DEM RATIO	1.04	1.04	1.04	1.04	1.04	1.04
PS= SS/SUPPLY	.56	.56	.56	.56	.57	.57
RPC= SS/DEMAND	.58	.59	.59	.59	.59	.59
AVERAGE WAGE RATE	24.873	26.816	28.872	31.079	33.469	36.056
EMPLOYMENT INDEX	1.025684	1.026629	1.027214	1.027693	1.028575	1.029897

SOLID WASTE RULES, CONTROL FORECAST

EMPLOYMENT TABLE (IN THOUSANDS OF JOBS)

	1984	1985	1986	1987	1988	1989
MANUFACTURING	373.497	380.601	384.060	394.417	404.352	411.610
AS A PCT OF U.S.	1.913	1.929	1.939	1.942	1.951	1.964
DURABLES	224.720	229.537	231.586	239.329	246.593	251.944
NONDURABLES	148.776	151.064	152.474	155.088	157.759	159.666
NON-MANUFACTURING	1187.925	1232.439	1267.073	1299.378	1336.926	1375.212
AS A PCT OF U.S.	1.954	1.973	1.990	1.998	2.007	2.017
MINING	9.831	10.107	10.077	9.936	9.885	9.843
CONSTRUCTION	68.420	70.587	72.564	75.764	78.085	79.810
TRANSPORT + PUB UT	97.346	99.568	100.651	102.011	103.523	104.674
FINANCE, INS,+ RE	107.961	111.458	115.354	119.572	124.528	129.874
RETAIL TRADE	343.318	358.976	370.954	380.987	393.759	407.574
WHOLESALE TRADE	116.385	119.076	120.462	121.212	122.353	123.573
SERVICES	436.003	453.938	468.246	481.037	495.770	510.652
AGRI/FOR/FISH	8.662	8.729	8.765	8.858	9.023	9.212
TOTAL GOVERNMENT	290.564	296.383	299.936	303.240	309.482	316.526
AS A PCT OF U.S.	1.543	1.550	1.546	1.540	1.536	1.533
ST AND LOCAL GOVT.	242.893	248.032	250.560	252.552	257.272	263.194
FED. GOVT. CIVI.	30.913	31.359	32.071	32.961	33.951	34.597
FED. GOVT. MILI.	16.758	16.992	17.305	17.727	18.258	18.735
FARM EMPLOYMENT	43.828	42.980	42.079	41.488	41.128	40.698
AS A PCT OF U.S.	3.586	3.586	3.586	3.586	3.586	3.586
TOTAL WAG&SAL EMP.	1895.813	1952.403	1993.147	2038.523	2091.889	2144.046
AS A PCT OF U.S.	1.889	1.905	1.916	1.920	1.926	1.933
POPULATION	4161.998	4222.868	4255.721	4285.855	4315.520	4344.502
AS A PCT OF U.S.	1.762	1.771	1.769	1.765	1.761	1.757

SOLID WASTE RULES, CONTROL FORECAST

EMPLOYMENT TABLE (IN THOUSANDS OF JOBS)

	1990	1991	1992	1993	1994	1995
MANUFACTURING	415.370	418.776	420.886	421.220	421.216	421.493
AS A PCT OF U.S.	1.978	1.993	1.998	2.000	2.005	2.011
DURABLES	255.336	258.689	260.511	261.054	261.380	261.989
NONDURABLES	160.034	160.087	160.374	160.166	159.836	159.504
NON-MANUFACTURING	1402.018	1423.252	1444.890	1464.495	1483.387	1502.302
AS A PCT OF U.S.	2.025	2.032	2.037	2.040	2.044	2.047
MINING	9.735	9.830	9.622	9.289	8.934	8.485
CONSTRUCTION	80.746	81.737	82.699	83.945	85.189	85.997
TRANSPORT + PUB UT	104.782	104.622	104.469	104.123	103.612	103.067
FINANCE, INS,+ RE	134.205	137.760	141.399	144.992	148.651	152.421
RETAIL TRADE	418.317	427.721	435.535	442.224	448.477	455.047
WHOLESALE TRADE	123.909	123.661	124.724	125.613	126.507	127.228
SERVICES	520.983	528.746	536.918	544.468	551.885	559.654
AGRI/FOR/FISH	9.339	9.175	9.525	9.842	10.132	10.402
TOTAL GOVERNMENT	323.237	329.459	335.278	340.844	346.289	351.656
AS A PCT OF U.S.	1.532	1.531	1.531	1.531	1.531	1.531
ST AND LOCAL GOVT.	269.023	274.522	279.803	284.877	289.857	294.766
FED. GOVT. CIVI.	35.120	35.576	35.966	36.333	36.689	37.045
FED. GOVT. MILI.	19.095	19.361	19.509	19.634	19.744	19.845
FARM EMPLOYMENT	40.190	39.435	38.777	38.168	37.639	37.135
AS A PCT OF U.S.	3.586	3.586	3.586	3.586	3.586	3.586
TOTAL WAG&SAL EMP.	2180.815	2210.921	2239.831	2264.727	2288.532	2312.586
AS A PCT OF U.S.	1.939	1.945	1.948	1.949	1.952	1.954
POPULATION	4372.527	4399.976	4426.659	4452.858	4478.029	4501.651
AS A PCT OF U.S.	1.753	1.749	1.746	1.743	1.739	1.736

SOLID WASTE RULES, CONTROL FORECAST

PERSONAL INCOME TABLE (IN BILLIONS OF DOLLARS)

	1984	1985	1986	1987	1988	1989
WAGE AND SAL DISB	32.972	35.273	38.006	41.341	45.128	49.449
PROPRIETORS INCOME	3.954	3.925	4.094	4.367	4.655	4.945
NON-FARM	2.724	2.856	2.983	3.160	3.334	3.505
FARM	1.230	1.069	1.112	1.207	1.321	1.441
OTHER LABOR INCOME	3.668	4.002	4.395	4.890	5.461	6.139
DERIVATION OF PERSONAL INCOME BY PLACE OF RESIDENCE:						
TOT LABOR + PROP INC	40.593	43.201	46.496	50.599	55.244	60.533
AS A PCT OF U.S.	1.899	1.907	1.919	1.928	1.938	1.949
LESS SOC INSR CONT	2.614	2.870	3.139	3.422	3.891	4.280
PLUS RESID ADJ	-.074	-.079	-.086	-.093	-.102	-.112
PLUS DIV,INT,RENT	10.637	11.833	12.734	13.989	15.379	16.564
PLUS TRANSFER PAY	6.568	6.986	7.387	7.864	8.419	9.135
PERSONAL INCOME	55.111	59.070	63.393	68.937	75.049	81.839
AS A PCT OF U.S.	1.836	1.844	1.849	1.853	1.857	1.861
LESS TAXES	8.349	8.706	9.030	9.908	10.865	11.832
FEDERAL INCOME+	4.598	4.974	5.387	5.865	6.453	7.026
STATE INCOME	2.168	2.035	1.819	2.057	2.245	2.445
OTHER TAXES	1.582	1.697	1.824	1.986	2.168	2.360
DISPOSABLE PER. INC.	46.762	50.365	54.362	59.029	64.183	70.007
CONSUMER PR INDEX	324.006	336.041	350.485	367.880	388.039	410.824
REAL DIS PER INC-'67	14.432	14.988	15.511	16.046	16.540	17.041
AS A PCT OF U.S.	1.749	1.766	1.782	1.785	1.790	1.797
BREAKDOWN OF LABOR AND PROPRIETOR'S INCOME:						
MANUFACTURING	10.324	11.014	11.806	12.955	14.207	15.564
DURABLES	6.346	6.797	7.292	8.056	8.886	9.777
NONDURABLES	3.978	4.218	4.514	4.899	5.322	5.787
NON-MANUFACTURING	23.213	24.922	26.939	29.288	31.941	35.010
MINING	.301	.319	.334	.348	.368	.392
CONSTRUCTION	2.167	2.295	2.461	2.705	2.940	3.186
TRANSPORT + PUB UT	3.183	3.390	3.626	3.913	4.227	4.575
FINANCE, INS,+ RE	2.565	2.772	3.050	3.376	3.757	4.217
RETAIL TRADE	3.971	4.281	4.634	5.028	5.502	6.066
WHOLESALE TRADE	3.149	3.333	3.545	3.778	4.045	4.359
SERVICES	7.728	8.378	9.128	9.968	10.918	12.015
AGRI/FOR/FISH	.149	.154	.162	.172	.184	.199
TOTAL GOVERNMENT	5.465	5.811	6.228	6.704	7.291	7.991
ST AND LOCAL GOVT.	4.533	4.825	5.162	5.540	6.015	6.598
FED. GOVT. CIVI.	.830	.877	.949	1.038	1.139	1.245
FED. GOVT. MILI.	.102	.109	.116	.126	.137	.149
FARM	1.592	1.454	1.523	1.652	1.804	1.967

SOLID WASTE RULES, CONTROL FORECAST

PERSONAL INCOME TABLE (IN BILLIONS OF DOLLARS)

	1990	1991	1992	1993	1994	1995
WAGE AND SAL DISB	54.126	59.214	64.644	70.417	76.686	83.534
PROPRIETORS INCOME	5.264	5.607	5.973	6.345	6.754	7.198
NON-FARM	3.708	3.935	4.179	4.419	4.683	4.976
FARM	1.555	1.672	1.794	1.926	2.072	2.222
OTHER LABOR INCOME	6.874	7.665	8.509	9.387	10.328	11.354

DERIVATION OF PERSONAL INCOME BY PLACE OF RESIDENCE:

	1990	1991	1992	1993	1994	1995
TOT LABOR + PROP INC	66.264	72.487	79.126	86.149	93.769	102.085
AS A PCT OF U.S.	1.960	1.970	1.976	1.980	1.984	1.989
LESS SOC INSR CONT	4.766	5.249	5.756	6.300	6.894	7.547
PLUS RESID ADJ	-.124	-.136	-.148	-.162	-.176	-.193
PLUS DIV,INT,RENT	17.717	19.105	20.563	22.106	23.706	25.425
PLUS TRANSFER PAY	9.960	10.859	11.856	12.959	14.138	15.410
PERSONAL INCOME	89.051	97.066	105.641	114.753	124.542	135.181
AS A PCT OF U.S.	1.865	1.869	1.871	1.871	1.872	1.873
LESS TAXES	12.917	14.125	15.417	16.794	18.284	19.912
FEDERAL INCOME+	7.695	8.442	9.242	10.099	11.028	12.046
STATE INCOME	2.657	2.892	3.142	3.407	3.692	4.003
OTHER TAXES	2.565	2.792	3.033	3.289	3.564	3.864
DISPOSABLE PER. INC.	76.133	82.941	90.224	97.958	106.258	115.269
CONSUMER PR INDEX	436.204	463.356	492.395	523.855	557.846	594.601
REAL DIS PER INC-'67	17.454	17.900	18.324	18.700	19.048	19.386
AS A PCT OF U.S.	1.802	1.806	1.808	1.808	1.809	1.810

BREAKDOWN OF LABOR AND PROPRIETOR'S INCOME:

	1990	1991	1992	1993	1994	1995
MANUFACTURING	17.007	18.601	20.235	21.895	23.664	25.588
DURABLES	10.735	11.805	12.873	13.951	15.102	16.361
NONDURABLES	6.271	6.796	7.362	7.944	8.563	9.227
NON-MANUFACTURING	38.325	41.886	45.751	49.883	54.389	59.325
MINING	.418	.456	.482	.502	.521	.533
CONSTRUCTION	3.448	3.748	4.067	4.426	4.818	5.221
TRANSPORT + PUB UT	4.933	5.325	5.739	6.166	6.613	7.087
FINANCE, INS,+ RE	4.724	5.239	5.807	6.438	7.147	7.960
RETAIL TRADE	6.685	7.367	8.068	8.801	9.588	10.448
WHOLESALE TRADE	4.700	5.059	5.494	5.955	6.455	6.989
SERVICES	13.202	14.465	15.840	17.317	18.938	20.747
AGRI/FOR/FISH	.216	.227	.253	.279	.308	.339
TOTAL GOVERNMENT	8.803	9.705	10.668	11.709	12.845	14.082
ST AND LOCAL GOVT.	7.278	8.035	8.846	9.723	10.681	11.726
FED. GOVT. CIVI.	1.364	1.495	1.632	1.779	1.939	2.113
FED. GOVT. MILI.	.161	.175	.191	.207	.225	.244
FARM	2.128	2.295	2.471	2.662	2.871	3.090

SOLID WASTE RULES, SIMULATION FORECAST
87/09/08.

SUMMARY TABLE FOR PRIVATE NONFARM SECTORS.

	1984	1985	1986	1987	1988	1989
PRIVATE NONFARM EMPLOYMENT (IN THOUSANDS OF JOBS)						
TOTAL	.105	.029	.043	.014	.530	.801
INTERMEDIATE	.070	.043	.047	.044	.223	.240
INDUCED	-.105	-.107	-.135	-.136	-.253	.163
EXPORT	.140	.093	.131	.106	.561	.398
EXOGENOUS	.160	.129	.179	.167	.663	1.048
COSTS RELATIVE TO THE U.S.						
PRODUCTION	.00029	.00025	.00026	.00026	.00059	.00077
FACTOR INPUTS	.00002	.00002	.00000	.00002	.00008	.00013
LABOR	.00001	.00001	.00002	.00002	.00008	.00013
FUEL	0	0	0	0	0	0
CAPITAL	.00006	.00005	.00003	.00006	.00013	.00018
INTERMED. INPUTS	.00045	.00039	.00042	.00041	.00090	.00116
PROD FOR LOCAL MKT	.00032	.00027	.00028	.00028	.00065	.00084
PROD. FOR EXPORT	.00024	.00021	.00021	.00022	.00049	.00064
OTHER VARIABLES:						
LABOR INTENSITY	.00000	.00000	.00000	.00000	.00000	.00000
MULT ADJ. INDEX	-.00000	-.00000	-.00000	-.00000	-.00000	-.00000
EXP. SHARE OF US-	.00	.00	.00	.00	.00	.00
EXP EMP-PCT OF EMP	.01	.01	.01	.01	.02	.00
EMP. AS PCT OF US	.00	.00	.00	.00	.00	.00
DEMAND (BILLIONS)	.016	.010	.008	.007	.024	.012
SELF SUPPLY (SS)	.004	.001	-.000	-.001	.005	.000
IMPORTS	.012	.009	.008	.008	.018	.012
OUTPUT (SUP-BIL)	.034	.027	.030	.028	.076	.087
SUP/DEM RATIO	.00	.00	.00	.00	.00	.00
PS= SS/SUPPLY	-.00	-.00	-.00	-.00	-.00	-.00
RPC= SS/DEMAND	-.00	-.00	-.00	-.00	-.00	-.00
AVERAGE WAGE RATE	.002	.002	.002	.002	.006	.007
EMPLOYMENT INDEX	0	0	0	0	0	0

SOLID WASTE RULES, SIMULATION FORECAST
87/09/08.

SUMMARY TABLE FOR PRIVATE NONFARM SECTORS.

	1990	1991	1992	1993	1994	1995
PRIVATE NONFARM EMPLOYMENT (IN THOUSANDS OF JOBS)						
TOTAL	.498	.322	.194	.095	.048	.014
INTERMEDIATE	.147	.109	.078	.047	.035	.026
INDUCED	.110	.061	.006	-.008	-.029	-.044
EXPORT	.241	.152	.111	.057	.042	.032
EXOGENOUS	.860	.722	.635	.559	.521	.485
COSTS RELATIVE TO THE U.S.						
PRODUCTION	.00067	.00057	.00051	.00045	.00042	.00039
FACTOR INPUTS	.00014	.00012	.00010	.00009	.00007	.00006
LABOR	.00014	.00013	.00012	.00010	.00008	.00006
FUEL	0	0	0	0	0	0
CAPITAL	.00021	.00014	.00013	.00012	.00011	.00010
INTERMED. INPUTS	.00098	.00085	.00076	.00067	.00063	.00059
PROD FOR LOCAL MKT	.00073	.00063	.00057	.00050	.00046	.00043
PROD. FOR EXPORT	.00056	.00048	.00043	.00037	.00034	.00032
OTHER VARIABLES:						
LABOR INTENSITY	.00000	.00000	.00000	.00000	.00000	.00001
MULT ADJ. INDEX	-.00000	-.00000	-.00000	-.00000	-.00000	-.00000
EXP. SHARE OF US-	.00	.00	.00	.00	.00	.00
EXP EMP-PCT OF EMP	.00	.00	.00	.00	.00	.00
EMP. AS PCT OF US	.00	.00	.00	.00	.00	.00
DEMAND (BILLIONS)	-.007	-.013	-.021	-.030	-.036	-.040
SELF SUPPLY (SS)	-.009	-.012	-.017	-.021	-.025	-.027
IMPORTS	.002	-.001	-.004	-.009	-.011	-.013
OUTPUT (SUP-BIL)	.059	.044	.032	.020	.015	.011
SUP/DEM RATIO	.00	.00	.00	.00	.00	.00
PS= SS/SUPPLY	-.00	-.00	-.00	-.00	-.00	-.00
RPC= SS/DEMAND	-.00	-.00	-.00	-.00	-.00	-.00
AVERAGE WAGE RATE	.006	.006	.005	.005	.004	.004
EMPLOYMENT INDEX	0	0	0	0	0	0

SOLID WASTE RULES, SIMULATION FORECAST
87/09/08.

EMPLOYMENT TABLE. (IN THOUSANDS OF JOBS)

	1984	1985	1986	1987	1988	1989
MANUFACTURING	-.005	-.028	-.042	-.056	-.061	-.120
AS A PCT OF U.S.	-.000	-.000	-.000	-.000	-.000	-.001
DURABLES	.005	-.015	-.025	-.036	-.033	-.086
NONDURABLES	-.010	-.013	-.018	-.020	-.028	-.034
NON-MANUFACTURING	.110	.058	.086	.071	.591	.921
AS A PCT OF U.S.	.000	.000	.000	.000	.001	.001
MINING	-.000	.000	.000	.000	.000	.000
CONSTRUCTION	.065	.036	.063	.062	.362	.290
TRANSPORT + PUB UT	.125	.109	.107	.099	.120	.102
FINANCE, INS,+ RE	-.009	-.009	-.012	-.011	-.015	.501
RETAIL TRADE	-.054	-.056	-.063	-.062	-.071	-.110
WHOLESALE TRADE	.006	.001	-.000	-.002	.016	.002
SERVICES	-.024	-.023	-.008	-.014	.178	.137
AGRI/FOR/FISH	.000	-.000	-.000	-.000	.001	.000
TOTAL GOVERNMENT	0	.005	.001	.002	.010	.030
AS A PCT OF U.S.	0	.000	.000	.000	.000	.000
ST AND LOCAL GOVT.	0	.005	.001	.002	.010	.030
FED. GOVT. CIVI.	0	0	0	0	0	0
FED. GOVT. MILI.	0	0	0	0	0	0
FARM EMPLOYMENT	0	0	0	0	0	0
AS A PCT OF U.S.	0	0	0	0	0	0
TOTAL WAG&SAL EMP.	.105	.034	.045	.016	.540	.831
AS A PCT OF U.S.	.000	.000	.000	.000	.000	.001
POPULATION	0	.077	.024	.032	.011	.366
AS A PCT OF U.S.	0	.000	.000	.000	.000	.000

SOLID WASTE RULES, SIMULATION FORECAST
87/09/08.

EMPLOYMENT TABLE. (IN THOUSANDS OF JOBS)

	1990	1991	1992	1993	1994	1995
MANUFACTURING	-.176	-.202	-.218	-.226	-.225	-.221
AS A PCT OF U.S.	-.001	-.001	-.001	-.001	-.001	-.001
DURABLES	-.131	-.152	-.164	-.170	-.170	-.166
NONDURABLES	-.045	-.050	-.054	-.056	-.056	-.055
NON-MANUFACTURING	.674	.524	.413	.321	.273	.235
AS A PCT OF U.S.	.001	.001	.001	.000	.000	.000
MINING	.000	.000	.000	.000	.000	.000
CONSTRUCTION	.198	.170	.148	.113	.104	.096
TRANSPORT + PUB UT	.074	.063	.054	.043	.038	.035
FINANCE, INS,+ RE	.432	.360	.300	.275	.252	.231
RETAIL TRADE	-.116	-.112	-.114	-.114	-.115	-.114
WHOLESALE TRADE	-.011	-.014	-.017	-.021	-.022	-.022
SERVICES	.097	.056	.042	.025	.016	.010
AGRI/FOR/FISH	.000	-.000	-.000	-.000	-.000	-.000
TOTAL GOVERNMENT	.042	.029	.021	.015	.010	.008
AS A PCT OF U.S.	.000	.000	.000	.000	.000	.000
ST AND LOCAL GOVT.	.042	.029	.021	.015	.010	.008
FED. GOVT. CIVI.	0	0	0	0	0	0
FED. GOVT. MILI.	0	0	0	0	0	0
FARM EMPLOYMENT	0	0	0	0	0	0
AS A PCT OF U.S.	0	0	0	0	0	0
TOTAL WAG&SAL EMP.	.540	.351	.215	.110	.058	.022
AS A PCT OF U.S.	.000	.000	.000	.000	.000	.000
POPULATION	.553	.355	.229	.139	.071	.037
AS A PCT OF U.S.	.000	.000	.000	.000	.000	.000

SOLID WASTE RULES, SIMULATION FORECAST
87/09/08.

PERSONAL INCOME TABLE (IN BILLIONS OF DOLLARS)

	1984	1985	1986	1987	1988	1989
WAGE AND SAL DISB	.005	.003	.004	.004	.022	.032
PROPRIETORS INCOME	.001	.000	.001	.001	.003	.003
NON-FARM	.001	.000	.001	.001	.003	.003
FARM	0	0	0	0	0	0
OTHER LABOR INCOME	.001	.000	.000	.000	.002	.003

DERIVATION OF PERSONAL INCOME BY PLACE OF RESIDENCE:

	1984	1985	1986	1987	1988	1989
TOT LABOR + PROP INC	.006	.004	.005	.005	.027	.039
AS A PCT OF U.S.	.000	.000	.000	.000	.001	.001
LESS SOC INSR CONT	.000	.000	.000	.000	.001	.002
PLUS RESID ADJ	-.000	-.000	-.000	-.000	-.000	-.000
PLUS DIV,INT,RENT	0	.000	.000	.000	.000	.001
PLUS TRANSFER PAY	-.000	.000	-.000	.000	-.002	-.002
PERSONAL INCOME	.006	.005	.005	.005	.024	.036
AS A PCT OF U.S.	.000	.000	.000	.000	.001	.001
LESS TAXES	.001	.001	.001	.001	.005	.007
FEDERAL INCOME+	.001	.000	.000	.000	.003	.004
STATE INCOME	.000	.000	.000	.000	.001	.002
OTHER TAXES	.000	.000	.000	.000	.001	.001
DISPOSABLE PER. INC.	.005	.004	.004	.004	.019	.030
CONSUMER PR INDEX	.135	.120	.133	.137	.320	.437
REAL DIS PER INC-'67	-.005	-.004	-.005	-.005	-.009	-.011
AS A PCT OF U.S.	-.001	-.000	-.001	-.001	-.001	-.001

BREAKDOWN OF LABOR AND PROPRIETOR'S INCOME:

	1984	1985	1986	1987	1988	1989
MANUFACTURING	.000	-.001	-.001	-.002	-.001	-.003
DURABLES	.000	-.000	-.001	-.001	-.001	-.002
NONDURABLES	-.000	-.000	-.000	-.001	-.001	-.001
NON-MANUFACTURING	.006	.005	.006	.006	.028	.040
MINING	.000	.000	.000	.000	.000	.000
CONSTRUCTION	.002	.001	.002	.002	.014	.012
TRANSPORT + PUB UT	.005	.004	.005	.004	.006	.006
FINANCE, INS,+ RE	-.000	-.000	-.000	-.000	-.000	.015
RETAIL TRADE	-.001	-.001	-.001	-.001	-.001	-.001
WHOLESALE TRADE	.000	.000	.000	-.000	.001	.000
SERVICES	-.000	-.000	.000	.000	.008	.007
AGRI/FOR/FISH	.000	.000	.000	.000	.000	.000
TOTAL GOVERNMENT	.000	.000	.000	.000	.001	.002
ST AND LOCAL GOVT.	.000	.000	.000	.000	.001	.002
FED. GOVT. CIVI.	.000	.000	.000	.000	.000	.000
FED. GOVT. MILI.	0	0	0	0	0	0
FARM	0	0	0	0	0	0

SOLID WASTE RULES, SIMULATION FORECAST
87/09/08.

PERSONAL INCOME TABLE (IN BILLIONS OF DOLLARS)

	1990	1991	1992	1993	1994	1995
WAGE AND SAL DISB	.026	.022	.018	.014	.012	.010
PROPRIETORS INCOME	.002	.002	.002	.001	.001	.001
NON-FARM	.002	.002	.002	.001	.001	.001
FARM	0	0	0	0	0	0
OTHER LABOR INCOME	.002	.001	.001	.000	.000	-.000

DERIVATION OF PERSONAL INCOME BY PLACE OF RESIDENCE:

	1990	1991	1992	1993	1994	1995
TOT LABOR + PROP INC	.030	.025	.021	.016	.013	.011
AS A PCT OF U.S.	.001	.001	.001	.000	.000	.000
LESS SOC INSR CONT	.001	.001	.001	.000	.000	.000
PLUS RESID ADJ	-.000	-.000	-.000	-.000	-.000	-.000
PLUS DIV,INT,RENT	.002	.002	.001	.001	.000	.000
PLUS TRANSFER PAY	.000	.000	.000	.000	.000	.000
PERSONAL INCOME	.032	.026	.021	.016	.014	.011
AS A PCT OF U.S.	.001	.000	.000	.000	.000	.000
LESS TAXES	.006	.005	.004	.003	.003	.002
FEDERAL INCOME+	.003	.003	.002	.002	.001	.001
STATE INCOME	.002	.001	.001	.001	.001	.001
OTHER TAXES	.001	.001	.001	.001	.000	.000
DISPOSABLE PER. INC.	.026	.021	.017	.013	.011	.009
CONSUMER PR INDEX	.394	.361	.344	.321	.320	.319
REAL DIS PER INC-'67	-.010	-.009	-.009	-.009	-.009	-.009
AS A PCT OF U.S.	-.001	-.001	-.001	-.001	-.001	-.001

BREAKDOWN OF LABOR AND PROPRIETOR'S INCOME:

	1990	1991	1992	1993	1994	1995
MANUFACTURING	-.006	-.008	-.009	-.011	-.012	-.013
DURABLES	-.005	-.006	-.007	-.009	-.010	-.010
NONDURABLES	-.001	-.002	-.002	-.002	-.003	-.003
NON-MANUFACTURING	.034	.030	.028	.025	.024	.023
MINING	.000	.000	.000	.000	.000	.000
CONSTRUCTION	.009	.009	.008	.007	.007	.007
TRANSPORT + PUB UT	.005	.004	.004	.004	.003	.003
FINANCE, INS,+ RE	.015	.013	.012	.012	.012	.012
RETAIL TRADE	-.001	-.002	-.002	-.002	-.002	-.003
WHOLESALE TRADE	.000	-.000	-.000	-.001	-.001	-.001
SERVICES	.007	.005	.005	.004	.004	.004
AGRI/FOR/FISH	.000	.000	.000	.000	.000	.000
TOTAL GOVERNMENT	.003	.003	.002	.002	.002	.002
ST AND LOCAL GOVT.	.002	.002	.002	.002	.002	.002
FED. GOVT. CIVI.	.000	.000	.000	.000	.000	.000
FED. GOVT. MILI.	0	0	0	0	0	0
FARM	0	0	0	0	0	0

SOLID WASTE RULES, SIMULATION FORECAST + CONSOLIDATION

SUMMARY TABLE FOR PRIVATE NONFARM SECTORS.

	1984	1985	1986	1987	1988	1989
PRIVATE NONFARM EMPLOYMENT (IN THOUSANDS OF JOBS)						
TOTAL	.105	.029	.043	.014	.530	.801
INTERMEDIATE	.070	.043	.047	.044	.223	.240
INDUCED	-.105	-.107	-.135	-.136	.253	.163
EXPORT	.140	.093	.131	.106	.561	.398
EXOGENOUS	.160	.129	.179	.167	.663	1.048
COSTS RELATIVE TO THE U.S.						
PRODUCTION	.00029	.00025	.00026	.00026	.00059	.00077
FACTOR INPUTS	.00002	.00002	.00000	.00002	.00008	.00013
LABOR	.00001	.00001	.00002	.00002	.00012	.00016
FUEL	0	0	0	0	0	0
CAPITAL	.00006	.00005	.00003	.00006	.00013	.00018
INTERMED. INPUTS	.00045	.00039	.00042	.00041	.00090	.00116
PROD FOR LOCAL MKT	.00032	.00027	.00028	.00028	.00065	.00084
PROD. FOR EXPORT	.00024	.00021	.00021	.00022	.00049	.00064
OTHER VARIABLES:						
LABOR INTENSITY	.00000	.00000	.00000	.00000	.00000	.00000
MULT ADJ. INDEX	-.00000	-.00000	-.00000	-.00000	-.00000	-.00000
EXP. SHARE OF US-	.00	.00	.00	.00	.00	.00
EXP EMP-PCT OF EMP	.01	.01	.01	.01	.02	.00
EMP. AS PCT OF US	.00	.00	.00	.00	.00	.00
DEMAND (BILLIONS)	.016	.010	.008	.007	.024	.012
SELF SUPPLY (SS)	.004	.001	-.000	-.001	.005	.000
IMPORTS	.012	.009	.008	.008	.018	.012
OUTPUT (SUP-BIL)	.034	.027	.030	.028	.076	.087
SUP/DEM RATIO	.00	.00	.00	.00	.00	.00
PS= SS/SUPPLY	-.00	-.00	-.00	-.00	-.00	-.00
RPC= SS/DEMAND	-.00	-.00	-.00	-.00	-.00	-.00
AVERAGE WAGE RATE	.002	.002	.002	.002	.006	.007
EMPLOYMENT INDEX	0	0	0	0	0	0

SOLID WASTE RULES, SIMULATION FORECAST + CONSOLIDATION

SUMMARY TABLE FOR PRIVATE NONFARM SECTORS.

	1990	1991	1992	1993	1994	1995
PRIVATE NONFARM EMPLOYMENT (IN THOUSANDS OF JOBS)						
TOTAL	.498	.322	.194	.087	-.014	-.041
INTERMEDIATE	.147	.109	.078	.055	.019	.012
INDUCED	.110	.061	.006	-.068	-.061	-.074
EXPORT	.241	.152	.111	.099	.028	.022
EXOGENOUS	.860	.722	.635	.544	.449	.419
COSTS RELATIVE TO THE U.S.						
PRODUCTION	.00067	.00057	.00051	.00046	.00037	.00034
FACTOR INPUTS	.00014	.00012	.00010	.00009	.00007	.00005
LABOR	.00014	.00013	.00012	.00010	.00007	.00005
FUEL	0	0	0	0	0	0
CAPITAL	.00021	.00014	.00013	.00012	.00010	.00009
INTERMED. INPUTS	.00098	.00085	.00076	.00068	.00056	.00052
PROD FOR LOCAL MKT	.00073	.00063	.00057	.00051	.00041	.00038
PROD. FOR EXPORT	.00056	.00048	.00043	.00038	.00031	.00028
OTHER VARIABLES:						
LABOR INTENSITY	.00000	.00000	.00000	.00000	.00000	.00001
MULT ADJ. INDEX	-.00000	-.00000	-.00000	-.00000	-.00000	-.00000
EXP. SHARE OF US-	.00	.00	.00	.00	.00	.00
EXP EMP-PCT OF EMP	.00	.00	.00	.00	.00	.00
EMP. AS PCT OF US	.00	.00	.00	.00	-.00	-.00
DEMAND (BILLIONS)	-.007	-.013	-.021	-.026	-.036	-.040
SELF SUPPLY (SS)	-.009	-.012	-.017	-.020	-.024	-.027
IMPORTS	.002	-.001	-.004	-.006	-.012	-.013
OUTPUT (SUP-BIL)	.059	.044	.032	.024	.008	.004
SUP/DEM RATIO	.00	.00	.00	.00	.00	.00
PS= SS/SUPPLY	-.00	-.00	-.00	-.00	-.00	-.00
RPC= SS/DEMAND	-.00	-.00	-.00	-.00	-.00	-.00
AVERAGE WAGE RATE	.006	.006	.005	.005	.004	.003
EMPLOYMENT INDEX	0	0	0	0	0	0

SOLID WASTE RULES, SIMULATION FORECAST + CONSOLIDATION

EMPLOYMENT TABLE (IN THOUSANDS OF JOBS)

	1984	1985	1986	1987	1988	1989
MANUFACTURING	-.005	-.028	-.042	-.056	-.061	-.120
AS A PCT OF U.S.	-.000	-.000	-.000	-.000	-.000	-.001
DURABLES	.005	-.015	-.025	-.036	-.033	-.086
NONDURABLES	-.010	-.013	-.018	-.020	-.028	-.034
NON-MANUFACTURING	.110	.058	.086	.071	.591	.921
AS A PCT OF U.S.	.000	.000	.000	.000	.001	.001
MINING	-.000	.000	.000	.000	.000	.000
CONSTRUCTION	.065	.036	.063	.062	.362	.290
TRANSPORT + PUB UT	.125	.109	.107	.099	.120	.102
FINANCE, INS,+ RE	-.009	-.009	-.012	-.011	-.015	.501
RETAIL TRADE	-.054	-.056	-.063	-.062	-.071	-.110
WHOLESALE TRADE	.006	.001	-.000	-.002	.016	.002
SERVICES	-.024	-.022	-.008	-.014	.178	.137
AGRI/FOR/FISH	.000	-.000	-.000	-.000	.001	.000
TOTAL GOVERNMENT	-.000	.005	.001	.002	.010	.030
AS A PCT OF U.S.	-.000	.000	.000	.000	.000	.000
ST AND LOCAL GOVT.	0	.005	.001	.002	.010	.030
FED. GOVT. CIVI.	0	0	0	0	0	0
FED. GOVT. MILI.	0	0	0	0	0	0
FARM EMPLOYMENT	0	0	0	0	0	0
AS A PCT OF U.S.	0	0	0	0	0	0
TOTAL WAG&SAL EMP.	.105	.034	.045	.016	.540	.831
AS A PCT OF U.S.	.000	.000	.000	.000	.000	.001
POPULATION	0	.077	.024	.032	.011	.366
AS A PCT OF U.S.	0	.000	.000	.000	.000	.000

SOLID WASTE RULES, SIMULATION FORECAST + CONSOLIDATION

EMPLOYMENT TABLE (IN THOUSANDS OF JOBS)

	1990	1991	1992	1993	1994	1995
MANUFACTURING	-.176	-.202	-.218	-.224	-.225	-.217
AS A PCT OF U.S.	-.001	-.001	-.001	-.001	-.001	-.001
DURABLES	-.131	-.152	-.164	-.167	-.169	-.163
NONDURABLES	-.045	-.050	-.054	-.056	-.055	-.054
NON-MANUFACTURING	.674	.524	.413	.311	.210	.176
AS A PCT OF U.S.	.001	.001	.001	.000	.000	.000
MINING	.000	.000	.000	.000	.000	.000
CONSTRUCTION	.198	.170	.148	.139	.087	.080
TRANSPORT + PUB UT	.074	.063	.054	.050	.036	.032
FINANCE, INS,+ RE	.432	.360	.300	.215	.198	.181
RETAIL TRADE	-.116	-.112	-.114	-.113	-.108	-.108
WHOLESALE TRADE	-.011	-.014	-.017	-.018	-.022	-.022
SERVICES	.097	.056	.042	.038	.020	.013
AGRI/FOR/FISH	.000	-.000	-.000	-.000	-.000	-.000
TOTAL GOVERNMENT	.042	.029	.021	.015	.010	.005
AS A PCT OF U.S.	.000	.000	.000	.000	.000	.000
ST AND LOCAL GOVT.	.042	.029	.021	.015	.010	.005
FED. GOVT. CIVI.	0	0	0	0	0	0
FED. GOVT. MILI.	0	0	0	0	0	0
FARM EMPLOYMENT	0	0	0	0	0	0
AS A PCT OF U.S.	0	0	0	0	0	0
TOTAL WAG&SAL EMP.	.540	.351	.215	.102	-.004	-.036
AS A PCT OF U.S.	.000	.000	.000	.000	-.000	-.000
POPULATION	.553	.355	.229	.139	.066	-.003
AS A PCT OF U.S.	.000	.000	.000	.000	.000	-.000

SOLID WASTE RULES, SIMULATION FORECAST + CONSOLIDATION

PERSONAL INCOME TABLE (IN BILLIONS OF DOLLARS)

	1984	1985	1986	1987	1988	1989
WAGE AND SAL DISB	.005	.003	.004	.004	.022	.032
PROPRIETORS INCOME	.001	.000	.001	.001	.003	.003
NON-FARM	.001	.000	.001	.001	.003	.003
FARM	0	0	0	0	0	0
OTHER LABOR INCOME	.001	.000	.000	.000	.002	.003
DERIVATION OF PERSONAL INCOME BY PLACE OF RESIDENCE:						
TOT LABOR + PROP INC	.006	.004	.005	.005	.027	.039
AS A PCT OF U.S.	.000	.000	.000	.000	.001	.001
LESS SOC INSR CONT	.000	.000	.000	.000	.001	.002
PLUS RESID ADJ	-.000	-.000	-.000	-.000	-.000	-.000
PLUS DIV,INT,RENT	0	.000	.000	.000	.000	.001
PLUS TRANSFER PAY	-.000	.000	-.000	.000	-.002	-.002
PERSONAL INCOME	.006	.005	.005	.005	.024	.036
AS A PCT OF U.S.	.000	.000	.000	.000	.001	.001
LESS TAXES	.001	.001	.001	.001	.005	.007
FEDERAL INCOME+	.001	.000	.000	.000	.003	.004
STATE INCOME	.000	.000	.000	.000	.001	.002
OTHER TAXES	.000	.000	.000	.000	.001	.001
DISPOSABLE PER. INC.	.005	.004	.004	.004	.019	.030
CONSUMER PR INDEX	.135	.120	.133	.137	.320	.437
REAL DIS PER INC-'67	-.005	-.004	-.005	-.005	-.009	-.011
AS A PCT OF U.S.	-.001	-.000	-.001	-.001	-.001	-.001
BREAKDOWN OF LABOR AND PROPRIETOR'S INCOME:						
MANUFACTURING	.000	-.001	-.001	-.002	-.001	-.003
DURABLES	.000	-.000	-.001	-.001	-.001	-.002
NONDURABLES	-.000	-.000	-.000	-.001	-.001	-.001
NON-MANUFACTURING	.006	.005	.006	.006	.028	.040
MINING	.000	.000	.000	.000	.000	.000
CONSTRUCTION	.002	.001	.002	.002	.014	.012
TRANSPORT + PUB UT	.005	.004	.005	.004	.006	.006
FINANCE, INS,+ RE	-.000	-.000	-.000	-.000	-.000	.015
RETAIL TRADE	-.001	-.001	-.001	-.001	-.001	-.001
WHOLESALE TRADE	.000	.000	.000	-.000	.001	.000
SERVICES	-.000	-.000	.001	.000	.008	.007
AGRI/FOR/FISH	.000	.000	.000	.000	.000	.000
TOTAL GOVERNMENT	.000	.000	.000	.000	.001	.002
ST AND LOCAL GOVT.	.000	.000	.000	.000	.001	.002
FED. GOVT. CIVI.	.000	.000	.000	.000	.000	.000
FED. GOVT. MILI.	0	0	0	0	0	0
FARM	0	0	0	0	0	0

SOLID WASTE RULES, SIMULATION FORECAST + CONSOLIDATION

PERSONAL INCOME TABLE (IN BILLIONS OF DOLLARS)

	1990	1991	1992	1993	1994	1995
WAGE AND SAL DISB	.026	.022	.018	.014	.009	.007
PROPRIETORS INCOME	.002	.002	.002	.002	.001	.001
NON-FARM	.002	.002	.002	.002	.001	.001
FARM	0	0	0	0	0	0
OTHER LABOR INCOME	.002	.001	.001	.000	-.000	-.000
DERIVATION OF PERSONAL INCOME BY PLACE OF RESIDENCE:						
TOT LABOR + PROP INC	.030	.025	.021	.016	.010	.007
AS A PCT OF U.S.	.001	.001	.001	.000	.000	.000
LESS SOC INSR CONT	.001	.001	.001	.000	-.000	-.000
PLUS RESID ADJ	-.000	-.000	-.000	-.000	-.000	-.000
PLUS DIV,INT,RENT	.002	.002	.001	.001	.000	-.000
PLUS TRANSFER PAY	.000	.000	.000	.000	.000	.000
PERSONAL INCOME	.032	.026	.021	.017	.010	.008
AS A PCT OF U.S.	.001	.000	.000	.000	.000	.000
LESS TAXES	.006	.005	.004	.003	.002	.002
FEDERAL INCOME+	.003	.003	.002	.002	.001	.001
STATE INCOME	.002	.001	.001	.001	.001	.001
OTHER TAXES	.001	.001	.001	.001	.000	.000
DISPOSABLE PER. INC.	.026	.021	.017	.014	.008	.006
CONSUMER PR INDEX	.394	.361	.344	.328	.284	.283
REAL DIS PER INC-'67	-.010	-.009	-.009	-.009	-.008	-.008
AS A PCT OF U.S.	-.001	-.001	-.001	-.001	-.001	-.001
BREAKDOWN OF LABOR AND PROPRIETOR'S INCOME:						
MANUFACTURING	-.006	-.008	-.009	-.011	-.012	-.013
DURABLES	-.005	-.006	-.007	-.008	-.010	-.010
NONDURABLES	-.001	-.002	-.002	-.002	-.003	-.003
NON-MANUFACTURING	.034	.030	.028	.025	.020	.019
MINING	.000	.000	.000	.000	.000	.000
CONSTRUCTION	.009	.009	.008	.008	.006	.006
TRANSPORT + PUB UT	.005	.004	.004	.004	.003	.003
FINANCE, INS,+ RE	.015	.013	.012	.010	.010	.010
RETAIL TRADE	-.001	-.002	-.002	-.002	-.002	-.002
WHOLESALE TRADE	-.000	-.000	-.000	-.001	-.001	-.001
SERVICES	.007	.005	.005	.005	.004	.004
AGRI/FOR/FISH	.000	.000	.000	.000	.000	-.000
TOTAL GOVERNMENT	.003	.003	.002	.002	.002	.002
ST AND LOCAL GOVT.	.002	.002	.002	.002	.002	.001
FED. GOVT. CIVI.	.000	.000	.000	.000	.000	.000
FED. GOVT. MILI.	0	0	0	0	0	0
FARM	0	0	0	0	0	0