Monitoring the Implementation of the Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota: Report 2001

A report by the Minnesota Department of Natural Resources

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Respectfully submitted to the Minnesota Forest Resources Council

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EXECUTIVE SUMMARY

This report discusses the findings from the second year of conducting field monitoring of timber harvesting and forest management guidelines on public and private forest land in Minnesota. The objective of this monitoring program continues to be to provide information to the state's forest land managers and policy makers on the application of sustainable harvesting and management guidelines as defined in the guidebook: *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines*. Prepared by the Minnesota Forest Resources Council (Council), this guidebook contains recommendations for addressing site-level water quality, wetland, wildlife habitat, riparian management, soil productivity, historic and cultural resources, and visual quality issues associated with conducting timber harvesting and forest management activities. The guidebook was published in 1999 as an integrated manual for use by the state's loggers, forest landowners, and forest resource managers.

A total of 118 harvesting sites were monitored in 2001. These sites were identified using a sampling procedure that randomly selected blocks of land **2** township in size throughout the forested area of the state. Within these blocks aerial photography, in combination with assistance from local forestry personnel, was used to identify recently harvested forest land. Landowners were subsequently contacted to secure permission to visit the site and gather site background information prior to conducting the field reviews. The focus of the field review was to describe conditions and practices in the context of quantifiable timber harvesting and forest management guidelines.

It is important to note that all sites monitored in 2001, as in 2000, were harvested and/or its stumpage sold under contact prior to publication of the Council's timber harvesting and forest management guidebook. Therefore, with the exception of water quality, wetland protection, and visual quality practices where guidelines have existed for several years, the report describes baseline harvesting and management practices (i.e., those that existed prior to publication of Minnesota's comprehensive timber harvesting and forest management guidelines). Subsequent annual field monitoring will describe how harvesting and management practices change over time, and assess the extent to which the management practices recommended in the guidebook are being applied across the state.

Some of the important findings from the second year's monitoring are given below.

- The application of timber harvesting and forest management guidelines was monitored on state, county, U. S. Forest Service, forest industry, and nonindustrial private forest land distributed broadly over the forested regions of the state.

- Twenty four percent of the monitored sites were visually sensitive. Landowners and loggers were aware of the visual sensitivity classification on 39% and 18% of these sites, respectively.

- Filter strip compliance with the guideline recommendation (<5% mineral soil exposure, dispersed over the filter strip) was 62% and ranged from 74% for water bodies adjacent to the harvest area to 52% for those water bodies located within the harvest area..

- For lakes, perennial streams and open water wetlands, 44% of riparian management zones (RMZ) met the guideline recommendations for width and residual basal area. A higher proportion of RMZ=s that met the guideline recommendations were adjacent to the harvest area compared to those for water bodies that were within (i.e., open water wetlands) or traversed (i.e., perennial streams) the harvest area.

- Only 4.5% of skid trail and road approaches to wetlands and streams had the appropriate water diversion devices installed to divert surface run off from directly entering these water bodies.

- The guidelines recommend that site infrastructure (i.e., roads, landings) occupy no more than 3% of the harvest area. The statewide average was 3.2%.

- Landings were located outside of filter strips and RMZs 77% and 94% of the time, respectively.

- Slash was retained at the stump or redistributed back on the site for 81% of the sites monitored.

- Rutting was found on 35 of the sites monitored. Rutting was confined to roads and skid trails only on 16 of these 35 sites.

- Skid trails were found to occupy less than 15% of the harvest area for 83% of the sites monitored.

- Sixty-three percent of the clearcut sites met the leave tree guideline recommendations.

I. INTRODUCTION

The Sustainable Forest Resources Act (SFRA) enacted in1995 and modified in 1999 (Minnesota Statutes, Sections 89A.01 to 89A.10) initiated an effort to resolve important forestry policy issues through collaborative approaches among diverse forestry interests. These forestry interests were organized into the Governor-appointed Minnesota Forest Resources Council (Council). Much of the initial effort of the Council focused on the development of timber harvesting and forest management guidelines for use on public and private forest land in Minnesota. The process of guideline development began in April 1996. Site level guidelines were developed for the topical areas of riparian zone management, forest soil productivity, historic/cultural resources, and wildlife habitat. These guidelines were integrated with existing water quality and wetland best management practices (BMPs) and visual quality BMPs into a single comprehensive guidebook. These guidelines were approved by the Council in December 1998, and the guidebook titled *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines* was published in April 1999.

To compliment the adoption and promotion of voluntarily applied timber harvesting and forest management guidelines, the SFRA mandated that application of the guidelines be monitored on public and private forest land. Implementation monitoring is the process of identifying and recording the combination of guidelines applied to protect specific resource functions and values on a site where timber harvesting or other forest management activity is conducted. Specifically, the SFRA states:

> *89A.07, Subd. 2. Practices and compliance monitoring. The commissioner shall establish a program for monitoring silvicultural practices and application of the timber harvesting and forest management guidelines at statewide, landscape, and site levels. The council shall provide oversight and program direction for the development and implementation of the monitoring program. To the extent possible, the information generated by the monitoring program must be reported in formats consistent with the landscape regions used to accomplish the planning and coordination activities specified in section 89A.06.*

Responsibility for implementation monitoring rests with the Minnesota Department of Natural Resources (DNR), with oversight and program direction provided by the Council. The monitoring program builds on past efforts to monitor the implementation and effectiveness of the BMPs to protect water quality, wetlands, and visual quality (Phillips et al. 1994).

All sites that were monitored in 2001 were harvested before and/or were contracted for harvesting prior to the publication of the timber harvesting and forest management (TH/FM) guidebook. For that reason, the results for the riparian, soil productivity, site specific wildlife, and cultural and historic guidelines are baseline (pre-guideline) information. However, the results for the water quality and wetland BMPs and visual quality guidelines are not baseline data because they have been the forestry standard for Minnesota for several years prior to publication of the Council's guidebook.

II. METHODOLOGY

The methodology and procedures for site selection in 2001 were essentially the same as were used for the 2000 implementation monitoring program. The reader is referred to the methodology section in the 2000 report titled *Monitoring the Implementation of the Timber Harvesting and Forest Management Guidelines on Public and Private Forest Land in Minnesota: Report 2000*. The changes to the methodology for the 2001 implementation monitoring program can be grouped into the following categories: 1) changes in the data collection forms and the data collected, 2) the amount of forest cover within a township needed to qualify as a "primary sampling unit" (PSUs) for site selection, and 3) changes to aerial photo interpretation.

A. Data collection forms

The detailed nature of the "site-profile and "pre-site visit" forms used in monitoring for 2000 often made it difficult to obtain timely completion and cooperation of the landowners, particularly the nonindustrial private forest (NIPF) landowners. The landowner questionnaire that was developed to replace these forms focused more on collecting the site specific information that could not be obtained through the onsite evaluations. Questions were deleted that elicited the landowner's perception or awareness of the presence of certain resources or conditions on their property (e.g., type and number of water bodies, soil type and soil drainage characteristics). However, additional information was also requested of the landowner which included: 1) identifying their primary objective for management, 2) identifying whether the timber harvesting and forest management (TH/FM) guidelines were used in planning or modifying the timber harvesting or roads activities, and 3) identifying whether the TH/FM guidelines were discussed during the onsite meeting between the landowner/resource manager and the logger/contractor.

The "onsite" data collection form was also modified to better characterize the conditions observed. **Visual quality:** The contractors were required to categorize the apparent harvest size of most and moderate visually sensitive sites into one of three measures: <5 acres, 5-10 acres, or >10 acres. **Water diversion structures:** Additional questions were included that focused on the extent of erosion and sedimentation to water bodies related to the use of water diversion structures. **Riparian management zones:** Data collected on RMZ width and basal area (BA) was expanded to include the following categories of response: 1) width of nonforested vegetation, 2) width and BA of uncut riparian forest, 3) width and residual BA of partially harvested riparian forest, and 4) width of clearcut (<25 BA) for the remainder of the recommended RMZ width for the specific type and size of water body. **Coarse woody debris:** The working definition for identifying coarse woody debris (CWD) was modified from "bark-on" down logs to using the visual indicators for decay classes 1 and 2 described by Harmon et al. 1986. **Snags:** The form was modified to capture the number of snags per acre present on site rather than just noting their presence or absence. Paper copies of the onsite forms were provided to the 3rd party contractors to record all of their observations. Completed forms were returned by the contractors to the DNR in St. Paul for data entry and analysis.

1. Data entry

The TH/FM guideline monitoring data was captured by a relational database, Microsoft Access 97 for Windows 95. The data was stored in a series of related tables in Access which enabled the data to be queried and made available for analysis.

2. Analysis of results

SAS (Statistical Analysis System) Version 8.0 was used to analyze the implementation monitoring results.

B. Changes to the site selection process for 2001

Site selection in both 2000 and 2001 was based on identification of harvest sites from aerial photography flown for randomly selected half townships in the forested areas of the state. In 2000, initial criteria for including a half township in the pool of PSUs was that it contain 160 acres of forest land. It was necessary to increase the criteria for the amount of forest land per PSU to at least six sections of timberland in order to obtain enough candidate sites at an affordable cost. This modification was retained for the 2001 monitoring program.

C. Changes to aerial photography interpretation for 2001

In 2000, the DNR's Resource Assessment unit identified the location and measured the size of all landings within the harvest unit that could be identified on aerial photographs. In 2001, Resource Assessment identified all landing locations visible on the aerial photos, but the contractor was responsible for determining the size of the landings. As in 2000, the contractor also identified and delineated any additional landings that were not identified by Resource Assessment.

Resource Assessment did not attempt to determine leave tree strategies or the number of scattered leave trees within the harvest area. The contractor delineated leave tree clumps within the harvest area and determined the number of scattered leave trees per acre. Leave tree clumps located adjacent to the site were later identified and delineated by monitoring program staff, not the contractor, based on site documentation and riparian management zone measures. Acreage for all leave tree clumps, harvest area, and total site area was then determined by Resource Assessment from the photos.

III. RESULTS AND DISCUSSION

A. Site distribution

Timber harvesting and forest management guidelines were monitored on the following forest landowner categories: state, county, U.S. Forest Service (USFS), forest industry (FI), and nonindustrial private forest (NIPF). The distribution of sites based on Council landscape regions is shown in Figure 1 and Appendix A. In total, 118 timber harvesting sites were evaluated. These sites were contained in 20 of 41 randomly selected PSUs. All but five of the timber harvest sites were located in the northern, northeast and north central Council landscape regions.

The number of sites by landowner category is shown in Figure 2. The NIPF sites monitored

were fewer than the number identified on the aerial photos or through local knowledge of NIPF timber harvesting activity. This was due to: 1) the inability to contact landowners, or 2) refusal by landowners to permit monitoring of the landowner=s timber harvesting activity. Permission to monitor was provided for all sites for all other landowner categories.

B. Harvest characteristics

The average timber harvest site for all ownerships was 21.3 acres (Figure 3). Average total site acreage (i.e., harvest area + adjacent leave tree acreage + adjacent RMZ) was 22 acres. Both measures for site acreage were less than found in 2000 (26.6 acre and 28.2 acre average, respectively) (Phillips 2001). The differences in average site acreage between years were due to one or more of the following reasons: 1) changes to the monitoring program methodology, 2) the relatively small sample size with large acreage variation between sites, and 3) improved skill of the photo interpreter to detect the smaller, less intensively harvested sites.

For 2001, timber harvesting sites were largest for the US Forest Service and smallest for state forest land. Using either timber harvest acres or total site acres, the average size decreased in the order:

USFS > FI > NIPF > county > state.

C. Landowner questionnaire

The landowner questionnaire was all or mostly completed for 110 of 118 monitoring sites. Eight of the 23 NIPF landowners chose not to fill out the landowner questionnaire while still allowing their timber harvests to be monitored for the application of the guidelines. This suggests that the landowner questionnaire needs to be simplified to increase the likelihood of NIPF landowner cooperation in completing the questionnaire.

D. Landowner objectives

Management objectives are important factors influencing project planning and how a landowner might utilize the flexibility built into the guidelines. The landowner questionnaire asked landowners to identify up to three management objectives for their timber harvest. These results are presented in Table 1. Timber harvesting and silviculture were the dominant management objectives cited for all landowner categories. Income and wildlife habitat were the second most frequently cited management objectives, followed by salvage logging, insect and disease control, recreation, and investment in that order. These results are similar to those reported previously (Phillips 2001).

In 2001, each landowner was also asked to identify his/her primary objective for management. These results are given in Table 2. Timber production was the primary landowner objective most frequently identified. Silviculture was also commonly cited. These two landowner objectives accounted for 90 of 105 (86%) primary landowner objectives identified in the questionnaires.

Table 1. Landowner objectives for management.						
Management objectives	**Landowner**					
	State	**County**	**USFS**	**FI**	**NIPF**	**Total**
Timber production	41	26	12	6	13	98
Silviculture	33	17	8	7	10	75
Wildlife habitat	17	8	7	2	7	41
Recreation	1	1	1	1	4	8
Income	4	20	0	2	9	35
Insect and disease	4	2	4	0	0	10
Investment	0	0	0	0	1	1
Salvage	6	5	0	0	0	11
TSI	0	1	0	0	0	1
Total number of sites where landowner objectives were identified	43	29	12	7	14	105*
Total number of sites by landowner category	44	32	12	7	23	118

* 13 landowners did not provide a response for this question

Table 2. Primary landowner objective for management.						
Primary Management objective	**Landowner**					
	State	**County**	**USFS**	**FI**	**NIPF**	**Total**
Timber production	24	17	11	6	3	61
Silviculture	12	8	1	1	7	29
Wildlife habitat	0	0	0	0	2	2
Recreation	0	0	0	0	0	0
Income	0	0	0	0	2	2
Insect and disease	2	0	0	0	0	2
Investment	0	0	0	0	0	0
Salvage	5	3	0	0	0	8
TSI	0	1	0	0	0	1
Total number of sites where landowner objectives were identified	43	29	12	7	14	105*
Total number of sites by landowner category	44	32	12	7	23	118

*13 landowners did not provide a response for this question

E. Pre-harvest planning

The TH/FM guidelines recommend the development of written plans for all forest management activities, including timber harvest. Plan writers are encouraged to utilize appropriate planning aids, such as aerial photography and topographic maps, when preparing a plan. They are also advised

to prepare detailed site maps to help communicate the details of the plan to those who will carry it out.

The landowner and resource manager were asked to identify the specific information resources they used in the preparation of their timber harvest plans. The results are presented in Table 3. One or more types of information resources were used on 95% of sites where the landowner questionnaire was completed. The most commonly used resource was aerial photography. Multiple information resources were used for timber harvests on 72 sites.

One of the most effective tools for communicating the details of a timber harvest plan is a site map identifying the location of critical site features (Table 4). Site maps were developed for 97 of 110 (88%) sites where the questionnaire was completed by the landowner/resource manager.

An onsite meeting between the landowner and/or resource manager and the logger/contractor is encouraged to share information and ensure a common understanding of what is expected. An onsite meeting was held on at least 86 of 93 (92%) sites (Table 5). This calculation excludes sites where landowner questionnaires were not completed or where the information provided was inadequate to determine if an onsite meeting was held.

Table 3. Site information resources used to provide landowner assistance for evaluating and developing plans.

Material	Landowner					
	State	County	USFS	FI	NIPF*	Total
Aerial photographs	44	32	12	7	7	102
Topographic maps	5	11	8	2	1	27
Soil surveys	1	6	12	0	0	19
Visual sensitivity maps	4	6	9	0	0	19
Other	31	8	6	0	2	47
Total number of sites by landowner	44	32	12	7	23	118
Total number of sites where site information resources were used	44	32	12	7	9	104
Total number of sites where multiple site information resources were used	36	21	12	2	1	72

*8 landowners did not provide a response for this question

Table 4. Number of sites for which site maps were developed by landowner category.

	Landowner					
	State	County	USFS	FI	NIPF	Total
Numberof sites	43	27	11	6	10	97

Table 5. Onsite meeting held by landowner/resource manager with the logger/contractor.

Landowner	Number of Sites				
	Yes	No	Cannot determine due to answers provided or no answer to question	Form not filled out by landowner	Total
State	40	0	4	0	44
County	18	5	9	0	32
USFS	11	0	1	0	12
Forest Industry	5	0	2	0	7
NIPF	12	2	1	8	23
Total	86	7	17	8	118

F. Commitment of Landowner to Apply Guidelines

One of the guideline implementation goals adopted by the Council was to obtain landowner commitment to apply the timber harvesting and forest management guidelines. In the Council's document titled "*The Timber Harvest and Forest Management Guideline Implementation Goals for 2000: A Progress Report* (Council Report #ME-0301)", the need for this commitment was described.

> "*Background. Awareness and understanding of the guidelines must be accompanied by a willingness to actually apply the guidelines. Evaluating how often and the extent to which a discussion of guideline application takes place during the pre-harvest planning between the forest landowner, the resource manager, and the logger can measure evidence of a commitment to apply the guidelines.*"

To obtain a measure of the landowner commitment to apply the guidelines, two questions were added to the landowner questionnaire for the 2001 monitoring program.

1. *Were the TH/FM guidelines used to plan the above activities or modify the plan?*
2. *Were the TH/FM guidelines discussed during the onsite meeting?*

The Council has established an implementation goal for these two guideline questions for all timber sales contracted for after the TH/FM guidebook was published. Timber harvests monitored in 2001 were harvested or contracted for harvest prior to the publication of the TH/FM guidebook in 1999.

The goal for all public forest resource agencies, forest industry, and professionally assisted NIPF timber sales is that at least 75% of the time resource managers and timber harvesters participate in a pre-harvest review of sale plans and regulations, including a discussion of the TH/FM guidelines (Council Report #ME-0301). The responses to these questions are given in Table 6. For question 1, 66 of 110 (60%) landowners who completed the landowner questionnaire indicated in the affirmative that the TH/FM guidelines were used to plan or modify the plan for their timber harvest. Twenty-six of 66 (39%) landowners who indicated that forest roads were constructed,

reconstructed or maintained as part of the timber harvest activity reported that the forest road guidelines were used to plan or modify the timber harvest plan.

Question 2 provides information about whether the TH/FM guidelines were discussed onsite between the landowner/resource manager and the logger/contractor (Table 6). Due to the way a number of the questions were answered by the landowner/resource manager, it could not be determined if an onsite meeting was held on 16 sites. In addition, there were the eight NIPF sites where the landowner did not fill out the questionnaire and three sites where no response was provided about an onsite meeting. For those landowners/resource managers who did respond, 64 of 91 (70%) indicated that they had discussed the TH/FM guidelines with the logger/contractor.

Considering that the data collected for these two questions is information from timber harvest planning activities conducted prior to the publication of the TH/FM guidelines, these results are somewhat surprising. The expected answer for both questions was "no". Two reasons could explain the majority of these responses. The first is that the landowners/resource managers answered the questions based on what they thought the authors wanted to hear. Some respondents may have been averse to indicating that they were not using the TH/FM guidelines. The second and more probable reason is that the landowner/resource manager was answering the questions based on the application of the water quality and wetland BMPs that have been the forestry standard since 1995. These BMPs were incorporated into the comprehensive TH/FM guidebook. Several respondents did specifically note they were answering the questions from that perspective.

Although the data presented in Table 6 likely reflects consideration of the water quality and wetland BMPs and not all of the comprehensive TH/FM guidelines, the results suggest that landowners and resource managers are willing to plan for the application of the appropriate guidelines to protect specific resource functions when that information is available, and to ensure that the logger/contractor understands what is expected to accomplish that protection.

Table 6. Willingness of landowners to apply timber harvesting and forest management guidelines.

Landowner	Guidelines used to plan or modify timber harvest plan				Guidelines discussed on-site between resource manager/landowner and logger/operator				
	yes	no	no answer**	Total	yes	no	no answer**	Unable to interpret if on-site meeting held	Total
State									
TH*	30	14	0	44	30	10	0	4	44
Roads	10	14	20	44	17	6	20	1	44
County									
TH	19	13	0	32	18	5	1	8	32
Roads	5	13	14	32	6	9	15	2	32
USFS									
TH	7	5	0	12	6	5	0	1	12
Roads	7	5	0	12	7	4	0	1	12
Forest industry									
TH	5	2	0	7	3	2	0	2	7
Roads	4	2	1	7	3	2	0	2	7
NIPF									
TH	5	10	8	23	7	5	10	1	23
Roads	0	6	17	23	4	2	17	0	23
Total									
TH	66	44	8	118	64	27	11	16	118
Roads	26	40	52	118	37	23	52	6	118

* timber harvesting

**includes both landowners who did not provide information in the landowner questionnaire and sites where roads were not constructed, reconstructed, or used for the timber harvest.

G. Forest Management and Harvest Methods

Timber harvesting involves the use of many different kinds of equipment to fell, skid and process trees in the woods to recover usable products. Timber harvesting also requires the development of temporary and permanent roads to permit these products to be hauled to manufacturing facilities and distribution centers. Forest management is the deliberate manipulation of the forest stand to achieve a variety of desired outcomes or management objectives over an extended period of time. Timber harvest is the primary tool utilized by landowners and resource managers to accomplish forest management objectives.

There are two primary silvicultural systems for utilizing timber harvest as a management tool, even-age and uneven-age management. Several harvest methods can be utilized to implement both silvicultural systems. Selection of which harvest method to use on a site depends on the landowner's/resource manager's management objectives. A summary of the silvicultural systems and harvest methods observed on the sites monitored in 2001 is found in Figure 4. All but three sites utilized some form of even-age management.

In order to retain critical vertical structure for wildlife habitat on clearcut areas, the TH/FM guidelines recommend leaving some mature (6 inch DBH or larger) trees, as scattered individual trees, in clumps, or both. Landowners/resource managers began to recognize the value of this recommendation before the guidelines were published. Puettmann et al. 1996 reported that clearcut harvests with residuals in Minnesota nearly doubled between 1991 and 1996, increasing from 41% to 77%. The increase was attributed to growing interest in providing for wildlife habitat, riparian protection, aesthetics, and nutrient retention. The 2001 monitoring program found this trend continuing. Fifty-four of 91 sites managed with even-age harvest used one of four harvest with reserve methods: 1) clearcutting with reserves-sprouting, 2) clearcutting with reserves-natural seeding, 3) clearcutting with reserves-artificial regeneration, and 4) seed tree. The most common harvest method, clearcutting with reserves-sprouting, accounted for 39% of all sites monitored. On-site moitoring found an additional 14 clearcut sites had scattered leave trees or leave tree clumps that met the guideline recommendations where the landowner/resource manager did not indicate the harvest method included reserve trees. Adding these sites to those previously identified as being managed with reserves, 68 of 91 (75%) used clearcutting harvest methods that provided for reserves. This is essentially the same proportion reported by Puttemann et al. 1996.

Most of the timber harvesting activity occurred in winter (Figure 5). Winter only harvesting accounted for 45% of total harvests where the landowner questionnaire was completed. Harvesting over more than one season was found for 22% of the sites. Monitoring for 2001 found fewer sites harvested in the summer than the 2000 monitoring results (Phillips 2001). The difference between years likely reflects one or more of the following: 1) the random nature of site selection, 2) differences in weather between years, and 3) changes in the market situation.

H. Visual quality assessment

Landowner awareness of the visual sensitivity of their property is an important step in promoting the application of guidelines to protect aesthetic resources. County visual sensitivity classification maps were previously developed to assist landowners, resource managers and operators in determining the visual sensitivity of the property to be harvested so that the appropriate guideline recommendations could be applied. Twenty-eight of 118 sites had a visual sensitivity classification (VSC) (Table 7). Two sites were classified Amost sensitive@, 7 sites "moderately sensitive@, and 18 sites "less sensitive".

For those sites classified as visually sensitive, the landowner questionnaire asked if the landowner/resource manager and logger/operator were aware of the harvest site's visual sensitivity rating (Table 8). Landowners/resource managers were aware of the visual sensitivity of their land on 11 of 28 (39%) of the VSC sites. Loggers/operators were aware on 5 of 28 (18%) of the VSC sites. Awareness of visual sensitivity was especially apparent for county and U. S. Forest Service land and least apparent for NIPF land.

Table 7. Summary of sites by ownership and visual sensitivity classification.

Landowner	Visual Sensitivity Classification			Total number of visually sensitive sites	Total number of sites by landowner
	Most	Moderate	Less		
State	0	3	11	14	44
County	0	1	4	5	32
USFS	1	0	1	2	12
Forest industry	0	0	0	0	7
NIPF	2	3	2	7	23
Total number of visually sensitive sites	3	7	18	28	

Table 8. Landowner awareness of visual sensitivity of timber harvest sites.

Landowner	Total number of sites by landowner category	Total number of visual sensitive sites	Landowner awareness	Operator awareness
State	44	14	4	3
County	32	5	5	1
USFS	12	2	2	1
Forest industry	7	0	0	0
NIPF	23	7	0	0
Total number of sites	118	28	11	5

Harvest areas tend to be more objectionable to the public as the perceived or apparent harvest size increases. This is particularly true for large, unbroken clearcuts. Apparent harvest size, the portion of a site visible from a visually sensitive travel route or vista, applies to sites in the most and moderate VSCs. For 2001 monitoring, the contractor assigned each harvest site to one of three

categories of apparent harvest: < 5 acres, 5-10 acres, and > 10 acres (Table 9). The guidelines call for an apparent harvest size of < 5 acres on sites classified as most sensitive. One of the two sites classified as most sensitive had an apparent harvest size < 5 acres and the other was 5-10 acres.

Moderately sensitive sites call for an apparent harvest size from 5-10 acres. Five of the seven moderately sensitive sites had an apparent harvest size 10 acres or less and two exceeded 10 acres for apparent harvest size.

Table 9. Apparent harvest size of timber harvesting sites.

Number of sites by visual sensitivity	Apparent harvest size (acres)		
	< 5	5-10	> 10
Most	1	1	0
Moderate	2	3	2

The TH/FM guidelines recommend various techniques be used to limit the apparent harvest size (Table 10). Of the nine most and moderately sensitive sites, six used multiple techniques, two used a single technique, and one used no technique to influence apparent harvest size. For the two sites where apparent harvest size exceeded 10 acres, no technique was used for one and a single technique was used on the other to limit apparent harvest size. Additional visual quality data has been collected and will be analyzed in the aggregate with the visual quality data collected in the 2000 and the 2002 monitoring programs.

Table 10. Techniques used to limit apparent harvest size.

Technique	Visual Sensitivity Classification	
	Most	Moderate
Utilize natural terrain	0	4
Create narrow openings into harvest area	1	0
Adjust contiguous linear feet of harvest frontage	0	1
Apply multiple stage cuts	2	1
Use tree buffers or uncut islands	2	5

I. Protection of cultural/historic resources and endangered, threatened and special concern species

Cultural/historic resources are generally fragile resources that are susceptible to damage from erosion, soil compaction, rutting, road construction, and other impacts associated with forest management activities. Knowledge of known resources is the first step in their protection. One of the most critical of the guideline recommendations for cultural/historic resource protection is for landowners to contact the appropriate organization or individual(s) to check on the presence of these resources prior to the initiation of the forest management activities.

Cultural resources were identified by the landowner/resource manager for three of the timber harvesting sites. Two of these cultural resources were old homesteads and the third was an old logging camp and logging damn. For all three sites, the cultural resource areas were avoided. No landings or skid trails were found in the area of any of these resources. These three cultural resource sites were identified through local knowledge and were not part of any agency inventory. The state archeologist's office reviewed the timber harvests and indicated that there were no known cultural resources for any of the sites. All landowners/resource managers who responded, except for the three sites where cultural resources were identified, indicated that they were unaware of the presence of any cultural resources for their land.

Checking inventories is also a principle TH/FM guideline recommendation for protection of endangered, threatened, and special concern (ETS) species. Three landowners identified the timber wolf as being in the vicinity of their land. The presence of an eagle was noted for one site. These responses were likely generalized notions of wildlife habitat as opposed to these species specifically inhabiting those sites. The timber harvest sites were checked for the presence of ETS species by the DNR. No problems were noted.

J. Use in filter strips and riparian management zones

A major focus of the TH/FM guidelines is the protection of wetlands and water bodies, which include nonopen water wetlands, open water wetlands, perennial and intermittent streams, lakes, seasonal ponds, and seeps and springs. The primary tools for providing this protection are filter strips and riparian management zones (RMZ).

Filter strips and RMZs serve different, but complimentary functions. Both define specified widths adjoining a wetland or water body where management activities are less intrusive than in the general harvest area. Filter strips are intended to maintain a relatively undisturbed forest floor around a wetland or water body. They disperse and slow surface flows of water, permitting the water to soak into the soil and trapping sediment, debris, nutrients, and chemicals before they enter a wetland or water body. Filter strips are recommended for all wetlands and water bodies.

RMZs are intended to protect the ecological functions and values of riparian areas. Vegetative disturbance is minimized. More mature trees are retained, and retention and establishment of longer-lived tree species is recommended. This is so that critical wildlife habitat is maintained and water temperature within water bodies remains within its normal range. RMZs are recommended for all open water wetlands, lakes, and perennial streams, and all intermittent streams wider than 3 feet.

1. Type and distribution of water bodies

The types and numbers of water bodies or wetlands found on or adjacent to the monitoring sites are shown in Figure 6. At least one water body or wetland was found on or adjacent to 110 (93%) of the monitored sites. Nonopen water wetlands far exceeded the presence of

any other water body or wetland type, accounting for 77% of the total, the same proportion as found in 2000 (Phillips 2001). The numbers of the different types of water bodies and wetlands decreased in the order:

NOWW > OWW > seasonal ponds > perennial streams > intermittent streams > lakes > seeps.

More seasonal ponds were identified in 2001 than in 2000. This is due to clarification of what constitutes a seasonal pond. The uncertainty of properly identifying seasonal ponds was recognized in the previous monitoring report (Phillips 2001).

2. Filter strip application

Maintenance of filter strips is recommended adjacent to all perennial and intermittent streams, lakes, open water wetlands, non-open water wetlands, seasonal ponds, and seeps and springs. An effective filter strip retains essentially undisturbed forest floor, maintaining its filtering capability to remove sediments, debris, nutrients, and pesticides, and permitting surface water to easily infiltrate into the soil. The recommended width of a filter strip is based on percent slope, with the width increasing as percent slope increases. The concept of the filter strip is also implicitly incorporated into the application of the RMZ.

Two primary factors assessed to evaluate implementation of the filter strip guidelines were the amount of disturbance (< 5% or $\geq$ 5% mineral soil exposure), and distribution of disturbance (dispersed or concentrated over the filter strip). The most effective filter strip is accomplished by keeping mineral soil exposure to < 5% dispersed over the filter strip. Evaluating a filter strip requires measuring the slope of the land adjacent to the wetland or open water body, selecting the appropriate filter strip width recommended by the guidelines for that slope, and determining the amount and distribution of soil disturbance within that filter strip area. The minimum filter strip width is 50 feet, increasing for slopes > 10% to a maximum width of 150 feet for slopes $\geq$ 70% (Table GG-1 of the TH/FM guidebook). This standard has been used within the Minnesota forestry community since publication of the 1995 BMP guidebook (MN DNR 1995).

The intrusion of roads, skid trails, and landings, and the placement of associated clearing debris, can compromise the effectiveness of filter strips. These infrastructure components are the areas of greatest disturbance, and should be located outside filter strips and RMZs to the greatest degree practical. Landings intruded into filter strips 23% of the time (Table 21). Clearing debris was placed in a filter strip 36 times and in RMZs nine times. Data for skid trails in filter strips is incomplete, but forest roads intruded into filter strips and RMZs 13 times. This does not include entries for crossing wetlands or water bodies, which will be discussed later.

The amount and distribution of disturbance for filter strips is shown in Table 11. Filter strips

were required for 346 wetlands and open water bodies on or adjacent to the timber harvest sites. Five of the intermittent and perennial streams traversed the harvest area and had separate filter strips identified for each side, bringing the total number of filter strips evaluated in 2001 to 351. Filter strip application was found to meet the guideline recommendation (i.e., <5% mineral soil exposure, dispersed) for 62% of the evaluations (Table 11). This is a decline from the 70% compliance found in 2000 (Phillips 2001) and represents a substantial decline from the over 90% compliance with the filter strip guidelines reported earlier for BMP monitoring (Phillips et al. 1994). The reason for the decline in implementation from 2000 is unknown. The most obvious reason for the apparent dramatic decline from the previous BMP monitoring results is that prior to 2000, all filter strips on a site were rated together. Now each filter strip is evaluated independently. The rationales for the lower levels of compliance for filter strip recommendations were discussed by Phillips 2001.

Table 11. Filter strip disturbance for all water bodies (percent of total).

Resource	< 5% dispersed	< 5% concentrated	≥ 5% dispersed	≥ 5% concentrated
NOWW	60.8	19.4	6.0	13.8
All other water bodies	65.1	15.7	10.8	8.4
Total (weighted mean)	61.8	18.6	7.1	12.5

The distribution and degree of disturbance in filter strips for nonopen water wetlands was similar to that for open water bodies (i.e., lakes, perennial streams, open water wetlands) (Table 11). Compliance with filter strip recommendations was also compared between those water bodies located within the harvest area and those located adjacent to the harvest area (Tables 12 and 13). The extent of disturbance of filter strips inside the harvest area was substantially higher than was observed on filter strips for water bodies adjacent to the harvest area. However, evidence of erosion was found in only 27 of 345 (7.8%) filter strips (erosion data was not collected for 6 filter strips).

Table 12. Filter strip disturbance for water bodies and wetlands within the harvest area (percent of total).

Resource	< 5% dispersed	< 5% concentrated	≥ 5% dispersed	≥ 5% concentrated
NOWW	52.0	17.7	9.9	20.4
All other water bodies	50.0	18.4	15.8	15.8
Total (weighted mean)	51.6	17.9	11.1	19.4

Table 13. Filter strip disturbance for water bodies and wetlands located adjacent to the harvest area (percent of total).				
Resource	**< 5% dispersed**	**< 5% concentrated**	**≥ 5% dispersed**	**≥ 5% concentrated**
NOWW	72.4	21.6	0.9	5.2
All other water bodies	77.8	13.3	6.7	2.2
Total (weighted mean)	73.9	19.3	2.5	4.3

3. Riparian management zones

Riparian management zones are intended to protect the ecological functions and values of riparian areas. Vegetative disturbance is minimized. More mature trees are generally retained, and retention and establishment of longer-lived tree species is recommended so that critical wildlife habitat is maintained and water temperature remains within its normal range. RMZs are recommended for all open water wetlands, lakes, and perennial streams, and all intermittent streams wider than 3 feet.

The RMZ guidelines were introduced for the first time in 1999 with the publication of the TH/FM guidelines. The reader is cautioned to remember that these results are baseline data reflecting management practices for sites that were harvested and/or the stumpage sold under contract prior to publication of the TH/FM guidebook. Subsequent monitoring will describe how these practices change over time in response to availability of RMZ guidelines.

Fifty-three water bodies were found on or adjacent to 39 monitored sites for which RMZs were recommended. Thirty-six of the water bodies were open water wetlands, 14 were perennial streams, and 3 were lakes (Figure 6). Two of the streams traversed the harvest area and a separate RMZ was evaluated for each side, increasing the number of RMZs to 55.

Data characterizing each RMZ was collected from measurements of a representative cross section. The width of non-forest, undisturbed forest, partially harvested forest (BA>25 sq.ft./acre), and clearcut (BA<25sq.ft./acre) was recorded for the full RMZ width recommended by the guidelines. Many RMZs had significant areas of non-forest vegetation (i.e. grass, sedge, brush, or shrubs), or were entirely composed of non-forest vegetation.

The recommended RMZ guidelines for width and residual tree basal area in the forested portion of the RMZ were met 44% (24 of 55 RMZs) of the time (Figure 7). Water bodies adjacent to the harvest area were more likely than water bodies within the harvest area to have an RMZ that fully met the guideline recommendations (Figure 8). Only 4 of 17 (24%) RMZs for water bodies within the harvest area met the guideline recommendations, compared to 21 of 38 (55%) RMZs for water bodies adjacent to the harvest area.

Figure 9 shows the number of RMZs in the various width classes for the water bodies within

and adjacent to the harvest area. About 80% of the adjacent water bodies that did not fully meet the RMZ guidelines did have RMZs at least 25 feet wide feet wide with an appropriate number of residual mature trees. In several cases these narrow RMZs had higher residual basal areas than the minimum recommended or had no harvest activity. This was not the case for the RMZs of water bodies within the harvest area.

The residual BA for perennial stream, open water wetland, and lake RMZs is summarized in Figure 10. The contrast in residual BA for these water bodies within and adjacent to the harvest area is shown in Figure 11. Residual RMZ BA was generally higher for lakes and open water wetlands than for perennial streams (Figure 10). Seven perennial streams and seven open water wetlands (25% of the RMZs found for 2001) were clearcut to the banks of the water bodies or to the edge of the non-tree vegetation adjacent to the water bodies.

The majority of perennial streams were located adjacent to the harvest area (Table 14). The two perennial streams that traversed the harvest area were less than three feet wide and the RMZs on both sides of these streams were clearcut to the waters edge. Failure to provide an RMZ for these smaller streams may have occurred because the landowner/resource manager or logger/operator were not aware of their presence due to their small size and the fact that harvest activity occurred in the winter.

Table 14. Number and type of perennial streams monitored within and adjacent to the harvesting area.

Location	Stream size (feet)		
	< 3	3-10	> 10
Within harvest area	2	0	0
Adjacent to harvest area	6	4	2

K. Protection of water quality and wetlands

1. Water body and wetland crossings

Crossing wetlands and open water bodies while conducting a forest management activity has the greatest potential for directly impacting water quality and the hydrologic and biologic function of these water bodies. Equipment using a crossing may carry mud and debris into the wetland or open water body, or leak fuel, oil, or other hazardous fluids. The approaches to a crossing can serve as a funnel directing surface water flow, and the attendant loads of sediment, organic debris, nutrients, and chemicals directly into a wetland or open water body. In addition, the crossing itself may modify the movement of water within a wetland or open water body, causing upstream ponding, increased channel scouring, or destabilization of the banks. If not properly installed, maintained, and rehabilitated, many of these problems can become significant and continue long after the crossing ceases to be used.

Crossing wetlands and open water bodies should be avoided whenever practical, but it is often necessary for hauling and harvesting equipment. Skid trail crossings for harvesting equipment are generally confined to the harvest area and are temporary in the majority of cases. Haul roads frequently must cross wetlands and open water bodies to access a site as well as reach an appropriate loading area on the site. Many of these roads and associated crossings are considered temporary, but will often be reused years later to access the same or other harvest locations. Many others are or become part of a permanent, maintained management and recreational transportation system.

Field monitoring in 2001 found 82 harvest sites with 207 skid trail and road crossings of nonopen water wetlands, open water wetlands, and perennial streams (Table 15). There were 375 approaches to these crossings, and 44 approaches for entering wetlands to harvest timber (Table 16). Crossings of and approaches to wetlands and open water by season of operation are given in Table 17. More than 62% of all crossings and approaches were found on winter only operations. The crossing of wetlands and open water bodies was avoided during the highest risk times of the year. A total of 20 streams and five open water wetlands, one seasonal pond, and one seep were crossed by roads and skid trails on or accessing 82 timber harvest sites monitored in 2001. None of the crossings were over of protected waters.

Table 15. Road and skid trail crossings by water body and wetland type.

Water body type	Road crossings	Skid trail crossings	Total
NOWW	64	115	179
OWW	3	2	5
Seasonal pond	1	1	2
Seep	0	1	1
Stream	15	5	20
Total	83	124	207

Table 16. Types of approaches for roads and skid trails.

	Roads	Skid trails	Total
Crossings	138	237	375
Entering wetland to harvest timber	6	38	44
Total	144	275	418

Table 17. Number of road and skid trail water and wetland crossings by season of operation.

Season of operation	Road and skid trail crossings	Approaches to entering wetlands to harvest timber	Total
Spring	2	8	10
Summer	11	0	11
Fall	31	3	34
Winter	120	32	152
Summer-fall	17	1	18
Fall-winter	8	0	8
Summer-fall-winter	2	0	2

Spring-summer-fall	1	0	1
Year round	7	0	7
Unknown	8	0	8
Total	207	44	251

Nearly sixty percent of the crossings were on skid trails (Table 18), and the majority of crossings (86%) were on nonopen water wetlands. Roads crossed four intermittent streams < 3 feet wide. All other road and skid trail crossings were over perennial streams. Fourteen of the stream crossings were on access roads to10 of the harvest sites, not directly on the harvest sites. Nine of these were for winter roads.

Table 18. Crossing structures applied on roads and skid trails.

Structure type	Number of structures		
	Roads	Skid trails	Total
Bridge	0	0	0
Culvert	13	0	13
Ice bridge	7	3	10
Ford	5	0	5
Fill	0	0	0
Wood mat	1	0	1
Frozen	49	60	109
Unknown	8	61	69
Total	83	124	207

It was possible to identify the type of crossing structure used for only 75 of the 83 road crossings, and 63 of the 124 skid trail crossings. Frozen conditions were the most common method of creating a road crossing, with frozen ground (49) and ice bridges (7) accounting for 75% of the crossings. The percentage was very likely the same or higher for skid trails. The on-site data collection forms have been modified for 2002 to capture more complete information for crossings. None of the road and skid trail crossings, with and without identified structures, were rehabilitated.

2. Approaches to water bodies and wetlands

The approaches to any crossing are just as important for protecting water quality as the crossings themselves. Failure to divert surface flows of water off a road or skid trail before it enters a filter strip or RMZ, and before it reaches the wetland or water body can result in increased erosion, and permit sediment, organic materials, nutrients, or chemicals to flow directly into a wetland or water body. Water diversion practices need to be in place as soon as a crossing and approach are created. These practices also need to be maintained as long as the crossing exists and until the location is stabilized once the crossing is removed.

Selecting crossing locations where the approaches are nearly flat or have a minimal grade

have less potential for erosion. Operations on frozen soil generally result in less disturbance, which also minimizes the risk of erosion. Fortunately most approaches are nearly flat. Approximately 34% of all approaches monitored had a grade ≤2%, and 75% had a grade ≤5% (Table 19). However, only 19 of the 419 approaches had and type of water diversion practices in place (Table 20).

Table 19. Grade of approaches to road and skid trail crossings.*

Approach grade (percent)	Number of approaches		
	Roads	Skid trails	Total
< 2	48	73	121
2 < 5	50	96	146
5 < 10	26	39	65
10 < 15	3	14	17
15 < 25	3	7	10
≥ 25	0	5	5
unknown	14	40	54
Total	144	275	419

* Length of approaches is not summarized due to contractor misunderstanding of what data to record

Table 20. Water diversion structures for road and skid trail approaches to crossings.

Structure type	Number of structures		
	Roads	Skid trails	Total
Broad based dips	2	0	2
Water bars (all types)	0	0	0
Lead-off ditch	3	0	3
Gravel surfacing	1	0	1
Natural barriers	1	0	1
Natural vegetation	0	2	2
Scattered slash	0	10	10
Total	7	12	19

The lack of water diversion practices on so many approaches, and the numbers of approaches with a grade >5% is similar to those found in 2000 (Phillips 2001). This reinforces the need to strongly emphasize the use of water diversion practices for wetland and water crossing approaches in training programs for loggers, natural resource professionals, and landowners. It also highlights the need to encourage inclusion of explicit language regarding these practices in contracts and improved project supervision to insure effective crossing practices are employed more widely.

L. Protection of forest soil resources

Soil productivity is determined by a wide variety of factors. Human activities on a site can

significantly impact many of them, enhancing or reducing soil productivity. The TH/FM guidelines attempt to limit negative impacts and encourage practices that will maintain or enhance productivity. The two most significant timber harvest activities that can affect soil productivity are logging and hauling equipment traffic on forest soils, and the removal of biomass from a site.

1. Logging and hauling equipment traffic on forest soils

The greatest potential for adverse impacts on forest soils from equipment operation is on the roads, landings, and primary skid trails, where repeated traffic occurs. Equipment traffic can compact and rut soil, remove vegetation whose root systems hold the soil in place, and redirect surface water flow. These impacts reduce the availability of nutrients and moisture for plant growth, increase the potential for erosion, restrict plant root growth, and can change the surface and subsurface hydrology of a site. Some impact from equipment operation is unavoidable during a timber harvest. The first step in minimizing those impacts is limiting the area of repeated equipment traffic.

The TH/FM guideline recommends that the roads and landings portion of site infrastructure occupy no more than 3% of the harvest area. Figure 12 shows the average percentage of sites in roads and landings for all ownerships, and by landowner category. The statewide averages are very similar to that reported in 2000 (Phillips 2001). The percentage of infrastructure averaged 3.2%, ranging from a high of 4.7% on forest industry lands to a low of 1.8% on U.S. Forest Service land. The percentage of site infrastructure decreased in the order:

FI>county>NIPF>state>USFS.

2. Landings

The most prolonged and intense equipment activity on a harvest site is normally on the landings. This is where all the wood is skidded to for processing and loading, and where most equipment maintenance and fueling occur. Minimizing the area occupied by landings, and locating them away from wetlands and water bodies, outside filter strips and RMZs is especially important for these reasons.

A total of 204 landings were identified during monitoring. All landings were located on stable ground, indicating locations were utilized that are not susceptible to slumping or landslides. On average, landings occupied 2.6% of sites (Figure 12), slightly higher than observed in 2000. Landing area, as a percent of harvest area, followed the same trend as that found for total infrastructure above, with forest industry highest and the U.S. Forest Service lowest.

Landings and associated fueling and maintenance areas were located outside filter strips and

RMZs 77% and 94% of the time, respectively, and they were located outside wetlands and water bodies 88% of the time (Table 21).

Table 21. Landing locations.

Ownership	Total number of landings	Outside RMZ	Inside RMZ	Outside filter strip	Inside filter strip	In wetland
State	67	19	2	54	13	9
County	52	12	0	36	16	6
USFS	24	0	0	17	7	3
Forest industry	11	4	0	11	0	0
NIPF	49	24	2	38	11	5
Total	203	59	4	156	47	23

3. Forest roads

The TH/FM guidelines strongly recommend limiting the mileage of forest roads to the minimum necessary to accomplish the landowner's management objectives. The guidelines also recommend careful location, design, construction, maintenance, and closure of forest roads as a means of reducing costs and improving operability, and limiting the area disturbed, compacted, and exposed to minimize the potential for erosion.

Implementation monitoring for 2001 found that forest roads occupied only 0.6% of the harvest area. This is slightly lower than observed in 2000 (Phillips 2001). The area in forest roads ranged from 0.8% for forest industry land to 0.5% for county lands, and decreased in the order:

FI>USFS>state>NIPF>county.

This data only accounts for the acreage in roads within the harvest site. It does not include the area of roads utilized to access the site, or roads adjacent to or crossing the site, but not utilized for the harvest operation monitored.

The TH/FM guidelines recommend using an appropriate combination of erosion control and water diversion practices on all road segments, especially those with a grade $\geq$2%. Unlike the BMPs in use prior to 1999, the current guidelines recommend using these practices in all locations, not just where there is a potential for surface runoff and sediment to impact water quality. These practices should be employed during construction, as long as the road exists, and after it is permanently closed until the site is revegetated and stabilized. However, implementation monitoring is only able to collect data for practices in place after the harvest activity is done, and data collection is only practical for road segments with a grade $\geq$2%.

A total of 87 road segments with a grade $\geq$2% were identified during on-site monitoring. Over 80% of the segments had a grade less than 10%, as is recommended in the guidelines

(Table 22). Only six of the 87 segments had any erosion control or water diversion practices installed (Table 23). Site conditions may have been stable enough to not require these practices, but only in a limited number of cases. This lack of use of erosion control and water diversion practices is a cause of substantial concern that is being addressed in the 2002 training programs for loggers and natural resource managers.

Table 22. Number of road and skid trail segments within various percent grades.

Segment grade (percent)	Number of segments		
	Roads	Skid trails	Total
2 < 5	16	3	19
5 < 10	54	39	93
10 < 15	11	61	72
15 < 25	5	74	79
≥ 25	0	17	17
Unknown	1	68	69
Total	87	262	349

Table 23. Water diversion structures on road and skid trail segments.

Structure type	Number of structures		
	Roads	Skid trails	Total
Broad based dips	1	0	1
Water bars (all kinds)	1	9	10
Lead-off ditch	1	0	1
Profile	0	1	1
Natural barriers	1	1	2
Scattered slash	2	105	107
None	81	146	227
Total	87	262	349

Access control for forest management sites is important because the roads involved are frequently intended for temporary or seasonal use, so they are not constructed to as high a standard as county and state highways. Since they may not be designed for year round use and often not part of a permanent, maintained road system, these roads can be easily damaged. Adequate access control reduces the problems with erosion, rutting, and continuing maintenance. To this end, the TH/FM guidelines recommend temporarily closing roads when conditions warrant, and permanently or temporarily closing roads when not in use.

Implementation monitoring for 2001 found that the majority of roads (57%) remained active (intended to be open to traffic) (Table 24). Many of these were all season roads utilized for many activities. Most of the remaining roads (38%) were temporarily closed. Only seven roads (6%) were identified as permanently closed. Access to the temporarily and permanently closed roads was controlled by some structure, such as a gate or barrier, 58% of the time.

Table 24. Road status.					
Ownership	**Active**	**Temporarily closed**	**Permanently closed**	**No roads**	**Total**
State	23	20	1	0	44
County	17	14	1	0	32
USFS	7	1	4	0	12
Forest industry	5	1	0	1	7
NIPF	14	7	1	1	23
Total	66	43	7	2	118

Eight of the active roads evaluated during monitoring had controlled access. This is most likely a case where the road continues to be used for management activities, but access is restricted to authorized personnel only. These were NIPF lands where the landowner declined to complete the landowner questionnaire, and the contractor was unable to determine the road status during the on-site inspection.

4. Skid Trails

Skid trails are generally more difficult to delineate on the harvest site than roads and landings. The TH/FM guidelines recommend limiting primary and secondary skid trails to no more than 10-15% of the harvest area. While primary skid trails are often relatively easy to detect, identification of secondary skid trails is problematic. Because of this limitation, no effort was made to determine an exact proportion of the site in skid trails. Instead, the contractor was required to estimate whether the primary or secondary skid trails were <15% or >15% or to determine that these values could not be estimated (Figure 13). Skid trails were found to occupy <15% of the harvest area on 83% of the sites. On 7.6% of the sites, the area occupied by primary skid trails could not be determined.

The contractor was also required to identify the dominant skidding pattern for the harvest site. These results are shown in Figure 14. On 46% of the sites the skidding pattern was either not evident or was randomly distributed lightly over most of the site. Skidding was focused on a well developed set of skid trails on the remaining 54% of the sites, and nearly 75% (47 of 63) of these were non-winter harvest sites. This re-enforces last years observation that frozen ground appears to mask or minimize the visible impact of a well developed set of skid trails. This makes monitoring of skidding patterns very difficult. Short of adopting much more intensive and expensive sampling methods, it is unclear how to more accurately monitor skidding patterns on site. The landowner questionnaire may be an alternative, but many landowners/resource managers will be unable to provide this information.

As with roads, the TH/FM guidelines recommend using an appropriate combination of erosion control and water diversion practices on all skid trail segments, especially those with a

grade ≥2%. Table 22 shows the number of skid trail segments identified with a grade ≥2%. A total of 262 of these skid trail segments were identified, but data on the observed percent grade was recorded for only 194. Only 22% of these 172 segments had a grade of < 10%, while 9% had a grade > 25%. Unlike roads, however, nearly half the skid trail segments had some type of erosion control and/or water diversion practice in place. The most common practice was the placement of scattered slash imbedded in the traffic surface, which helps divert and slow surface water flow. On going training will continue to emphasize the need for these practices.

5. Slash disposal and distribution

Retaining or redistributing slash on the site is important as a major nutrient-retention strategy. This strategy is particularly important for nutrient poor sites with soils that are: 1) predominantly deep, well drained, or excessively well drained sand; 2) predominantly deep organic (>24 inches deep); or 3) predominantly shallow soils (< 8 inches deep) over bedrock. Slash also provides cover, food, and growing sites for plants and animals. The positive benefits to retaining or redistributing slash on the site must be balanced with the need to safely and efficiently operate equipment on the site, to regenerate the stand, and to minimize the potential for additional compaction that might occur from redistributing the slash.

The results of this evaluation are given in Table 25. A combination of two of these slash disposal methods were utilized on seven sites. Slash retained on the site at the stump was the most common method found and was applied on 59% of the sites. This is the preferred method of slash disposal for maintaining forest soil productivity on most sites. Slash piled at landings and slash piled and burned were methods utilized on 25% of the sites. Frequently this was done as part of preparing the site for replanting or as a means of pest control.

Table 25. Slash management on timber harvest sites.						
Landowner	**Number of sites**	**Retained onsite**	**Redistributed**	**Piled on landing**	**Piled and burned**	**Number of slash management options utilized**
State	32	25	3	6	0	34
County	23	11	2	9	2	24
USFS	7	2	3	3	0	8
Forest industry	44	26	12	6	3	47
NIPF	12	6	6	0	0	12
Total	118	70	26	24	5	125*
* Seven sites reported two slash management options utilized						

6. Rutting

The objective of many soil specific guidelines is to minimize equipment effects on productivity by reducing the area of the site impacted by rutting. Rutting is the creation of depressions made by the tires or tracks of equipment involved in forest management activities (e.g., skidders, forwarders, log trucks). It occurs when soil strength is not sufficient to support the load applied by the vehicles. The adverse effects of rutting include modifying the surface hydrology of the site for both upland and wetland soils, damaging roots, compacting the soil and plugging soil pores. The latter two inhibit root growth, reduce aeration, and slow or disrupt movement of water into and through the soil.

The contractor was required to collect information on whether rutting occurred in wetlands, RMZs, filter strips, roads, skid trails, and the general harvest area. For purposes of monitoring, rutting in the general harvest area was identified if ruts covered more than 2% of the general harvest area. The general harvest area excludes roads, primary and secondary skid trails, filter strips, RMZs, and wetlands (except where the harvest site is a wetland).

Rutting needs to be minimized over the entire harvest area, but is often a consequence of timber harvesting. The TH/FM guidelines recommend that rutting be confined to the roads and skid trails to the extent practical. Rutting was found on 35 (30%) of the sites. It is encouraging to note that rutting was confined to just the roads and skid trails on 16 of those 35 sites. The numbers of sites where rutting was found for specific site features is given in Figure 15. It was common to find rutting had occurred on more than one site feature.

On nine sites, the contractor reported ruts on skid trails in wetlands that exceeded six inches in depth for distances greater than 300 feet in length. Ruts in excess of these values can induce blockage of cross drainage, resulting in the ponding of water up gradient to the flow. It is also necessary to minimize extensive rutting to minimize down

road channelization of water. Overall, rutting on these site features was found to decrease in the order:

skid trails > wetlands > roads > general harvest area > filter strips > RMZs.

Rutting was evident most often for harvests conducted in winter (Figure 16), accounting for more than 37% of the sites on which rutting occurred. The rutting found for winter sales probably reflects the warmer winters common for the past few years.

The TH/FM guidelines identify operating techniques to employ to minimize rutting. The landowner questionnaire asked the landowner/resource manager to identify the techniques they used to minimize rutting. The landowners/resource managers for 84 sites identified practices utilized to minimize rutting. These results are shown in Table 26. Twenty-nine of the 35 sites where rutting occurred used one or more of these practices and six used none. Three of the six that used no practices only had rutting on roads or skid trails.

Table 26. Practices utilized to reduce the potential for rutting.

Mitigating practice	Number of sites
Low ground pressure equipment	31
Operating equipment on a slash mat	27
Reduced load size	6
Shift operation to another portion of the site	14
Pack snow to promote freezing of the soil	23
Temporarily cease operations	13
Restrict operations to frozen conditions	16
Total	84

M. Applications for wildlife habitat

1. Coarse woody debris

Coarse woody debris is an important component of forest sustainability as it provides habitat for forest critters and plants as the stand regenerates following forest management activities. The guideline recommendation is to create or retain two to five bark-on down logs per acre at least six inches in diameter for the general harvest area. The recommendation for riparian areas is for at least four "bark-on" down logs per acre that are at least six inches in diameter. The guidelines are further refined by recommending that hollow butt sections or other defective lengths of at least six feet are preferred, and that sound logs and six to 12 inch diameter logs can be used if they represent the best available candidates.

Monitoring results from 2000 (Phillips 2001) found that landowners were not meeting the guideline recommendation. Only 21% and 22% of general harvest areas and riparian

Table 27. Bark-on down logs per acre for general harvest area and RMZ by statewide and landowner category.

Landowner	Total number of sites by landowner category	Total number of RMZs by landowner category	Bark-on down logs (number of sites)				
			General harvest area*			RMZ**	
			< 2	2-5	>5	< 4	≥ 4
State	44	14	6	9	28	5	12
County	32	11	5	9	18	2	16
USFS	12	2	1	6	5	1	1
Forest industry	7	2	2	3	2	0	3
NIPF	23	10	6	10	7	3	11
Total number of sites	118	39	20	37	60	11	43

*Data not recorded for the general harvest area for one site
**Data not recorded for two RMZs

management zones, respectively, met the guideline recommendation for "bark-on" down logs. It was suggested that for many of these logs the bark had sloughed off by the time the inspections were conducted. For monitoring in 2001, the standard was modified to evaluate decay classes of "sound" down logs as described by Harmon et al.,

1986. The results of this evaluation are found in Table 27. Based on the revised standard of measurement, the guideline recommendation for "bark-on" down logs was met for 83% and 80% of general harvest areas and riparian management zones, respectively.

2. Leave tree distribution

Leave trees and snags are retained on timber harvests to provide vertical structure and habitat for wildlife species as the stand regenerates. The TH/FM guidelines provide recommendations for retaining leave trees and snags at the site level while recognizing that there is a temporal and spatial (i.e., landscape) consideration for fully implementing these guidelines. The guidelines do not address directly in recommendations how to incorporate the landscape context into Aon-the-ground@ decisions. However, the Council's Guideline Implementation Monitoring Technical Committee adopted a standard that the appropriate area adjacent to the clearcut be considered in evaluating leave tree acreage. For adjacent clumps to be considered in the calculations, they had to be located adjacent to RMZs or other resources (e.g., cultural, visual buffers) adjacent to the site, and the leave tree clump could not be large enough to be commercially viable.

There are two components that make up the leave tree recommendations contained in the TH/FM guidelines. One component is retaining on clearcuts a minimum of 5% of the harvest area in leave tree clumps of at least 1/4 acre. The second component is to retain $\geq$ 6 scattered individual leave trees per acre on the harvest area. In both cases the trees must be at least six inches in diameter of a mix of desirable species. The preferred alternative is to retain clumps, but if the site has leave trees that conform to either condition, the guideline recommendation is met. It is often the case that a site will have both components that meet

the guideline recommendation. An area that needs further review and discussion is the situation where neither leave tree clumps nor scattered leave trees individually meet the guideline recommendations, but when summed together, provide for a substantial leave tree component for the site.

In the landowner questionnaire, the intent of the landowner/resource manager to provide leave trees and snags was queried. These results are presented in Table 28. The landowner/resource manager indicated that leave trees and snags were to be retained on 78% and 75% of timber harvests, respectively. Where these resources were not to be provided, the landowner/resource manager was asked to specify the reason. The major reason cited for not providing leave trees was to facilitate aspen management. Other reasons included concern for operator safety and insect and disease issues. Reasons cited (often several per site) for not providing snags included concerns for: visual quality (7), public safety (4), specific forest management applications (4), and operator safety (1).

Table 28. Landowner statement of intent to retain leave trees and snags.

	Leave trees to be retained			Snags to be retained		
	yes	no	no answer	yes	no	no answer
Number of sites*	79	13	9	76	14	11

*excludes 17 sites that are thinnings or shelterwood management or where landowner/resource manager did not answer.

The number of sites that met the guideline recommendation for scattered leave trees by landowner category is given in Table 29. Fifty-four percent of the timber harvest sites had $\geq$ 6 scattered leave trees per acre. This finding is similar to previous results (Phillips 2001).

Table 29. Number of timber harvest sites with ≥6 scattered leave trees per acre having diameters ≥6 inches.

Landowner	Total number of sites by landowner category	Number of sites for which leave tree recommendations apply	Number of sites with ≥6 scattered leave trees per acre
State	44	32	23
County	32	31	11
USFS	12	11	6
Forest industry	7	6	0
NIPF	23	20	14
Total	118	100	54

As described earlier, leave trees were calculated for internal clumps and for total leave tree clumps that include those adjacent to the harvest area. Internal leave tree clumps (i.e., those totally within the cut boundaries of the harvest area) were found on 16 of 100 sites and averaged 11.2% of the area of those specific sites across all landowner categories where $\geq$5% of the harvest area was retained in internal leave tree clumps (Table 30). The percentage of harvest area retained in internal leave tree clumps by landowner category ranged from 12.6% for NIPF land to 0% for forest industry and decreased by landowner category in the order:

NIPF > county > USFS > state > FI.

The percentage of sites where internal leave tree clumps were retained within a landowner category ranged from 25% for NIPF land to 0% for forest industry land and decreased in the order:

NIPF > county > USFS > state > FI.

Table 30. Percent of timber harvest area occupied by internal leave tree clumps by landowner for those sites with >5% acreage in internal leave tree clumps.

Landowner	Total number of sites by landowner category	Number of sites for which leave tree recommendations apply	Number of sites with internal clumps >5% of harvest area	Average percent of harvest area in internal clumps for those sites with internal clumps
State	44	32	2	8.1
County	32	31	7	11.5
USFS	12	11	2	9.9
Forest industry	7	6	0	0
NIPF	23	20	5	12.6
Total	118	100	16	11.2

Table 31. Percent of timber harvest sites occupied by total leave tree clumps by landowner for those sites with >5% acreage in total leave tree clumps.

Landowner	Total number of sites by landowner category	Number of sites for which leave tree recommendations apply	Number of sites with total leave tree clumps >5% of harvest site	Average percent of total site area in clumps for those sites with clumps
State	44	32	3	8.3
County	32	31	8	13.4
USFS	12	11	6	15.1
Forest industry	7	6	2	15.9
NIPF	23	20	6	13.5
Total	118	100	25	13.4

When forest land adjacent to the site was considered, total leave tree clumps (internal plus adjacent) were found on 25 of 100 even-age management sites and averaged 13.4% of the area of those specific sites across all landowner categories where $\geq$5% of the total site acreage was retained in leave tree clumps (Table 31). The percentage of the total site in clumps by landowner category for those specific sites ranged from 15.9% for forest industry land to 8.3% for state forest land and decreased by landowner category in the order:

FI > USFS > NIPF > county > state.

The percentage of sites where leave tree clumps for total site acreage (harvest area + adjacent

leave tree area + adjacent forested RMZ) were retained by landowner category ranged from 54.5% for USFS to 9.4% for state forest land and decreased by landowner category in the order:

USFS > FI > NIPF > county > state.

As stated previously, the guideline recommendation is met by providing for either the appropriate number of scattered leave trees per acre and/or by retaining the appropriate size and percentage of leave tree clumps for the harvest site. The proportion of the site retained as internal leave tree clumps (≥5%) or as scattered leave trees (≥6 trees/acre, diameter ≥6 inches) by landowner category is shown in Table 32. The number of sites where one or both of these conditions were met was found on 60 of the 100 even-age management sites or 60% of the total. The proportion of total site acreage retained as leave tree clumps (≥5%) or as scattered leave trees (≥6 trees/acre, diameter ≥6 inches) by landowner category is also shown in Table 33. The number of sites where one or both of these conditions were met was 63 of the 100 even-age management sites or 63% of this total, a figure similar to what was reported previously (Phillips 2001).

Table 32. Number of sites occupied by each type of leave tree clump and/or scattered individual leave trees by landowner that met or exceeded the guideline recommendations.

Landowner category	Total number of sites by landowner category	Number of sites for which leave tree recommendations apply	Number of sites	
			Internal clumps + scattered leave trees	Total clumps + scattered leave trees
State	44	32	23	23
County	32	31	16	16
USFS	12	11	7	8
Forest industry	7	6	0	2
NIPF	23	20	14	14
Total	118	100	60	63

3. Distribution of snags

Snags provide habitat for wildlife requiring tree cavities, perches, and bark foraging sites. The TH/FM guidebook is not specific in recommending numbers of snags or their distribution on the timber harvest site. The inference seems to be to provide for as many snags as possible. This lack of more specific guidance makes it difficult to determine if the guideline is being met beyond the question *"Were snags retained?"* The Council's Guideline Implementation Monitoring Technical Committee agreed to collect data on numbers of snags retained. Four categories for snags were agreed to: 0, <1, 1-2, and >2 per acre. These categories were selected with no definitive knowledge of the numbers of snags needed as a category or in combination with leave trees to provide the vertical structure for maintaining a sustainable level of wildlife habitat. The recommendations for leaving snags applied to 100 of 118 sites,

excluding thinnings and shelterwood management. Eighty percent of these sites retained at least one snag per acre per site with 43 % of sites having more than two snags per acre per site (Table 33).

Table 33. Number of timber harvest sites statewide with snags retained for vertical structure.

	Snags/acre			
	0	< 1	1-2	> 2
Number of sites	4	15	38	43

4. Maintaining oaks

The TH/FM guidelines recommend retaining oaks on harvest areas for continued mast production during stand regeneration. Oaks were present on 44 of the timber harvest sites, but were present in the forest adjacent to the timber harvest on 53 sites. This indicates that the oak component was reserved on 83% of these sites.

N. Quality control

A quality control team made up of representatives of the Technical Committee visited 10 sites or 8.5% of the total to review and evaluate compliance with contract specifications for site monitoring. What continues to be the most useful outcome for the quality control team is the time spent evaluating and discussing the guideline measures in the field and determining whether those measures are appropriate or need additional modification to continue to improve the monitoring program.

IV. CONCLUSIONS

The 2001 monitoring program captures additional baseline data against which implementation of Minnesota=s timber harvesting and forest management guidelines can be assessed through subsequent monitoring efforts. Practices evaluated on the 118 harvest sites evaluated for the second years monitoring effort include logging road and landing infrastructure, skid trails, slash disposal, leave trees and other wildlife habitat considerations, and riparian management.

The 2001 monitoring program also assessed the extent to which the forestry community=s existing guidelines (BMPs) for water quality and wetlands protection and visual quality are being implemented. However, changes in the protocols for conducting field monitoring limit comparison to past water quality, wetland, and visual quality monitoring findings. The current monitoring program provides for quantitative evaluations of each resource feature (e.g., wetland) individually, so multiple occurrences of the same resource on a given harvest site are treated as independent evaluations. This is in contrast to water quality, wetland, and visual quality monitoring efforts prior to 2000 where evaluations characterized the predominant practice across the entire site when multiple occurrences of the same resource were found.

The TH/FM guideline implementation monitoring program provided the following.

- A description of various timber harvest practices being applied in Minnesota immediately prior to availability of the guidelines, and how those practices compare to recommendations contained in the guidebook. Specific conditions and practices assessed include riparian management, water and wetland approaches and crossings, pre-harvest planning, conformance with visual quality recommendations, slash disposal and distribution, extent of rutting, leave tree distribution, pre-harvest review for cultural resources and ETS species, site infrastructure percentage, skid trail distribution and water diversion device use for roads and skid trails.

- Identification of changes needed for conducting future TH/FM guideline implementation monitoring efforts. Examples include modifications to criteria for identifying primary sampling units used in identifying harvest sites for review, presite visit landowner/resource manager/logger interview questions, and parameters evaluated during the site visit.

- The need to emphasize continued education and training efforts for loggers, resource managers, and landowners, particularly in the areas of installing appropriate protection measures for water and wetland approaches and crossings and the use of temporary structures.

- Information to assist the Forest Resources Council in evaluating the extent to which its guideline implementation goals are being met. This includes the goal of assessing awareness and understanding of the guidelines as measured through attendance of introductory guideline training and field demonstrations as well as application of the guidelines over time.

VI. RECOMMENDATIONS FOR FUTURE MONITORING

In preparing for the 2001 guideline monitoring effort, needed changes that will improve the efficiency and accuracy of data collection were identified. Meetings were held with the Technical Committee, aerial photo interpretation(s), and among Acore@ team members to identify improvements to the process for 2001. The following is a summary of changes planned for the 2001 monitoring effort:

1. PSU Selection

   For 2001 the PSU criteria was tightened up to increase the potential for timber harvests to occur within the PSUs. The criteria for the minimum forest land acreage within each PSU was increased from 160 acres of forest to six square miles of timberland (i.e., at least one third of the PSU in forest).

2. Aerial photo interpretation and data collection

   Phase 1 of aerial photo interpretation:

This phase consists of evaluating all of the photos in the selected PSUs and looking for timber harvests that occurred within the past two years. In advance of this phase of the process in 2001, a letter will be sent out to agencies and private industry requesting that they submit all timber harvests conducted within those PSUs on their lands. The aerial photo interpreter(s) will use this list to verify and further calibrate the identification of recent harvests.

Phase 1A:

Once the preliminary sites are identified the landowners will be contacted to verify that a harvest did indeed occur at that location, and within the given time period. Each landowner will be asked to verify the delineation of the harvest boundary. Once the final site package is set, Council and DNR staff will contact all landowners and request a full set of documentation for the harvest site including but not limited to maps, regulations, planning documents, and documentation of considerations for special features.

Phase 2 of aerial photo interpretation:

Once the final set of 120 sites has been established, the aerial photo interpreter(s) will go back to rectify and geo-reference the photos, and conduct certain measurements on each site. Changes in 2001 include:

- Identifying and delineating all open water features that require an RMZ that are within 1.5 times the theoretical RMZ width of the cutting boundary.
- Identifying the visual sensitivity of the site and designating a location from which the contractor will evaluate the visual quality guidelines.

Phase 3 of aerial photo interpretation:

After the contractor has completed the field evaluations, the photos will again come back to the aerial photo interpreter(s) to add detail and make modifications as indicated by the field contractor. Changes for 2001 include:

- Mapping roads on the site and measuring the average width of each road. The aerial photo interpreter(s) will then measure length and surface area of delineated roads.
- The contractor will be delineating all leave tree clumps, strips, and islands (these will not be delineated ahead of time). The aerial photo interpreter(s) will then map and measure the size of the leave tree clumps, strips, and islands delineated by the contractor.
- The aerial photo interpreter(s) will calculate the area of landings based on the location delineated on the aerial photograph by the contractor. This calculation will be compared to the area of landings determined by the contractor onsite.
- The aerial photo interpreter(s) will be making more measurements of the area occupied by forested and non-forested portions of RMZs, both actual and theoretical.

C. Distribution of Request for Proposal (RFP)

After phase 2 is complete, the package of completed sites will be made available to the potential contractors for review in preparation of their bids. For 2000, not all photos were available at the

time the RFP was available for review. In 2001, the packet will contain the locations and photos for all sites to be monitored.

D. Collection of presite and site profile information

At the same time as the aerial photo interpretation is occurring, Council and DNR staff will be collecting background information for each of the final sites. The vehicle to be used is the site profile and presite worksheets. These worksheets have been modified for 2001. In addition, a user friendly questionnaire will be developed to be used for the landowner/resource manager interview that provides the data needed to complete the site profile and presite worksheets. Part of this data collection will include a request for copies of all documentation connected with the harvest.

2. Calibration workshop

The calibration workshop will be expanded for the second round of monitoring. In particular a full day will focus on wetland identification. As part of this calibration workshop, clarifying the criteria for defining seasonal ponds will be a priority. Additional training sites will be visited to provide more opportunities for discussion. It is anticipated that the workshop will last the better part of a week.

F. Onsite data collection

The contractor will be given more information for each site than in the first round of monitoring, including more complete timber sale documentation. Each packet will contain two different scales of aerial photo, and complete site documentation including site maps, landowner information, contact person, cruise information, visual quality concerns identified, and appropriate telephone numbers.

Some significant changes will be made to the onsite data collection worksheet. Changes for 2001 include:

- Global Positioning System data collection will be eliminated. Instead the contractor will be required to complete an accurate and legible map of each monitoring site with locations of features clearly identified on the map.

- Leave tree categories will be expanded to the following: <1, 1-5, 6-12, >12. Also a breakdown of leave tree clumps, strips, and islands will be developed according to their location.

- The occurrence of snags will be identified by one of four categories: 0, <1, 1-2 and >2 snags per acre.

- A review of coarse woody debris classes for the general harvest area and the RMZs.

Identification of three or four measurable decay classes may replace numbers of Abark-on@ down logs for coarse woody debris.

7. Visual quality evaluations.

Visual quality sensitivity will be determined by the Resource Assessment unit when reviewing the aerial photographs rather asking the landowner/resource manager. The aerial photo interpreter will indicate on the aerial photo where the contractor will collect the data on visual quality. To determine the VSC for each monitoring site, the digital image of the county VSC map will be overlain with each monitoring site, and the VSC will be determined by photo interpretation. If the monitoring site is within a reasonable distance of a road, lake, river, or designated state trail so that the photo interpreter judges that the site is visible from the road or other site feature, the monitoring site will be given a VSC corresponding to the VSC of the road or other site feature. In some cases, sites may be visible from several features. For example, a site may be visible from both a road and a lake. The site would then have two VSC=s and the contractor would have to rate the visual quality guidelines from each feature from which the site is visible.

Visual quality assessments should be expanded for the second round of monitoring to include streams, lakes and recreational trails, if specified on the applicable county maps. When the choice is discretionary on the map, the visual quality rating will be made. The accuracy of determining the VSC for sites which border roads, lakes, and rivers should be very high. When the site is not adjacent to the features, it will be more difficult to be certain that the sites are truly visible from the features. The place where the evaluation of lakes, streams, and recreational trails will take place is the closest place that is accessible to the public. For recreational trails, only those that are designated specifically on the visual quality sensitivity maps will be evaluated.

8. Monitoring follow-up.

During evaluation of data, the additional acreage of various site components (e.g., leave tree clumps) located on the aerial photos by the contractor(s) will be used to finalize acreage of site components.

G. Other suggested changes for monitoring in 2001

$ Define and clarify the criteria when water diversion devices are appropriate for road and skid trail surfaces.

$ Clarify for the contractor the criteria for what constitutes an active road and the type of closure.

$ Estimate if total skid trails (i.e. primary + secondary) occupy <15% or $\geq$15% of the harvest area or whether the percentage cannot be determined.

VII. GLOSSARY

Apparent harvest size:

Artificial regeneration: To replace a stand of harvested trees with a group or stand of young trees by direct seeding or planting of seedlings or cuttings.

Basal area: The cross-sectional area of a live tree at 4.5 feet above ground. Basal area may be measured in square feet per tree or square feet per acre.

Best Management Practices: A practice ro set of practices that are determined by a state or a designated planning agency to be the most effective and practical means of controlling point or non-point source pollution. In this case reference is to the set of BMPs in the publication "Protecting Water Quality and Wetlands in Forest Management - Best Management practices in Minnesota".

Clearcutting: A regeneration or timber harvesting method that removes essentially all trees in a stand in one operation.

Coarse woody debris: Stumps and fallen trunks or limbs of more than 6 inch diameter at the large end.

Cultural resources:

Culvert: A metal, wooden, plastic or concrete conduit through which water can flow.

Endangered species: A species threatened with extinction throughout all or a significant portion of its range.

ETS species: Endangered, threatened and special concern species *(see individual definitions)*

Even-age management: A planned sequence of treatments designed to maintain and regenerate a stand of trees with on or two age classes. The range of trees ages is usually less that 20% of the rotation age.

Felling: The process of severing trees from stumps.

Filter strip: An area of land adjacent to a water body that acts to trap and filter out suspended sediment and chemicals attached to sediment before it reaches the surface water. Harvesting and other forest management activities are permitted in a filter strip as long as the integrity of the filter strip is maintained and mineral soil exposure is kept to a minimum.

Forest management:

Guidelines: A specific practice or combination of practices designed, when applied onsite, to protect specified functions and values.

Harvest area: The area of a site where timber harvesting actually took place as apposed to the entire area of the site where management activity occurred.

Heritage elements (Natural heritage element): Rare plants, animals, native plant communities or sites (such as nesting sites) which are listed on the Minnesota Natural Heritage Database. The Natural Heritage Database is an accumulation of known locations of these rare plants, animals, native plant communities or sites which may require special management considerations.

Ice bridge: A temporary bridge constructed from snow and ice, used to cross an area during winter.

Implementation monitoring: The process of identifying and recording the combination of guidelines applied to protect specific resource functions and values on a site where a timber harvest or other forest management activity is conducted.

Infrastructure: The network of access roads, approaches, trails and landings used to move equipment onto and around a forest management site.

Intermittent stream: Streams with well-defined channels, banks and beds that flow only certain times of the year, when they receive water primarily from runoff or snow melt. During dry years, these streams may cease to flow entirely or may be reduced to a series of separate pools..

Landing: A place where trees and logs are gathered in or near the forest for further processing or transport.

Landscape:

Leave tree: Live trees selected to remain on a forest management site to provide present and future benefits to wildlife, including shelter, resting sites, cavities, perches, nest sites, foraging sites, mast and coarse woody debris.

Log bundle: Several logs tied together or otherwise bunched designed to provide support for crossing a small depression such as a stream coarse. A log bundle is normally laid so that the logs are perpendicular to the road or trail. Ideally log bundles are removed upon completion of the need for the crossing. This is not a recommended practice in the TH/FM guidelines.

Low water ford: A place in a stream designated for vehicle crossing during low-water flow.

Nonopen water wetland: A wetland that generally does not have observable surface water. According to the USF&WS wetland classification system (circular 39), it includes type 1 (seasonal flooded basins),

type 2 (inland fresh meadows), type 6 (shrub swamps), type 7 (wooded swamps), and type 8 (Bogs) wetlands.

Onsite worksheet: The worksheet used to collect the information needed for monitoring the implementation of TH/FM guidelines while on the forest management site.

Open water wetland: Wetlands with shallow to deep open water generally having readily observable surface water. Water depth varies from a few inches to less than 10 feet. According to the USF&WS wetland classification system (circular 39), it includes type 3 (shallow marsh), type 4 (deep marsh), and type 5 (shallow open water) wetlands.

Perennial stream: Streams with well-defined channels, banks and beds, that exhibit essentially continuos flow. These streams flow year round, but surface water may not be visible during extreme drought.

Permanent road: A forest road intended to be left in place for the long term.

Primary Sampling Unit: A stratified subsample of the state (e.g., **2** township) in which timber harvests are identified and added to the pool of potential monitoring sites.

Primary skid trail: An arterial route used by skidders or forwarders to haul trees and logs to the landing. Primary skid trails are heavily traveled routes which are fed by a system of secondary skid trails of less frequent travel. Primary skid trails are typically traversed 10 or more times by heavy equipment.

Presite visit worksheet: The worksheet used to gather information about a monitoring site prior to actually going out onto the site. The information specifically relates to planning guidelines and can be obtained prior to onsite review.

Riparian area:

Riparian management zone: That portion of the riparian area where site conditions and landowner objectives are used to determine management activities that address riparian resource needs. It is the area where riparian guidelines apply. See the Th/FM guidebook for specifics on recommended RMZ widths and management.

Rutting: The creation of linear depressions made by the tires or tracks of vehicles, usually under wet conditions.

Seasonal pond: Sometimes called *vernal pools*, seasonal ponds are depressions in the soil surface where water pools during wet periods of the year, typically in spring (vernal) and fall (autumnal). A seasonal pond will have an identifiable edge caused by annual flooding and local topography, The edge is best identified during the spring or fall , but it may be identified during dry periods by the lack of forest

litter in the depression. Such depressions typically are fishless and retain water for longer periods that puddles. (*Note*: The leaf litter is replenished annually but is consumed during inundated periods and noticeably depleted thereafter. Deciduous litter will likely be consumed faster and more thoroughly than conifer litter.)

Seasonal road: A permanent road designed for long-term periodic use, such as during dry and frozen periods. Seasonal roads are built to lower engineering standards and have minimal material surfacing.

Secondary skid trail: A skidding route used to haul felled trees or logs from the back portions of a site to the primary skid trails. Secondary skid trails branch out from a primary skid trail and are less heavily traveled. Secondary skid trails are traversed from 3-10 times by heavy equipment.

Seeps and seepage wetlands: Small wetlands (often less than an acre are two) that generally occur where ground water comes to the surface. Soils at these sites remain saturated for some portion or all of the growing season, and often stay wet throughout the winter.

Silviculture:

Single tree selection: A timber harvest method where individual trees of all size classes are removed more or less uniformly throughout the stand, to promote growth of remaining trees and to provide space for regeneration.

Skidding: The act of moving trees from the site of felling to a loading area or landing.

Slash: Residual woody material created by logging or timber stand improvement.

Snag: A standing dead tree.

Special concern species: A species that , although not endangered or threatened, is extremely uncommon in Minnesota or has unique or highly specific habitat requirements. Special concern species may include 1) species on the periphery of their range in Minnesota, but not listed as threatened or endangered; and 2) species that were once threatened or endangered but now have increasing, protected or stable populations.

Spring (as a form of wetland): Small wetlands were ground water visibly flows to surface, typically year around, and often creating a small stream.

Sprouting: A forest regeneration method where shoots arise form the base of a harvested tree either from the stump or by suckering from the root system.

Sustainable forest:

Temporary road: Generally a minimum-standard road designed for short-term use during a specific project, such as a timber harvest. Use of temporary roads is typically limited to dry or frozen conditions to minimize rutting and compaction.

Threatened species: A species likely to become endangered in the foreseeable future throughout all or a significant portion of its range.

Timber harvest:

Timberland:

Uneven-age management: A planned sequence of treatments designed to maintain and regenerate a stand with three or more age classes. All age classes could be represented.

Visual quality: A subjective measure of the impact that viewing an object, landscape or activity has on a person's perception of attractiveness.

Water crossing approach: That portion of a trail or road immediately previous to the crossing of a wetland, or Water body. For the purposes of this report a water crossing approach is considered to be that portion of a road or trail from the outer (landward) edge of the filter strip or RMZ, whichever is wider, to the water or wetland being crossed.

Water diversion structure: A lead-off ditch, water bar, or other structure designed to carry water runoff into vegetation, duff, ditch, or dispersion area, so that it does not gain the velocity and volume which causes soil movement and erosion.

Wetlands: Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or where the land is covered by shallow water. Wetlands must have the following three characteristics: 1) a predominance of hydric soils (soils that result from wet conditions), 2) inundation or saturation by surface water or ground water at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation (plants adapted to wet conditions), and 3) under normal conditions, a prevalence of hydrophytic vegetation.

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IX. APPENDIX A. Location of Implementation Monitoring Sites.

County	Twp	Rng	Landowner category and number of sites	Total sites
Crow Wing	43	28	County (2)	2
Aitkin	44	23	County (1)	1
Itasca	54	25	State (3)	2
St. Louis	55	14	State (2), county (1)	3
Lake	56	10	FI (2), USFS (4), county (1)	7
St. Louis	60	16	NIPF (3), county (7)	10
St. Louis	60	21	FI (4), state (7), NIPF (5)	16
Lake	61	11	USFS (2)	2
Cook	62	1E	State (1), USFS (1)	2
St. Louis	64	21	FI (1), state (3)	4
Koochiching	69	22	State (8), county (1)	9
Wabasha	109	12	NIPF (1)	1
Cass	136	31	County (8), NIPF (1)	9
Hubbard	141	32	State (9), NIPF (9)	18
Cass	142	27	State (6), County (3), NIPF (3)	12
Clearwater	144	37	County (1)	1
Itasca	147	28	USFS (5)	5
Koochiching	151	29	County (4)	4
Koochiching	157	25	State (1), county (2)	3
Rosseau	159	40	NIPF (1)	1
Lake of the Woods	160	35	State (6)	6
			Total	118