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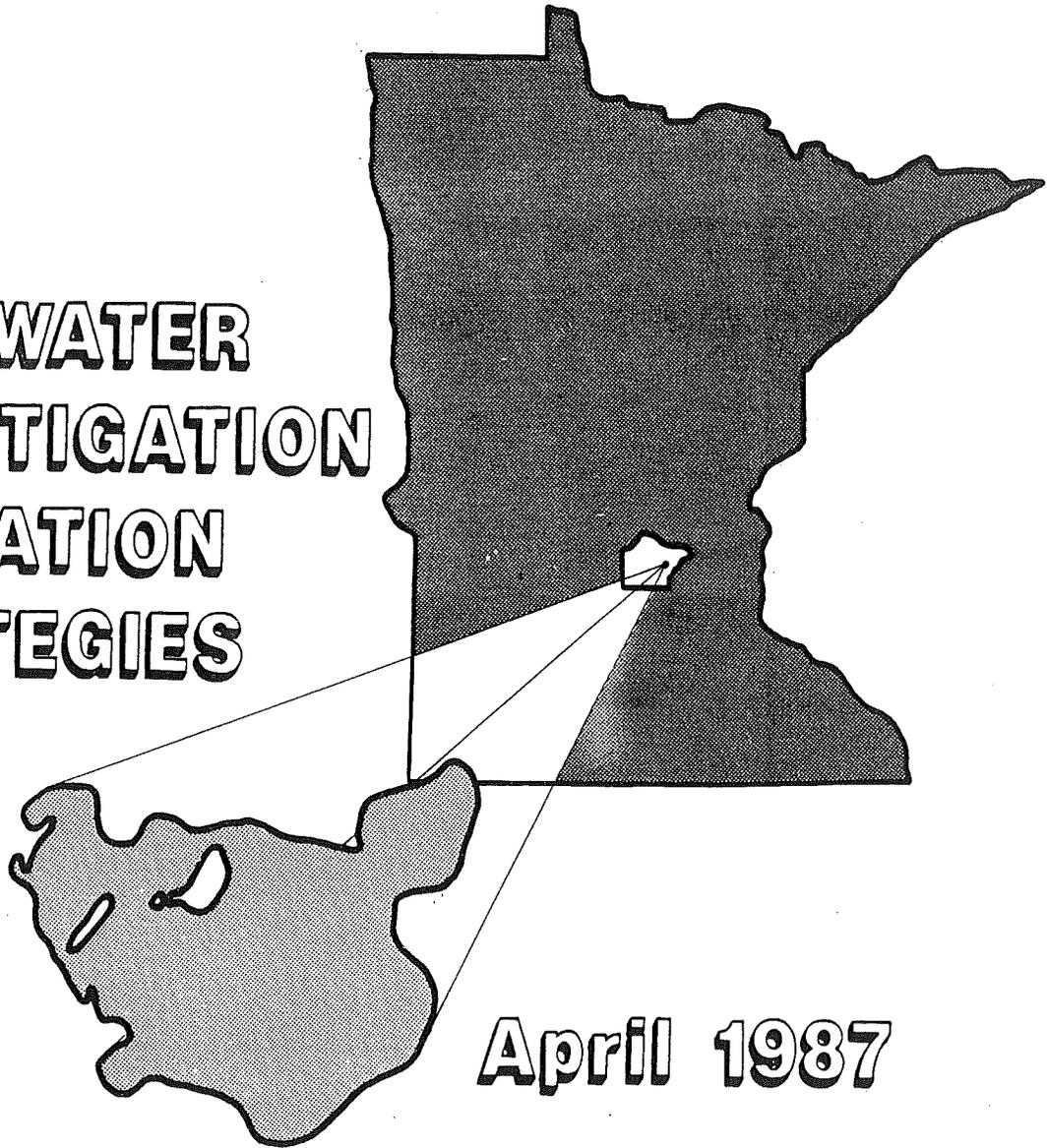
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BEEBE LAKE

(Wright County, 86-23)

HIGH WATER INVESTIGATION MITIGATION STRATEGIES



April 1987

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HIGH WATER INVESTIGATION
AND
MITIGATION STRATEGIES
FOR
BEEBE LAKE
BASIN #86-23
WRIGHT COUNTY

Minnesota Department of Natural Resources
Division of Waters

April 1987

Through an agreement between the Department of Natural Resources and the United States' Federal Emergency Management Agency (FEMA), a study was conducted to determine effects and mitigation strategies for high water problem basins. The work that provides the basis for this publication was supported by funding under a cooperative agreement with the Federal Emergency Management Agency. The substance and findings of that work are dedicated to the public. The author and publisher are solely responsible for the accuracy of the statements, and interpretations contained in this publication. Such interpretations do not necessarily reflect the views of the Federal Government.



ACKNOWLEDGEMENT

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INTRODUCTION

Beebe Lake is located in east central Wright County, Minnesota, approximately 30 miles northwest of the Twin Cities metropolitan area. The lake is 5 miles east of the City of Buffalo, and most of its area is within Sections 29 and 30 of Township 120 North, Range 24 West (Plate 1).

Beebe Lake is one of over 50 landlocked lakes within glaciated terrain in Minnesota which, in recent years, have been experiencing highwater level problems. These lakes have no active natural outlets for surface water outflow and are susceptible to large natural water level fluctuations. The duration of these fluctuations is usually on the order of years and is dependent on long-term climatic trends. These lakes typically have small watershed-to-lake area ratios, usually less than 5 to 1.

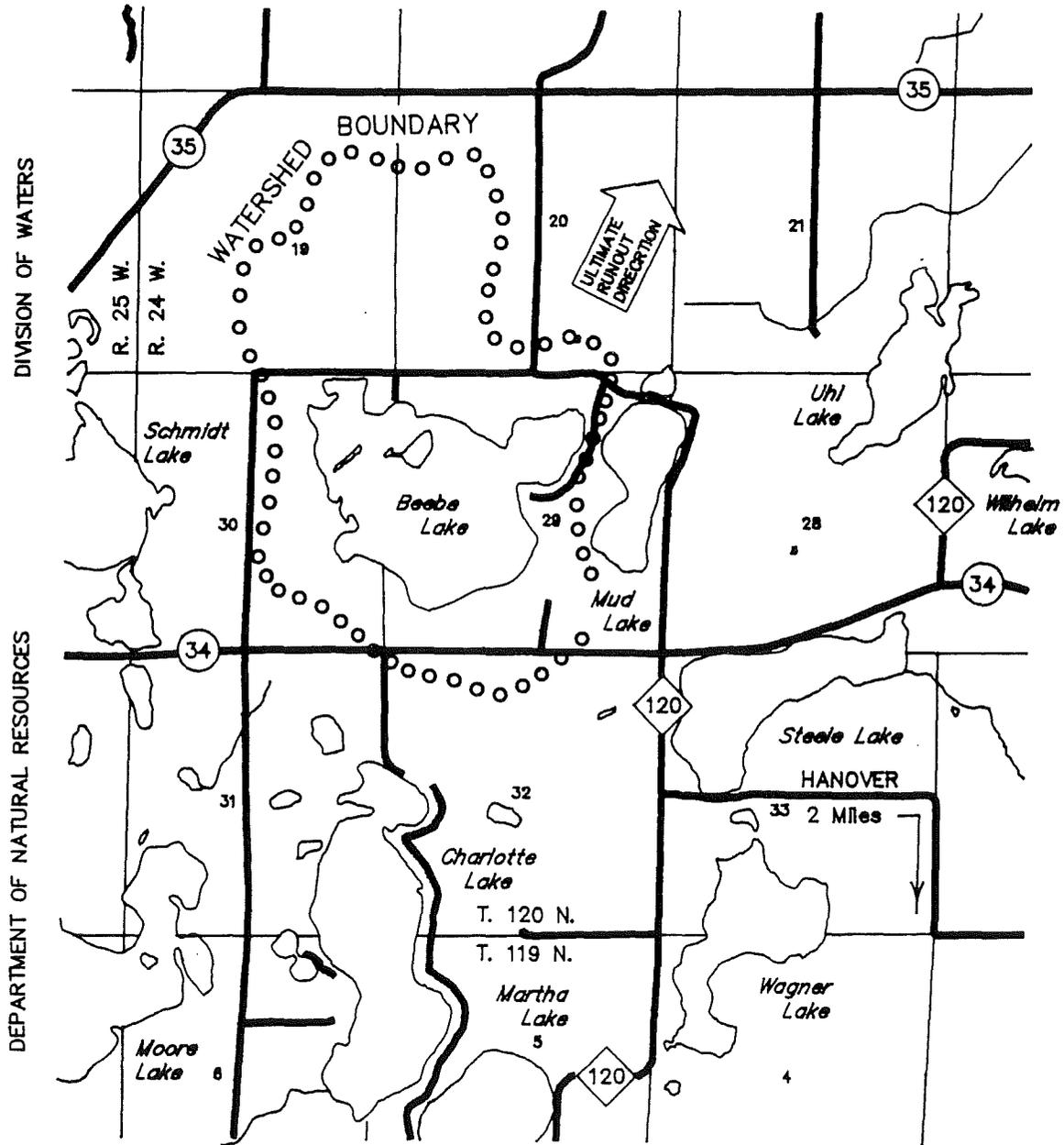
Beebe Lake is situated in glacial moraine deposits associated with the Des Moines lobe glaciation. In recent years, the lake level began to rise after heavy rainstorms, and by the summer of 1986 the lake rose to within 0.8' of the Ordinary High Water Level (OHW elevation 969.6', NGVD, 1929)⁽¹⁾, which resulted in the flooding of several structures.

This report is intended as a resource document to assist landowners and the local unit of government in terms of long range planning, developing flood loss reduction or mitigation strategies and in obtaining assistance in dealing with a high water level problem lake. In addition, this report will include background data on the watershed setting, geology, soils, climatology, fish and wildlife, water quality, historic water levels, and land use and existing development.

The report which follows is divided into 4 parts: Summary and Conclusions, Part 1, Part 2 and Appendices. Part 1, through the presentation and analysis of watershed, geologic, precipitation, water level and other data, will identify the source of the problem, project future conditions and identify the potential impact of continued rising water levels. Part 2 will identify mitigation options and implementation strategies. The Appendices will provide additional background data to be used by landowners and local, state and federal officials.

¹National Geodetic Vertical Datum of 1929 is used for all elevations included in this report.

PLATE 1



SCALE
4000 FEET



SUMMARY AND CONCLUSIONS/RECOMMENDATIONS

Water Level Data (See Part 1)

- In August of 1986 Beebe Lake was at elevation 968.57', an elevation 1.03' below its ordinary high water elevation of 969.6'. Beebe Lake's water level reacts to both surface (above ground) runoff and ground water inflow.
- There is a correlation between the area's annual precipitation and Beebe Lake's water level. During the last 5-year period, there has been an excess of 28.94" of precipitation above the normal precipitation for this general area. This has resulted in significant surface and ground water inflow and caused the current high water problems.
- This area in the past has experienced alternating wet and dry periods of varied duration. The current period may continue for several more years resulting in still higher water levels.
- If the lake were to rise to elevation 976.57', 27 additional structures would be flooded with 1986 assessed market values totalling \$1,149,198. At this elevation, it is estimated a minimum \$1,013,053 of damage would
- Methodologies do not exist which can predict what Beebe Lake's maximum elevation will be in the future. The major factor on limiting potential increases in lake levels would be if the lake should reach its natural runout elevation of 972.60'.
- Methodologies do exist which can calculate the probabilities of future water levels considering the long-term impact of above or below normal precipitation (i.e., both increases and decreases in water levels). There is a one-percent probability that Beebe Lake will: 1) rise above elevation 969.8' on December 1, 1987; or 2) exceed elevation 973.0' on December 1, 1991. Conversely, there is a one-percent probability the lake will: 1) fall below elevation 966.6' by December 1, 1987; or 2) fall below elevation 965.1' on December 31, 1991. There is a 50% probability (a 50/50 chance) that Beebe Lake will be at elevation 968.1' on December 1, 1987 and elevation 968.9' in approximately 5 years.

Mitigation Strategies (See Part II)

- The flood protection standards for new development in Wright County's current flood plain ordinance do not apply to the Beebe Lake shoreline because a flood delineation is not currently shown for the lake on the County's current flood plain zoning map. The County must properly regulate new development with its existing state-approved shoreland regulations with two recommended revisions, as follows:
 - 1) New development within the lake's shoreland district must be elevated, at a minimum to elevation 972.8' (4' above the highest known water level). It is recommended that the County adopt a flood protection elevation of 973.6'. This will insure that all new development is above Beebe Lake's natural runout elevation; and

2) For all new construction a provision should be added which requires an elevated road access to the minimum flood protection elevation established by the County (presently 972.8' and recommend at 973.6').

- The County should develop a strategy to address the inundation of sewage treatment systems and wells, as well as the abandonment of flooded structures. The DNR will work with the County in formulating and implementing joint actions where appropriate.
- Flood insurance is available to all landowners and renters in the unincorporated areas of Wright County. A structure and/or its contents can be insured. Landowners or renters adjacent to Beebe Lake should explore purchasing flood insurance, especially those located below elevation 973.6'.
- Landowners can take emergency measures to protect existing development. The safest method is either relocating a structure to natural ground above elevation 973.6' or elevating a structure at its existing site on fill to a minimum recommended flood protection elevation of 973.6'. Emergency protection measures, such as filling, sandbagging, diking, etc., will require a permit from the County. A design professional should be contacted in advance to insure the flood protection measure will function properly.
- State and federal cost-sharing programs may be available to assist landowners and/or local governmental bodies in dealing with a high water problem. These programs include the U.S. Army Corps of Engineers' flood control authorities, Small Cities Development Block Grant Program, Section 1362 or the Federal Flood Disaster Protection Act of 1973 and the State's Flood Loss Reduction Legislation. Local interests should explore these programs and the requirements for an acceptable local sponsor to submit the application.
- At the request of Wright County, the Corps of Engineers is investigating the possibility of a federally cost-shared flood control project on Beebe Lake. The information in this report will be made available to the Corps of Engineers to assist in their study effort. Local interests should participate in this study effort to the degree possible. Should a federally cost-shared project be feasible, local interests must designate a "local project sponsor" acceptable to the Corps of Engineers.
- Comprehensive basinwide solutions to high water problems are best implemented when a local entity or interest group takes the lead role. The legislature has established special taxing procedures and quasi-governmental authorities (e.g., lake improvement districts/watershed districts) which can be used to deal with high-water type problems. Landowners and local governmental bodies should: 1) define their respective roles in dealing with the existing high water problem; and 2) if necessary, use the special taxing procedures and/or quasi-governmental authorities to implement feasible basinwide solutions.

The report which follows goes into greater detail on the issues of water level data and mitigation measures (including additional recommendations). Part II also presents in detail state permit requirements for future actions which would affect the lake basin proper. The reader is encouraged to read the remainder of this report. The Department of Natural Resources will assist local interests in the degree possible in implementing future flood loss reduction measures.

PART 1

GEOLOGIC SETTING

Beebe Lake is located in glacial moraine deposits associated with Des Moines lobe glaciation. In general the glacial drift consists of gray, calcareous silty till (recorded as "clay" on drillers logs) with some surficial and buried sand and gravel deposits. The glacial deposits are approximately 180 ft. thick in the area, and are underlain by the Cambrian Ironton and Galesville sandstones.

Drillers' logs from water wells in the area give a clearer picture of the stratigraphic relationships of glacial deposits in the immediate vicinity of the lake (Plate 2). The lake is situated in glacial till (recorded as "yellow clay", "blue clay" or "clay" on the drillers' logs). Beneath the till is a buried gravel deposit which is 40-80 ft. deep in the vicinity of the lake. It is unclear whether the gravel intersects the lake bottom on its eastern side. The gravel is underlain by a layer of till, which is underlain by a sand/gravel deposit above bedrock.

SOILS

The soils surrounding Beebe Lake are loam, clay loam, or silty clay loam developed over silty or calcareous glacial till. The soils are of moderate to low permeability. There were sandy beach deposits along the eastern shore of the lake at the time of soil mapping but are likely flooded at the present time. The lake bottom sediments consist of muck and sand.

HYDROGEOLOGIC SETTING

The primary water-bearing units in the area are buried sands and gravels within the till. Wells in the area obtain water from these deposits. The regional direction of ground water flow in the deeper (100 ft.) buried drift aquifers and in the underlying bedrock aquifers is to the southeast toward the Crow River. Local flow systems with different ground water flow directions may exist around the lake. The lake is in contact with glacial till, implying rather slow rates of ground water seepage into and out of the lake. If the buried gravel deposit does intersect the lake bottom, a more direct connection between the ground water system and the lake would exist. However, even at the slower rates of seepage through glacial till, the contribution to the lakes water budget can be significant, especially if a ground water mound develops on the down-gradient side of the lake and blocks outflow to the ground water system.

Ground water levels in the area have been steadily increasing during the last decade due to above average precipitation. Lake levels have also risen, since lakes are an expression of the ground water table. Increased net ground water inflow to the lake should be expected if the lake level is artificially lowered by the installation of an outlet. This should be taken into account in the design of any outlet structure.

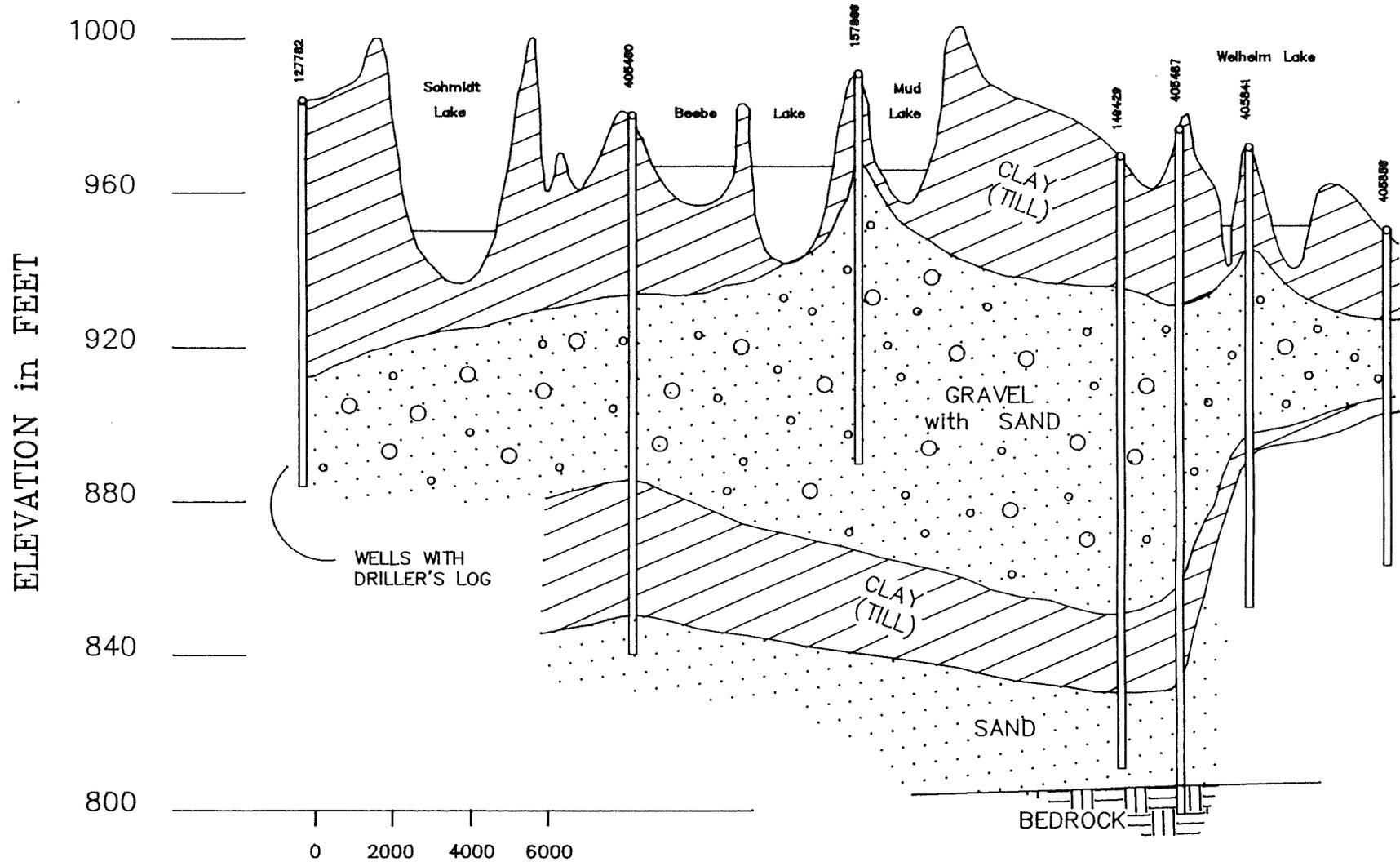


PLATE 2 : STRATIGRAPHY of GLACIAL DRIFT DEPOSITS in the BEEBE LAKE AREA (Information from drillers's logs).

WATERSHED

The total watershed area for Beebe Lake is approximately 1,084 acres (Plate 1 on Page ii). The watershed of 1,084 acres minus the lake water surface area of about 315 acres equals 769 acres or a total watershed area to lake area ratio of about 2½:1.

This effective watershed to lake area ratio of about 2½ to 1 is generally considered adequate to maintain lake levels during periods of normal precipitation. During periods of below normal precipitation the lake level would probably drop in elevation and during periods of above normal precipitation it would be expected to see a rise in elevation. Since, in recent years, the area has been experiencing periods of above normal precipitation it is not surprising to see a rise in the lake water level.

From the available data, it would appear that a closed basin (no outlet) such as Beebe Lake has been experiencing above normal lake water levels due primarily to above normal precipitation which results in increased surface water runoff together with increased net groundwater flow into the lake.

A field survey completed on May 8, 1987, indicates that the surface water of Beebe Lake would ultimately runout towards the northeast if the lake would ever reach elevation 972.60' (See Plate 1 on Page ii).

WATER QUALITY

Water quality information for Beebe Lake exists in the files of the Department of Natural Resources for the years 1939, 1941, 1955, 1976, 1981, and 1982. The files of the Pollution Control Agency contain water chemistry and clarity data for the years 1981 through 1986. Beebe is a moderately hardwater, eutrophic (nutrient enriched) lake. High levels of total phosphorus were measured in the water column in late June 1981. There are no other direct measurements of nutrient enrichment.

Water quality problems have included an occasional winterkill, algal blooms, and poor water clarity at midsummer. A diversity of aquatic weeds grow at depths of up to ten feet. These weeds aid in the maintenance of dissolved oxygen in the water column but grow very densely in areas. Beebe Lake has experienced recent water level increases, the effect of which has been to improve early spring water clarity. The bacteriological water quality issues of flooded septic systems and pastures were not addressed.

FISH AND WILDLIFE

The Minnesota Department of Natural Resources' Fisheries Lake Survey Reports (dated 1955, 1976, 1980 and 1982) classify Beebe Lake in ecological and management terms as Centrarchid (Bass/Panfish). The survey reports indicate that the fish population of the lake includes northern pike, walleye pike, black and white crappies, bluegills, largemouth bass, hybrid sunfish, pumpkinseed, yellow perch, black and yellow bullheads, white suckers, carp and gold shiners. The lake normally experiences only minor winter kills (low oxygen content) and it would take a severe winter (long duration with heavy snow cover) to produce a significant winter kill situation. It has been reported in recent years that the bullhead population is becoming more of a problem and may require some future action to assist in controlling the population. Overall, the fish population is average to good in both the number and size categories. Natural spawning is excellent for largemouth bass and panfish, good for crappies and less than fair for northern and walleye pike.

The Department of Natural Resources has not performed a wildlife field survey for Beebe Lake. However, the lake and its riparian area does provide important habitat for a large number of wildlife species. Of the approximately 290 species of birds regularly found in the Lake States, 100 inhabit wetlands and another 80 are attracted to wetland edges. Of the 67 mammalian species in the Lake States, 6 have wetland habitats and approximately 40 other mammals are associated with or attracted to wetland edges. Reptiles and amphibians show a similar dependence on wetland habitats.

Wildlife such as gulls, terns, loons, pelicans, grebes, coots, cormorants, ducks, geese, swans, eagles, osprey, as well as other species of birds, use lakes for feeding and migrational resting areas. Shallow lakes and shallow portions of deeper lakes together with their riparian areas, provide important feeding, breeding, nesting and brooding habitat for a great variety of bird species including herons, egrets, bitterns, rails, cranes, hawks, snipe, sandpipers, kingfishers, warblers, sparrows, and pheasants, as well as ducks, geese and swans.

In addition, mink, muskrat, beaver, otter and water shrew also rely on lake and wetland habitats. Their riparian areas provide habitat for a variety of species of mammals such as raccoons, hares, weasles, moles, shrews, fox and deer.

Appendix B contains a more detailed presentation of water quality, fish and wildlife management, development history, and other information.

PRECIPITATION

Buffalo Area

Long Range Normal Annual Precipitation Average (St. Cloud data
1893-1986) = 26.84"

Normal Annual Precipitation (current trends) 1951-1980 = 29.03" (Plates 3 and 4)

Actual Annual Precipitation:

1982-1986

1982 = 35.03"
1983 = 33.35"
1984 = 32.43"
1985 = 37.13"
1986 = 36.15"

5-year period, = 34.82"/year
yearly average
precipitation

Excess above = 28.94"
normal
precipitation
for 5-year
period (current trends)

1977-1986

1977 = 35.00"
1978 = 31.32"
1979 = 28.01"
1980 = 24.00"
1981 = 23.97"
1982 = 35.03"
1983 = 33.35"
1984 = 32.43"
1985 = 37.13"
1986 = 36.15"

10-year period = 31.64"/year
yearly average
precipitation

Excess above normal = 26.09"
precipitation for
10-year period (current trends)

A more in-depth discussion of climatological data is contained in Appendix C.

PLATE 3

ANNUAL PRECIPITATION

OF BUFFALO, MN

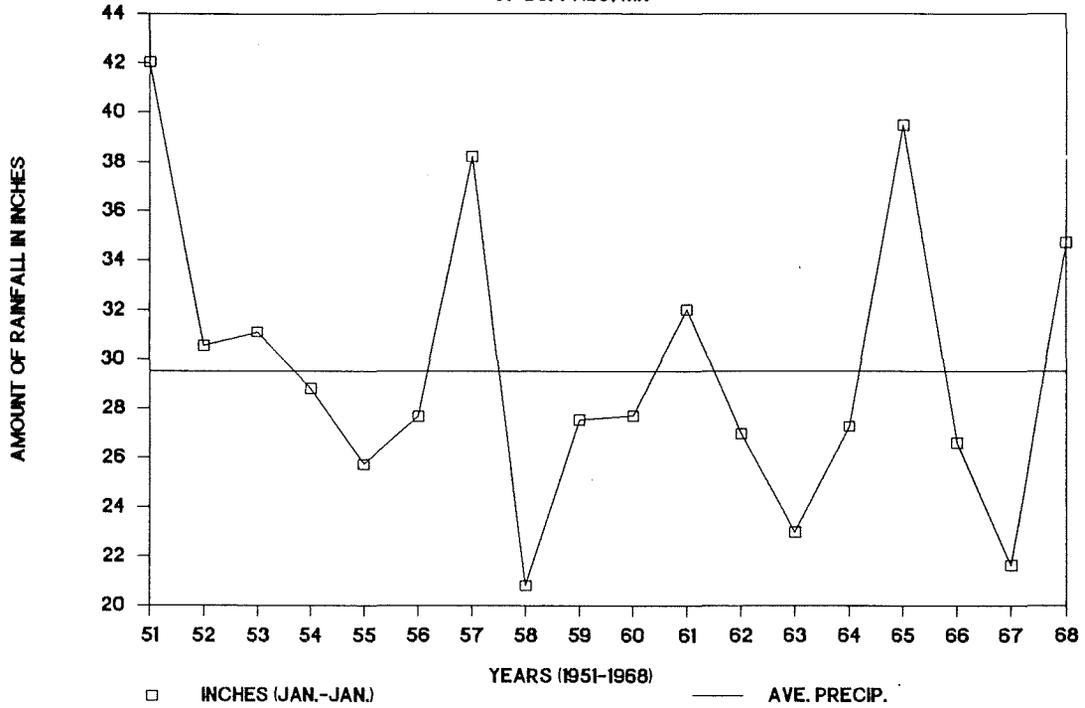
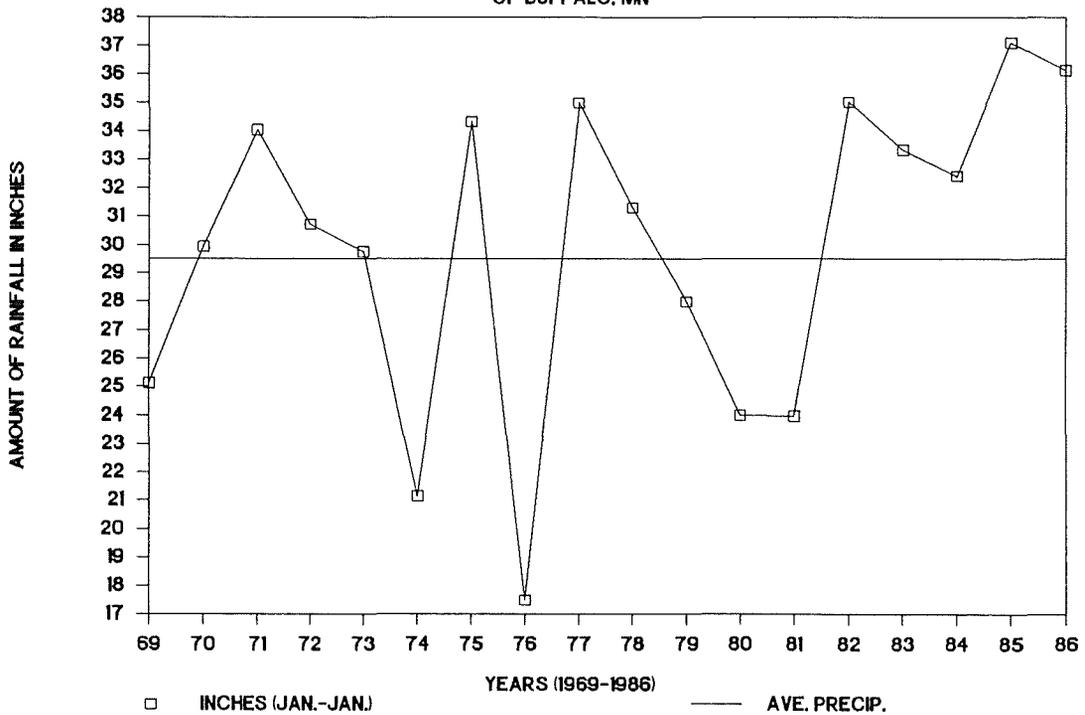


PLATE 4

ANNUAL PRECIPITATION

OF BUFFALO, MN



WATER LEVEL HISTORY

The Department of Natural Resources' Beebe Lake file contains eight fairly reliable surface water elevations dated from October 27, 1959 through May 8, 1987 (see Chart 1 and Table 1 below). The available precipitation and lake level data indicate a correlation between the area's annual precipitation and the lake's water level. From 1982 through 1986 (last five years), the area received an additional 28.94 inches of precipitation over the normal annual precipitation of 29.03 inches. The water level of the lake (968.8') on August 22, 1986 was within 0.8' of the lake's Natural Ordinary High Water Mark (969.6') and was presumably due to several years of above normal precipitation.

It should also be noted that the precipitation patterns in this area are characterized by alternating wet and dry periods of varied duration (Plates 5 and 6). These long-term precipitation variations could continue into the future and Beebe Lake's water surface elevation will respond accordingly. Because above normal periods (several years) of precipitation of longer duration than the current period have occurred in the past, the current period may continue for several more years resulting in continued increasing lake levels.

CHART 1

BEEBE LAKE - WRIGHT CO.

WATER SURFACE ELEVATION

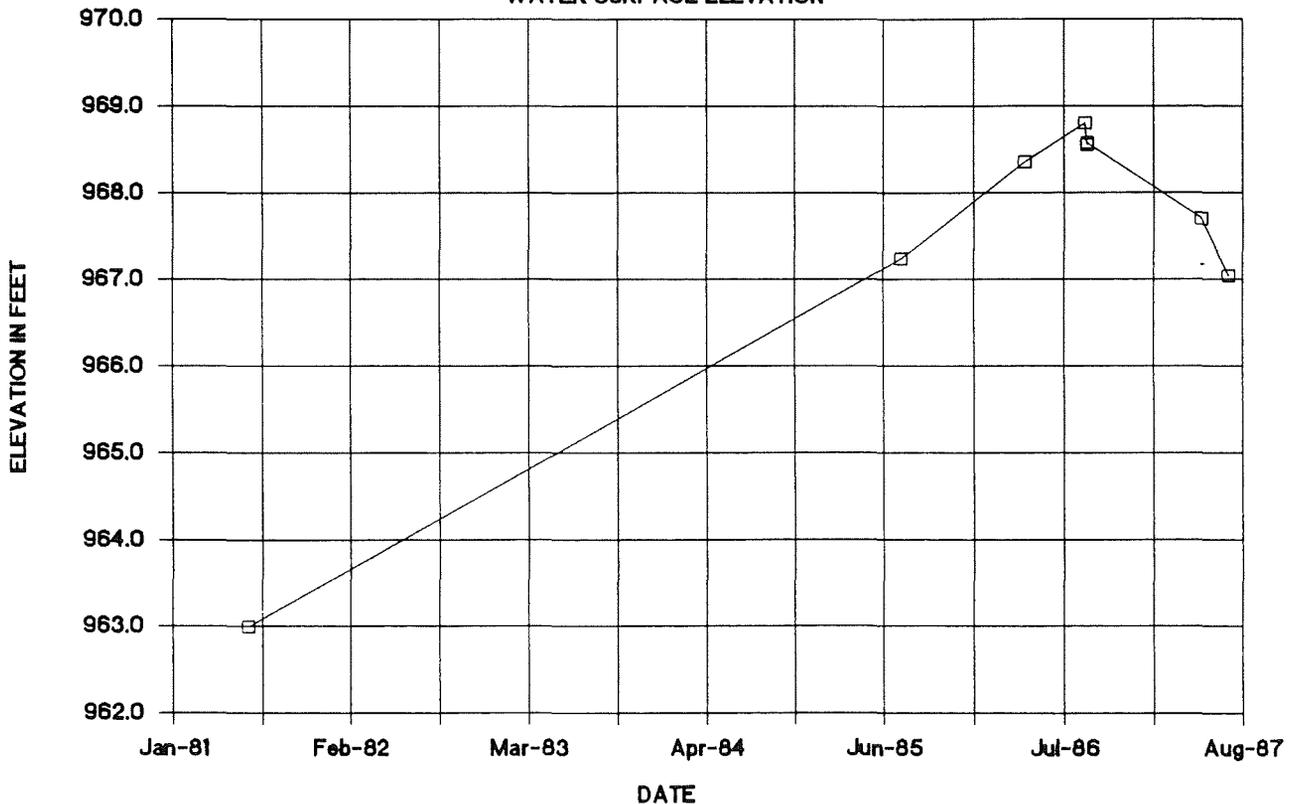


Table 1
WATER LEVEL HISTORY

<u>Date</u>	<u>Water Level</u>	<u>Source</u>
10/27/59	963.20'	DNR Fish & Wildlife
1981	963.00'	USGS Quadrangle Map
7/11/85	967.24'	DOW Field Survey
4/10/86	968.35'	DOW Field Survey
8/22/86	968.80'	DOW Field Survey
8/26/86	968.55'	DOW Field Survey
8/27/86	968.57'	DOW Field Survey
5/8/87	967.70'	DOW Field Survey

PLATE 5

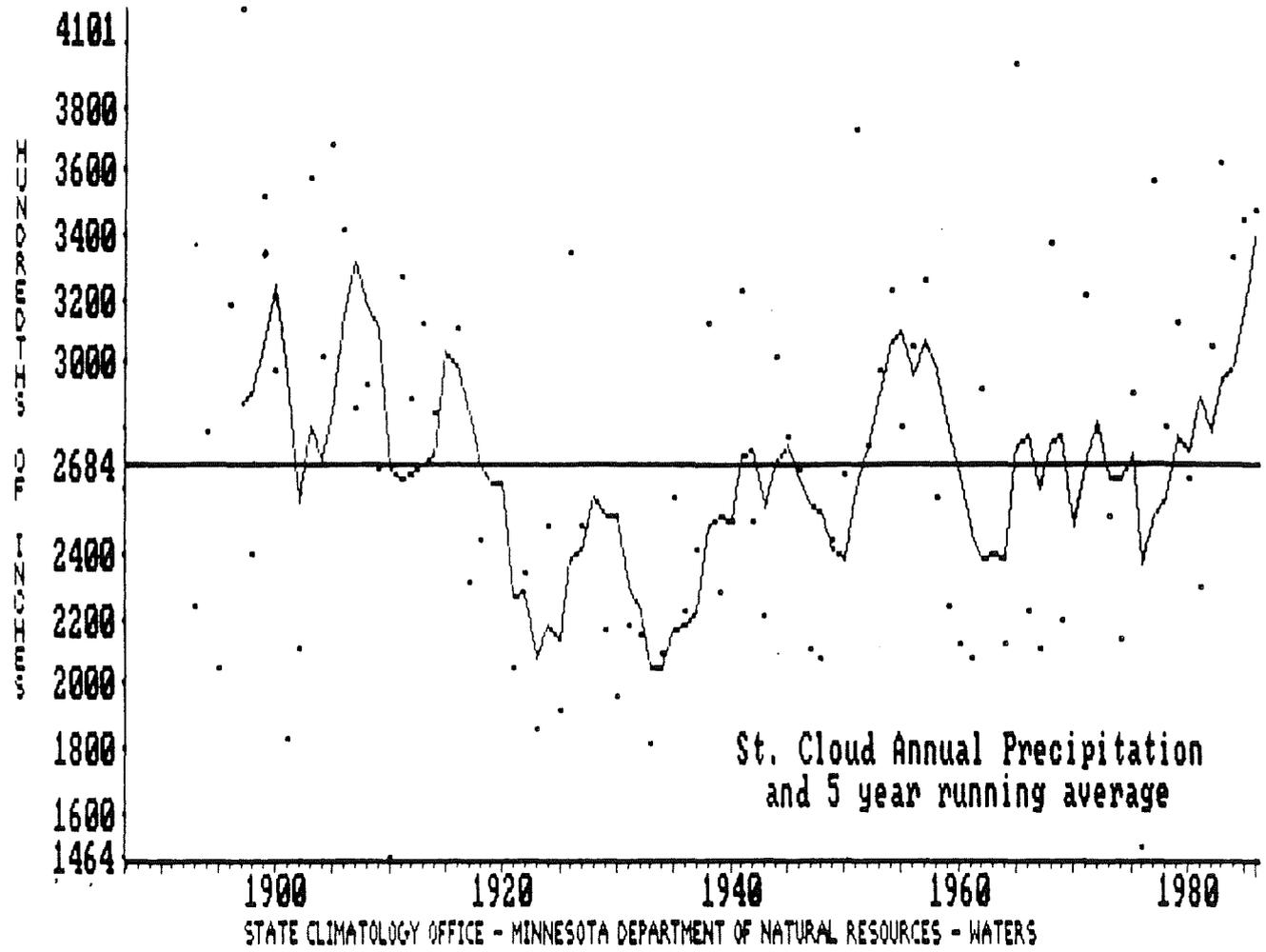
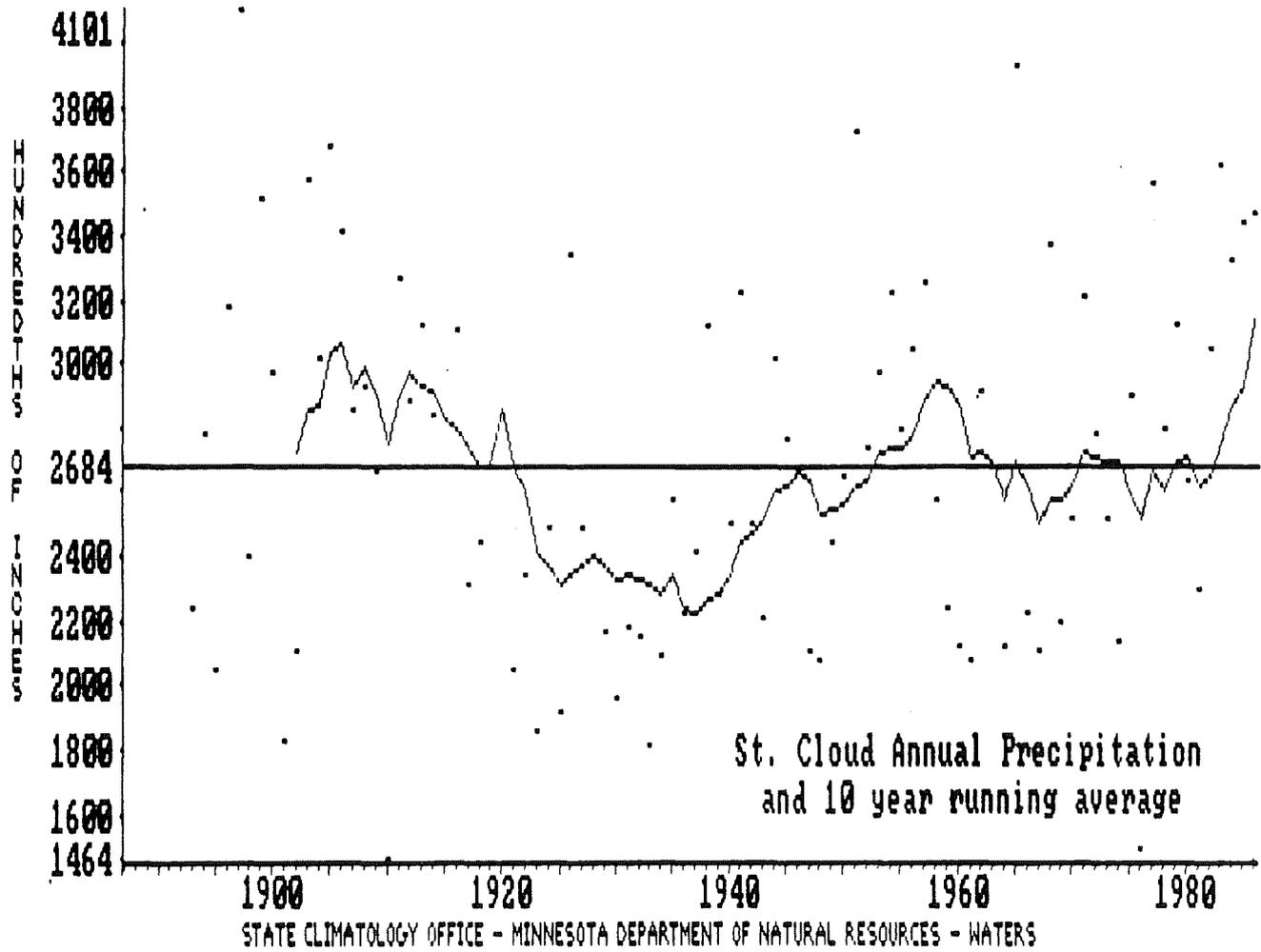


PLATE 6



ORDINARY HIGH WATER LEVEL (OHW)

The Ordinary High Water level (OHW)⁽²⁾ for Beebe Lake has been determined by the Department of Natural Resources, Division of Waters in accordance with Minnesota Statute § 105.37, Subdivision 16. OHW data was obtained from field surveys completed on July 15, 1985, and the subsequent analysis indicated the OHW to be at elevation 969.60'.

OHW General

Resource management and riparian rights pertaining to an inland lake are dependent upon identification and establishment of that lake's Ordinary High Water (OHW) elevation. The OHW is coordinated with the upper limit of the lake basin and defines the elevation (contour) on the lakeshore which delineates the boundary of public waters. Identification of the OHW comes from an examination of the bed and banks of a lake to ascertain the highest water level where the presence and action of water has been maintained for a sufficient length of time to leave recoverable evidence. The primary evidence used to identify the OHW of a lake consists of vegetational and physical features found on the banks of the lake.

Because trees are the most predominant and permanent expression of upland vegetation they are used as OHW indicators wherever suitable species and sites can be located. Particular attention must be given to the species of upland growth selected for consideration. In general, willow, cottonwood and most ash are very water tolerant; maples and elms tolerant; and most birch intermediately tolerant and oak intolerant. The less tolerant trees make the best indicators but factors in addition to species also have to be considered such as age, the slope of ground, the effect of water and ice action on the shoreline and the physical condition and growing characteristics of the trees. Water dependent vegetation such as cattails will follow lake levels as they rise and fall and therefore provide little evidence as to the lakes OHW, except in cases where more permanent vegetation does not exist.

Physical features searched for include soil characteristics, beachlines, beach ridges, scarp or escarpment (more prominent scarp can often be found in the form of the undercutting of banks and slopes), ice ridges, natural levees, berms, erosion, deposition, debris, washed exposed shoreline boulders, high water marks, movement of deposits as a result of wave action, top and toe of bank elevations as well as water levels. Caution is taken to be aware that many of

²According to Minnesota Statutes Section 105.37, Subdivision 16, "ordinary high water level" means the boundary of public waters and wetlands, and shall be an elevation delineating the highest water level which has been maintained for a sufficient period of time to leave evidence upon the landscape, commonly that point where the natural vegetation changes from predominantly aquatic to predominantly terrestrial. For watercourses, the ordinary high water level shall be the elevation of the top of the bank of the channel. For reservoirs and flowages the ordinary high water level shall be the operating elevation of the normal summer pool.

the listed geomorphological features may take a long time to develop and also that several sets of these features may be found. That is, a lake likely will have more than one stage where the action of water has left recoverable evidence however only the stage coordinated with the upper limit of a basin are used to assist in identifying the OHW level. As an extreme example, water level stages resulting from the drought years of the 1930's certainly were the result of natural conditions extending over a number of years, but the resulting recoverable evidence is of no use in OHW determinations.

ANTICIPATED FUTURE LAKE LEVELS - PROBABILITIES

The problem facing landowners and government bodies for land-locked lakes is to respond to high water problems when there is no specific formula which tells us exactly when and how much a lake will go up or down. What we have seen so far is that Beebe Lake level fluctuations have been closely related to how much or how little precipitation falls at the lake. Precipitation patterns have historically varied significantly in this area and currently the pattern is on the upswing. No one can predict with certainty whether this will continue into the next six months, year, or five-years, etc.

The probability of different scenarios of future water level conditions can be estimated from historical precipitation data and groundwater and lake level data. The DNR, Division of Waters has used a water budget computer model with a long term series of monthly precipitation to determine probabilities of anticipated lake levels for the end of one and five year periods. Each end of period anticipated level was computed using the specific period or slice of historic precipitation (1 year or 5 years) and the known December 1, 1986 lake level. By using all of the specific periods within the precipitation record, a series of anticipated lake levels is developed and then statistically analyzed to assign probabilities to the range of computed levels.

The in-house water budget computer model "WATBUD" computes net monthly inflow and outflow volumes and then storage routes them through the lake using the previous months lake level for initial conditions. The inflows consist of precipitation and runoff computed from precipitation using a constant coefficient. Outflows consist of evaporation and any discharge from an outlet. A constant monthly groundwater seepage rate may be an inflow or outflow and together with the rainfall-runoff coefficient are used as calibration parameters to provide a balanced water budget.

At Beebe Lake the WATBUD model was calibrated for the period July, 1985 through August, 1986 using monthly precipitation from the St. Cloud and pan evaporation data from Becker. An initial lake level of 968.6' recorded August 27, 1986 was used with monthly time series precipitation data from St. Cloud precipitation record (1893 to 1986) to compute the specific one and five year period anticipated lake level series.

The modeling results indicate that there is a one-percent probability the lake level would rise above elevation 970.6' on December 1, 1987 and a one-percent probability the lake will exceed elevation 973.1' on December 31, 1991. These elevations are still several feet below the ultimate runoff. Conversely, probabilities exist which state the likelihood the lake elevation may fall. There is a one-percent probability the lake may fall below elevation 967.3' by December 1, 1987 and a one-percent probability the lake may fall below elevation 965.7' on December 31, 1991. The modeling results also suggest a 50-percent probability (a 50/50 chance) that the lake will be at elevation 968.7' on December 1, 1987 and 969.5' in approximately 5-years.

The water budget modeling concerned itself with relatively long term periods of total precipitation and did not attempt to determine the impacts of major short duration storm events which occur relatively quickly. A management plan for an area must consider the impact of these storm events because of their severe nature and there is little or no time to react to them.

The probability of lake level increase was also computed for the 24 hour and 10 day duration 100-year storm events. Assuming the same initial condition lake elevation of 968.6', the 100-year 24 hour duration event of 5.7 inches of precipitation would result in a lake level increase of 1.0 foot to elevation 969.6' and the 100-year 10 day runoff of 7.2 inches would result in a lake level increase of 1.8 feet to elevation 970.4'.

POTENTIAL STRUCTURAL DAMAGES

To determine the impact of potential continued increases in water levels, descriptive base data were collected for certain structures along the shoreline of Beebe Lake. These base data were collected in August of 1986, when the lake was at elevation 968.57'. While the potential maximum elevation of Beebe Lake is unknown, it was felt surveying structures within an approximate 5-6' vertical elevation above elevation 968.57' would identify those structures most immediately subject to flood damage.

The example below shows a generic fact sheet that was completed for each structure surveyed. The elevations provided are in Mean Sea Level Datum, 1929 Adjustment, and were determined from instrument surveys. Plate 7 on the following page shows the location of each structure surveyed. Appendix D contains the actual fact sheet for each structure surveyed with a numerical index to match the location map.

EXAMPLE

Structure number : Doe, John
Name : R.R. 1
Address : City, MN 55312

Legal Description: Lake Subdivision
N 1/2, Sec. 24., Twp. 122, R. 29
Lot 2

Floor Elevation : 970.81'
Ground Elevation : 968.40'

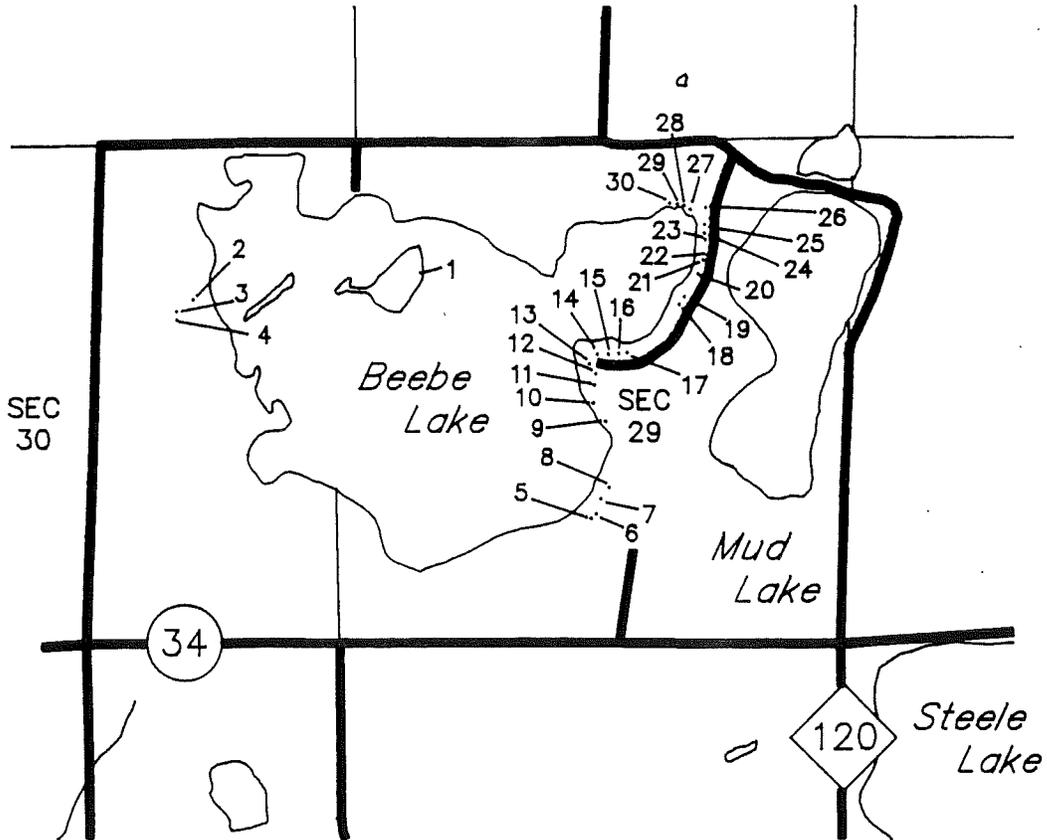
Basement : Yes
Walkout : Yes

Assessed Market Value
Building Value : \$25,300.00
Land : \$15,200.00

Total Value : \$40,500.00

STRUCTURE PHOTO PROVIDED

PLATE 7



DEPARTMENT OF NATURAL RESOURCES

DIVISION OF WATERS



Not to Scale

Potential structural losses for Beebe Lake can be viewed from two different viewpoints:

First - Once water enters a structure (e.g., in the walkout level) for an extended period of time (e.g., over a winter season), the structure has minimal or no monetary value. The rationale being the structure's habitability to the owner is seriously in question and, on the competitive real estate market, the structure would be most likely unsellable. In effect, the structure's useful and economic life has ended. The loss to the landowner would be the structure's fair market value prior to the water entering the structure. Table 2 tabulates the total assessed market values per incremental increase in water levels. The total loss for all newly damaged structures between elevations 968.57' and 976.57' would be \$1,149,198.

Second - The actual loss to the landowner could be viewed as the physical damage to the structure caused by the water. This assumption is premised upon the water receding at some future date and the landowner could fix the damage and re-occupy the structure. Table 2 tabulates the estimated actual damage to each structure by incremental 1' increase in lake levels. At elevation 976.57', an estimated \$1,013,053 of structural damage would occur. The reader is cautioned that the damage figures are taken from generalized assumptions and are applicable for basinwide planning purposes only.

The decision making process to take corrective measures can include the analysis of the degree of risk exposure, the anticipated benefits (losses prevented) and the cost of corrective measures. The data presented thus far should aid landowners and local officials in assessing the degree (probability) of risk exposure. Special reference should be given to the discussion on anticipated future lake levels on pages 15 and 16 and the site specific surveyed elevations found in Appendix D. Basinwide solutions to a given problem (e.g., a lake outlet) often-times are based upon the total dollars worth of anticipated benefits (losses prevented). Table 2 was provided to show the estimated losses which could occur should the lake continue to rise.

Again, potential loss figures provided here were from generalized assumptions and the intent was to not provide exact projected damages for individual structures. Potential damages per individual structure would have to be determined after a site-specific investigation. Pages 27-31 in Part II do provide suggested site specific protection measures and general construction guidelines which could be followed.

Table 2
Potential Increases in Flood Losses
By
Incremental Increases in Water Levels

	Structure Number as Shown on Location Map	Market Value of Building	First Floor Level	Walkout Level	Ground Level at Base of Crawlspace or Basement	Potential Damages/ Row Totals		Potential Damages/ Cumulative Row Totals	
						Market Value	Actual Damages ⁴	Market Value	Actual Damage
Structures below elevation 968.57 ¹ presently flooded ¹	29 27 1	\$20,600 12,400 19,600	973.97 969.25 970.81	966.97 N/A N/A	N/A 967.20 968.40				
New damages between elevations 968.58 and 969.57	No New Structures at this Elevation	N/A	N/A	N/A	N/A	N/A	\$ 20,630	N/A	\$ 20,630
New damages between elevations 969.58 and 970.57	13 ⁵ 17 ⁶ 28	\$47,000 45,000 13,200	974.87 977.20 970.25	N/A 970.20 N/A	967.87 N/A N/A	\$105,200	\$ 33,950	\$105,200	\$ 54,580
New damages between elevations 970.58 and 971.57	19 11 16	\$44,900 75,100 63,000	977.69 971.16 975.10	970.69 N/A N/A	N/A N/A 968.10	\$183,000	\$139,280	\$288,200	\$193,860
New damages between elevations 971.58 and 972.57	18 24 21 6 25	\$59,600 40,800 21,900 59,800 40,400	978.59 978.63 972.20 979.38 979.42	971.59 971.63 N/A 972.38 972.42	N/A N/A N/A N/A N/A	\$222,500	\$ 86,715	\$510,700	\$280,575
New damages between elevations 972.58 and 973.57	22 14 15 10 2 12 3 8	\$59,700 35,100 40,100 52,300 1,166 54,500 1,166 78,200	979.70 979.73 980.03 980.05 973.10 981.10 973.50 980.53	972.70 972.73 973.03 973.05 N/A 973.40 N/A 973.53	N/A N/A N/A N/A N/A N/A N/A N/A	\$322,232	\$176,642	\$832,932	\$457,217
New damages between elevations 973.58 and 974.57	4 20 9 23 30 7	\$ 1,166 34,200 Abandoned 37,800 63,600 61,900	973.70 980.73 973.90 974.07 974.30 981.32	N/A 973.73 N/A N/A N/A 974.32	N/A N/A N/A N/A N/A N/A	\$198,666	\$302,881	\$1,031,598	\$760,098
New damages between elevations 974.58 and 975.57	26	\$50,700	974.92	N/A	N/A	\$ 50,700	\$186,055	\$1,082,298	\$946,153
New damages between elevations 975.58 and 976.57	5	\$66,900	976.00	N/A	N/A	\$ 66,900	\$ 66,900	\$1,149,198	\$1,013,053

¹ Beebe Lake's water surface elevation was 968.57' in August of 1986, which was the time the structure elevation data were collected.

² A) 1986 assessed water value supplied by County Assessor.

³ B) The market values for structures #2, #3 and #4 were obtained by taking the average of the total market value of all three structures.

³ With the exception of #12, the main floor elevation of all other structures was estimated by adding 7' to the walkout floor elevation.

⁴ A) Estimated damage for walkouts followed the recommendations of the National Flood Insurance Program's Loss Adjustment staff by: 1) assuming 20% damages when flood water was up to 1' in depth in a structure; 2) assuming an additional 55% damage when the flood water was greater than 1' in depth but less than the floor level of the main habitable floor; and 3) assuming total damage, or an additional 25% damage, when water reaches the main habitable floor.

B) Estimated damage for crawlspace/basements followed the recommendations of the National Flood Insurance Program's Loss Adjustment staff by: 1) assuming 25% damages when flood water was up to 1' in depth in a structure; and 2) assuming total damage, or an additional 75% damage, when water reaches the main habitable floor.

C) The figures provided do not include the additional costs for removal and disposal of flooded/abandoned structures, providing replacement water supply and waste treatment systems or abandonment of flooded wells according to health department standards. The reader should be cautioned these figures do not include any allowance for contents damage because of the uncertainty whether contents would be removed prior to damage to the structure. If an adjustment is to be made for contents damage, the author recommends a 20% adjustment to each figure provided.

⁵ The basement of structure #13 was estimated at 967.87' by subtracting 7' from the main floor elevation.

⁶ Twenty-five percent additional damages will occur when water enters any structure with a second level above elevation 976.57'. The first structure where this would occur is #17 at elevation 977.20'. See column "First Floor Level".

PART II

FLOOD HAZARD MITIGATION - INTRODUCTION

A broad definition of flood hazard mitigation is those actions taken by individuals and governmental bodies to prevent future flood losses. Prevention of future losses can pertain to existing structures already at risk as well as future development which, if built improperly, will be subject to flood damage. Individual strategies by the landowner should also consider properly insuring oneself against financial, catastrophic loss.

Part II will emphasize those structural and nonstructural hazard mitigation actions which will prevent future losses. These actions will generally include flood insurance, local government land use regulations, lake level control structures (especially state permit requirements) and site-specific flood protection techniques (i.e., flood proofing). There will also be a discussion of: 1) potential non local cost-sharing programs to assist in constructing hazard mitigation measures; and 2) institutional frameworks for implementing these measures.

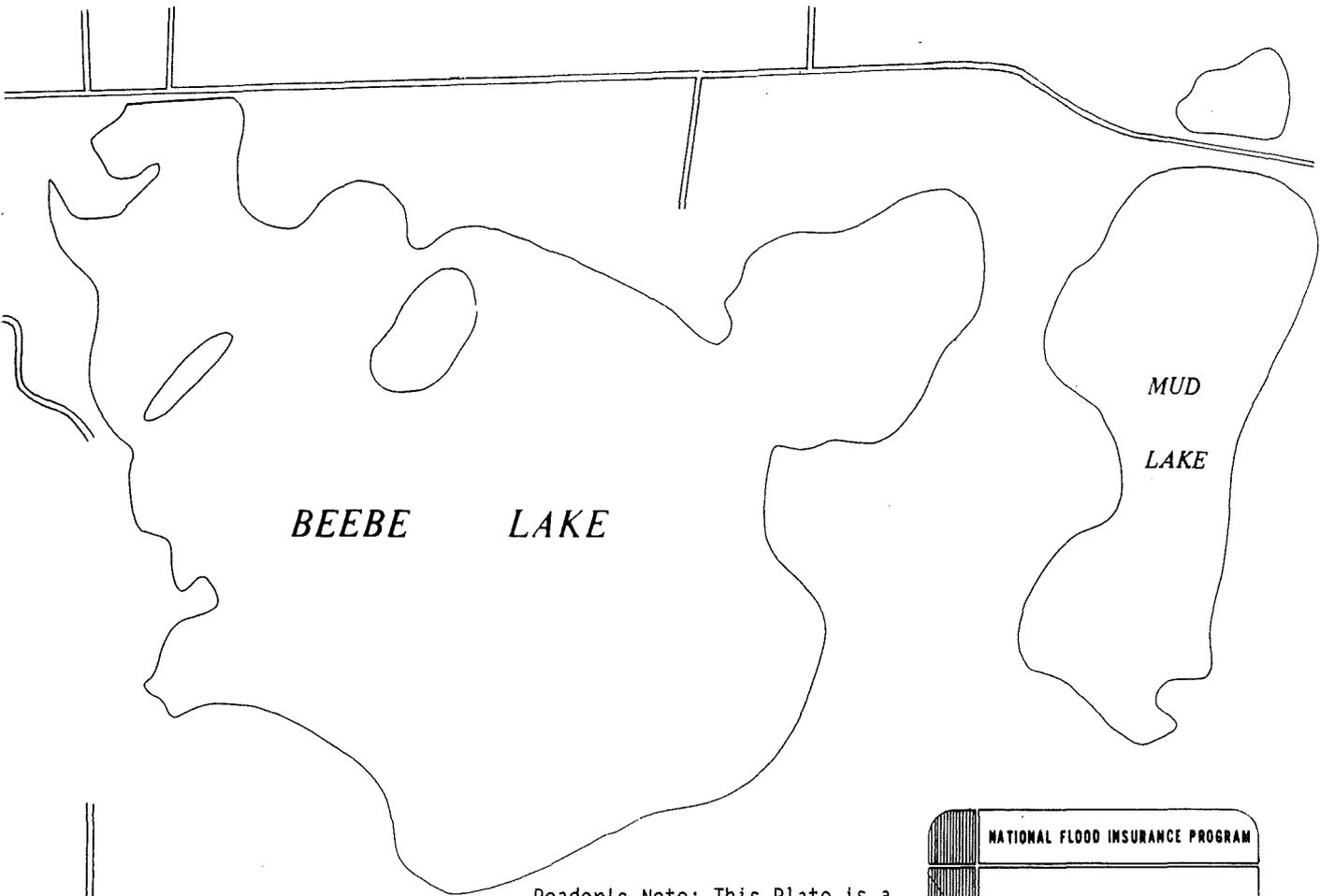
FLOOD INSURANCE

Landowners adjacent to Beebe Lake can purchase flood insurance through Wright County's eligibility in the National Flood Insurance Program (NFIP). Actually, all property owners and renters in the unincorporated areas Wright County can purchase flood insurance regardless of whether or not the property is located in an identified flood hazard area. This latter point must be stressed because a review of Wright County's Flood Insurance Rate Map (Plate 8) indicates a flood hazard delineation has not been provided for Beebe Lake. The significance of a lack of a flood hazard delineation will be discussed in greater detail on Pages 26 and 27 for the discussion on local government land use regulations.

Obviously, the decision to purchase flood insurance will be based primarily on the probability that a structure and/or its contents will be flooded. The decision making process must also take into consideration the provisions of the standard flood insurance policy which identifies amongst other things:

- when losses are covered (i.e., a general condition of flooding exists);
- items covered and not covered;
- removal of a flood damaged structure from a site;
- a "loss in progress" (5-day waiting period); and
- special loss adjustment for continuous lake flooding.

PLATE 8



BEEBE LAKE

MUD LAKE

34

Reader's Note: This Plate is a portion of Wright County's Flood Insurance Rate Map, Panel 33 of 45, dated March 3, 1987, showing the Beebe Lake area. As indicated bottom right, the area is presently Zone C for flood insurance purposes. If a 100-year flood delineation would have been provided, there would have been a dark shaded area shown, labelled as Zone A.

KEY TO MAP

500-Year Flood Boundary	—————	
100-Year Flood Boundary	—————	
Zone Designations* With Date of Identification e.g., 12/2/74		
100-Year Flood Boundary	—————	
500-Year Flood Boundary	—————	
Base Flood Elevation Line With Elevation In Feet**	—————	513
Base Flood Elevation In Feet Where Uniform Within Zone**		(EL 987)
Elevation Reference Mark		RM7x
River Mile		• M1.5

**Referenced to the National Geodetic Vertical Datum of 1929

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

WRIGHT COUNTY,
MINNESOTA
UNINCORPORATED AREAS

PANEL 33 OF 45
(SEE MAP INDEX FOR PANELS NOT PRINTED)

PANEL LOCATION

COMMUNITY-PANEL NUMBER
270534 0033 8

MAP REVISED
PRELIMINARY

MAR 3 1987

Federal Emergency Management Agency

120

Table 3 identifies the amount of flood insurance coverage available via the NFIP. Wright County has been in the Regular Program since March 1, 1979 so, for residential structures, \$185,000 of coverage is available for a structure and 60,000 for contents. Questions pertaining to flood insurance premiums (i.e., costs) should be referred to the NFIP toll-free at 1-800-638-6620. It should be noted that all areas not now mapped as having a flood delineation on the Flood Insurance Rate Map are considered "Zone C" for flood insurance rating purposes. Zone C has the cheapest flood insurance premium costs. The reader is also cautioned that if contents coverage is desired it must be specifically requested.

Table 3

	Emergency Program	Regular Program	
	Total Amount Available Basic Coverage	Addi- tional Limits	Total Coverage Available
Residential Buildings - Single Family	\$35,000	\$150,000	\$185,000
Residential Contents	10,000	50,000	60,000
Other Residential Buildings	100,000	150,000	250,000
Small Business - Buildings	100,000	150,000	250,000
Small Business - Contents	100,000	200,000	300,000
Other Nonresidential Buildings	100,000	100,000	200,000
Other Nonresidential Contents	100,000	100,000	200,000

The most important factors in determining whether flood insurance will cover a loss are:

- 1) Is the water body experiencing a "general condition of flooding"? A general condition of flooding is defined in the standard flood insurance policy as:
 - "A general and temporary condition of partial or complete inundation of normally dry land areas from:
 - a. The overflow of inland or tidal waters;
 - b. The unusual and rapid accumulation or runoff of surface waters from any source;
 - c. Mudslides (i.e., mudflows) which are proximately caused by flood, as defined above and are akin to a river of liquid and flowing mud on the surface of normally dry land areas, as when earth carried by a current of water and deposited along the path of the current.
 - The collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding the cyclical levels which result in flood, as defined above.

-Sewer (drain) backup, which is covered only if it is caused by flood, as defined above."

- 2) Was an insured structure and/or its contents damaged by direct surface water contact during a general condition of flooding?

Land-locked lakes with no outlets do not react to high water like streams/rivers and waterbodies with outlets. The latter, generally go up and down fairly quickly (days or weeks) and there is little question that a general and temporary condition of flooding has occurred. Lakes such as Beebe can increase and decrease in elevation very slowly over a period of years. While the NFIP will judge each land-locked lake with a high water problem individually, a general condition of flooding has been determined to exist on Beebe Lake.

It must be pointed out that a flood insurance policy only covers a structure and its contents. Department of Natural Resource's experience with the NFIP claims adjustment process indicates that surface water must come into direct physical contact with an insured structure during a general condition of flooding before the loss will be eligible for reimbursement. Seepage losses due to water table fluctuations during a general condition of flooding will not be reimbursed. The following is a general description of items covered and not covered (specific questions on coverage should be referred to the above-noted NFIP toll-free number):

A building and its contents may be insured. Almost every type of walled and roofed building that is principally above ground can be insured. In most cases, this includes mobile homes, but not travel trailers or converted buses. Gas and liquid storage tanks, wharves, piers, bulkhead, crops, shrubbery, land, livestock, roads, machinery or equipment in the open and motor vehicles are among the types of property which are not insurable.

There is a 5-day waiting period for a flood insurance policy to take effect. A loss which occurs during the 5-day waiting period after a policy has been taken out is considered a "loss in progress" and will not be covered by the NFIP. This is a critical factor. The reader may wish to refer back to the Part 1, pages 15 and 16 for the discussion on anticipated water surface elevations.

The discussion on anticipated water surface elevations stresses two important facts. First, no one can predict a maximum water surface elevation for Beebe Lake. If the lake should continue to rise, a dampening effect would occur as the lake reaches its runout elevation at elevation 972.60'. If the cause is the lake reacting only to long-term, above normal precipitation, then the assumption would be as the lake rises slowly (e.g., 1-2' per year) a landowner would have sufficient advance warning to purchase flood insurance and meet the 5-day waiting period before a loss occurs.

The second important factor to consider is that Beebe Lake can react quickly to high intensity rainfall events (i.e., the 100-year 24 hour and 100-year, 10-day rainfall events). These high intensity rainfall events do occur randomly over time with little or no advance warning to the landowner. If these rainfall events were to occur, there would likely be insufficient time for a landowner to purchase a flood insurance policy and meet the 5-day waiting period.

The previous section on anticipated lake levels indicates that at a starting lake elevation of 968.60' Beebe Lake would bounce 1.0' upward during a 100-year, 24 hour rainfall event and 1.8' upward to elevation 970.4' for a 100-year, 10-day rainfall event. Landowners should refer to Appendix D which provides actual lowest floor elevations for adjacent shoreland development. It is the author's recommendation that, at a minimum, any landowner with a structure below elevation 973.6' (slightly above runout elevation 972.60') should purchase flood insurance.

The NFIP has recently adopted special provisions to deal with continuous lake flooding situations. These provisions are provided below for the reader's information.

W. Continuous Lake Flooding: Where the insured building has been flooded continuously for 90 days or more by rising lake waters and it appears that a continuation of this flooding will result in damage reimbursable under this policy to the insured building of the building policy limits plus the deductible, the Insurer will pay the Insured the building policy limits without waiting for the further damage to occur if the Insured signs a release agreeing (i) to make no further claim under this policy, (ii) not to seek renewal of this policy, and (iii) not to apply for any flood insurance under the National Flood Insurance Act of 1968, as amended, for property at the property location of the insured building. If the policy term ends before the insured building has been flooded continuously for 90 days, the provisions of this paragraph (W) still apply so long as the first building damage reimbursable under this policy from the continuous flooding occurred before the end of the policy term.

It should also be noted that the DNR has had discussions with the NFIP about whether a flood insurance policy will reimburse a landowner for the cost of removing a damaged structure from a site. Under most situations the answer is yes. A determining factor is that the cost of removal, in combination with the reimbursement for all covered losses, does not exceed the limits of structural coverage. If a landowner is considering purchasing flood insurance, the issue of maintaining additional coverage for removal of a damaged structure should be kept in mind.

A discussion on basement coverage will be provided here because of the number of structures with "walkout" basements adjacent to Beebe Lake. In the early 1980's, the NFIP reduced coverage to basement areas to cover primarily damage only to the structural components (e.g., foundation walls, floors, etc.) and limited contents. There would no longer be coverage for finishing materials on walls and floors and most contents. A basement was defined, though, as a space subgrade on all four sides. Therefore, a walkout basement is not subgrade on all four sides and does not meet the definition of a "basement". The coverage reductions do not apply to structures with walkout lower levels.

This section was intended to provide background information on the NFIP and information relevant to lake flooding situations. Specific questions should be referred to the NFIP. Flood insurance can be purchased through any licensed insurance agent or broker who can write property insurance in Minnesota. Landowners contemplating purchasing flood insurance should locate an insurance agent familiar with the NFIP.

LOCAL GOVERNMENT
LAND USE REGULATIONS

Proper enforcement of land use regulations for new development includes not only new construction but also modifications, additions to and repair of existing construction. Wright County, by virtue of its eligibility in the NFIP, must properly regulate new development in flood prone areas to insure continued eligibility in the NFIP for all citizens in the unincorporated area of the County.

As noted earlier, the current Flood Insurance Map for Wright County does not show a flood delineation (i.e., Zone A) for Beebe Lake. This means that: 1) technically, Wright County does not now have to apply the provisions of its floodplain ordinance to new development bordering Beebe Lake; and 2) the NFIP, while making flood insurance available to property owners, places no minimum development standards to be met by the County when regulating new development on Beebe Lake.

The obvious question is what prudent course of action should Wright County take when regulating new development adjacent to Beebe Lake? Wright County must continue to properly enforce its state-approved shoreland management regulations adopted pursuant to Minnesota Statute, Chapter 105. The basic regulatory components of the County's shoreland regulations relevant to flooding potential on a land-locked basin include:

- The County must specify a lowest floor or flood protection elevation. In the absence of a 100-year flood level, all new structures and additions/modifications. Substantial repairs of existing construction must be elevated with the lowest floor (including basement) to 4' above the highest known water level. The highest recorded water level is at 968.8', and it must be noted that the ordinary high water elevation (OHW) has been established at 969.6'. The ordinary high water level represents a water level that has been maintained in the (historic) past for a sufficient period of time to leave evidence upon the landscape. Therefore, by definition the highest known water level in this particular case must at least be equal to the OHW which has been set at 969.6'. The regulatory elevation for Beebe Lake is then $969.6' + 4' = 973.6'$, NGVD, 1929;
- On-site water supply and sewage treatment systems must be designed so as not to be impaired/contaminated during times of flooding. These systems, at a minimum must be designed to elevation 973.6'; and
- New subdivisions, prior to approval by the County, must be reviewed to insure the area is suitable for the proposed use including a consideration of the potential for flooding. Each newly created lot must have a building site and a location for on-site utilities above elevation 973.6'.

The basic issues as to whether a flood delineation should be added to the County's Flood Insurance Rate Map (FIRM) are essentially three-fold:

- 1) A flood delineation would provide a notification to potential purchasers of existing property that the area is flood prone (and the potential magnitude of the flooding) and that the purchase of flood insurance may be advisable;

- 2) Flood insurance in a mapped Zone A (approximate 100-year floodplain) would be mandatory for all federally insured, financed or regulated mortgages, grants, etc., thus protecting the investment of the public at large. Otherwise, a landowner may default on a mortgage if a non-insured loss were to occur; and
- 3) Would the delineation of an approximate Zone A on the FIRM better facilitate the future regulation of new development adjacent to Beebe Lake?

The latter of the above-noted three issues will be discussed first. It is the Department of Natural Resources' opinion that the County's current shoreland zoning and subdivision regulations will adequately regulate new development on Beebe Lake with the adoption of an elevated road access requirement. New access roads should be elevated to the identified Regulatory Flood Protection Elevation.

The County must assess whether using a elevation 973.6' under its current shoreland regulations is proper long-term strategy for regulating new development. The County should look to the long-term because the economic life of new residential construction extends many decades into the future.

The Department of Natural Resources must point out that the safest course of action would be to establish a Regulatory Flood Protection Elevation at a point above the runout (e.g., elevation 973.6'). The previous section on anticipated water levels indicates that Beebe Lake can bounce (or rise) as much as 2.8' during long periods of above normal precipitation.

The significance of the 2.8' bounce is dependent upon the lake's water surface elevation at the start of the five-year period -- an elevation which cannot be predicted in advance. Although it would appear unlikely that Beebe Lake would be above its OHW at the time a one-percent, five-year rainfall event would occur we know if these two events did coincide significant damages would occur to all development below that level. Again, because of the uncertainty of future water levels the safest course of action is to regulate new development above the runout.

Adding a flood delineation on the County's FIRM would primarily act as a consumer awareness device for potential purchases of property and would also better protect the investment of federal dollars in mortgages, subsidized flood insurance, etc. The County has the authority to properly regulate new development with its current shoreland regulations, in the absence of a flood delineation and the jurisdiction of its floodplain ordinance. Adding a flood delineation on the FIRM would have to be premised on the selection of a flood elevation which best serves the public's interest. The decision will be left to the Federal Emergency Management Agency, with local input.

PROTECTING NEW/EXISTING STRUCTURES

As mentioned in the previous section on local land use regulations, new construction and additions, modifications to and repair of existing structures must be protected against potential flood damage. The minimum protection level pursuant to local shoreland regulations is 972.8'. The Department of Natural Resources strongly encourages a local flood protection level for Beebe Lake of 973.6' at a minimum.

The most prudent method of protecting new and existing development in a potentially long duration flooding event is to elevate the building site on properly compacted fill. The lowest floor (including crawlspaces, basements, and other enclosed areas), must not extend below the identified flood protection level, even if continuous fill is placed around the structure to the identified flood protection level. Standard flood proofing techniques for enclosed spaces below the flood protection level generally are not recommended in flood plains for land-locked basins. This is due to the long duration of flooding and associated saturated soil conditions. Although flood proofing of spaces is generally not recommended when flooding is long-duration, more detailed information is available in the report "Flood Proofing Regulations" which has been adopted into the State Building Code.

Taking emergency action to protect existing development presents a particular problem to the landowner and the community. Because these activities require structural modifications to structures, grading/filling, alteration to shoreline vegetation, etc., a development permit will be required from the local unit of government. The County would review the proposal so as to insure neighboring properties are not affected and the lake resource protection standards are met (e.g., setbacks, flood protection, vegetation removal, etc.)

Plates 9 and 10 provide a number of potential emergency protection measures. The decision to employ any given measure will depend on the site-specific flooding situation. These emergency protection measures are presented here so as to inform the reader of the general design factors which must be considered. The reader is cautioned that an engineer or architect and the local building code official should be consulted prior to the design of emergency flood protection measures.

Except for the following two situations, a landowner may choose the protection level for emergency protection measures.

- 1) A structure has been damaged to 50-percent of its market value at the time of loss and the landowner wishes to repair the damage; or
- 2) The emergency protection measures would equal or exceed 50-percent of the structures market value.

For the two above situations, the structure, at a minimum, must be protected to elevation 972.8' (or to a higher elevation if the County wishes to adopt one).

The reader is requested to pay special attention to the discussion of levees and filling around structures on Plates 9 and 10 on the following pages. Levees are temporary measures and should not be considered as a permanent solution. In no case should a structure protected by a levee be used for human occupancy. This is especially true when the top of the levee is higher than 1-2' above the lowest floor level. A sudden collapse of the levee or overtopping can cause structural failure to the supporting walls, inundating the building with little warning and causing serious damage. All damageable items should be removed from potentially damaged areas and provisions should be made to allow water to enter the building (to equalize water pressure inside and out) should the levee fail.

PLATE 9 FLOOD PROTECTION MEASURES

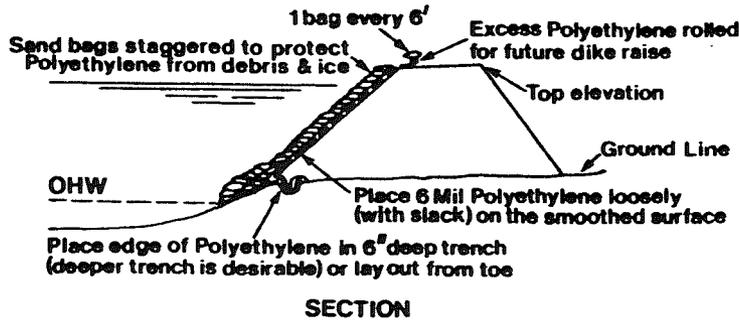
The following information is being presented to stress the importance of following prudent design and permit review procedures prior to installing emergency or permanent protection measures. Design guidelines assisted by a qualified professional are not

only cost effective (e.g., the measure will work as designed and will not be over or under-designed), but protect the investment of the landowner. Community permit review will insure consistency with local land use controls which were designed to avoid haphazard,

unregulated shoreline encroachment that will have adverse impacts on adjoining landowners, long term property values and the lake resource.

TYPE OF PROTECTION

EARTHEN LEVEE



SECTION

GENERAL DESIGN CONSIDERATIONS

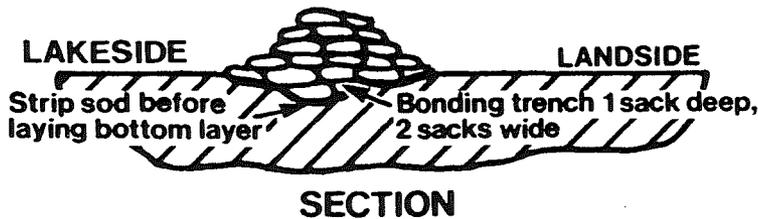
These criteria are guidelines for construction of temporary levees. The criteria are not for permanent protection and not intended for long term exposure to high water.

- Site Preparation: Remove topsoil and vegetation on the foundation of the levee. This material can be stockpiled and used for cover of the levee.
- Construction Materials and Placement: The preferred material is clay as it is relatively impervious if compacted properly. The material should be placed in layers not exceeding 9 inches and compacted with four to six passes of a roller. Impervious material such as sand or sandy-clay can be used. This material requires a flatter side slope than clay. Place material in layers not more than 12 inches, and compact with not less than two passes of a roller.
- Side Slope (minimum):
Clay - 1 vertical on 2½ horizontal
Sand - 1 vertical on 3 horizontal (lakeward)
1 vertical on 5 horizontal (landward)

- Top Width: Clay - 8 feet
Sand - 10 feet
 - Interior Drainage: Pumping will always be required for removal of seepage and rainfall behind the levee. The amount of pumping depends on the foundation soils, the levee material and the drainage area behind the levee.
 - Slope Protection: Protection is needed on the lakeward side of the levee to prevent erosion from wave action. The preferred protection is a layer of rock riprap 12 inches in diameter with a filter underneath (filter cloth, poly sheeting). Protection of the toe of the levee and foundation is critical for areas of high wave action. A second method of protection is reinforced polyethylene sheeting weighted with sandbags.
 - Placement in Water: Construction of earthen levees in water is not recommended. A temporary sandbag levee can be constructed and the area behind pumped. Then the earthen levee can be constructed behind the sandbag levee.
- *Each project should be analyzed and designed by an engineer competent in earthen structure construction.

29

SANDBAGGING



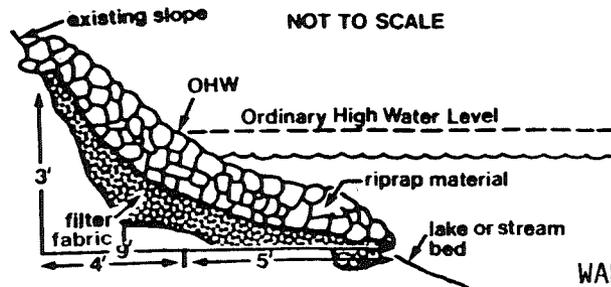
SECTION

A sandbag levee provides temporary protection from short term rises in lake elevations.

- Site Preparation: Remove topsoil and vegetation. Dig a bonding trench to key in the levee to the foundation.
- Construction Materials and Placement: Sand or predominantly sandy or gravelly material should be used. Woven plastic sandbags are preferred if the levee is long term, as burlap bags will deteriorate over time. Bags should be filled ½ full, lapped when placed, and tamped tightly in place. The bags should be staggered when placing to prevent gaps through the levee.
- Cross Section: The base width should be 3 times the height, as a minimum. The top width should be sufficient to add additional bags to raise the levee if needed. A maximum height of 3 feet is recommended.

- Seepage Barrier: Polyethylene sheeting may be incorporated into the lakeward face of the levee to reduce seepage. Placement is similar to placement on an earthen levee.
- Interior Drainage: Pumping will be required for removal of seepage and rainfall behind the levee. Sandbag levees will seep more than earthen levees, as the material is pervious and the cross section is not as wide.
- Placement in Water: If the levee is placed in the water, it is important to monitor the levee for settlement, erosion under the levee and excessive seepage.

RIPRAP: NATURAL SHORELINE OR FILL EMBANKMENT PROTECTION



- Natural rock riprap 12" in diameter or larger
- Finished side slope no steeper than 3:1 (3' horizontal to 1' vertical)
- A transitional layer of filter fabric is required to be placed between the slope or embankment material and the riprap.

WARNING: Fill placed below the Ordinary High Water Level may require a permit.

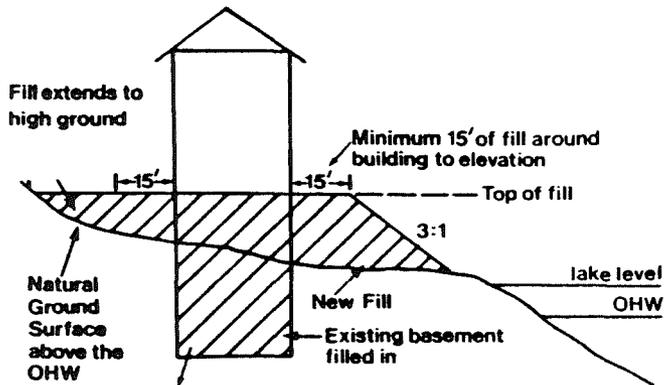
PLATE 10

FLOOD PROTECTION MEASURES

TYPE OF PROTECTION

GENERAL DESIGN CONSIDERATIONS

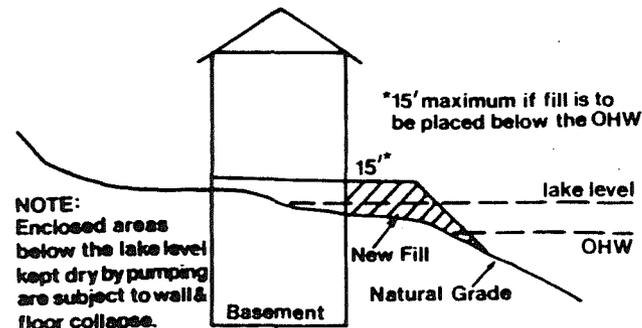
ELEVATED STRUCTURE (PERMANENT)



NOTE: Enclosed areas below the lake level intentionally kept dry by pumping are subject to wall and floor collapse.

- Stabilized fill elevation underneath and 15' around the structure
- Fill selection and placement shall recognize the effects of saturation from flood waters on slope stability, uniform and differential settlement and scour/wave action.
- Fill material would be preferably granular and free-graining, placed in compacted layers.
- The minimum distance from any point of the building perimeter to the top of the edge of the fill slope shall be 15'.
- Side slope sections of fill areas should be anticipated to experience wave action and must be properly riprapped or otherwise protected.
- The area to be filled shall be properly cleared of trees, brush, debris or other growth which the building officials considers unstable as a foundation material.

PERMANENT FILLING AROUND STRUCTURE



NOTE: Enclosed areas below the lake level kept dry by pumping are subject to wall & floor collapse.

- The side slope of the fill area shall be properly protected by a method of protection as outlined above.
- Pumping lower level enclosed areas may result in hydrostatic pressure levels being higher on the outside of the walls as compared to the inside of the walls. This pressure differential can cause walls to collapse or floors to buckle.

WARNING: Fill placed below the Ordinary High Water Level may require a permit.

Secondly, fill could be placed around an existing building to keep surface water away. It is likely that the fill material adjacent to the building will become saturated because of the potentially long duration of the high water and the porosity of the soil. Water pressure will likely build on the outside walls at an elevation equal to the lake level. Any attempt to keep the area inside the building dry by pumping will create differential pressures inside and outside of the building's walls. This could lead to wall and floor collapse and, in no case, should the building be used for human occupancy. A design professional should be consulted prior to pumping the inside of a structure to determine if the structure can tolerate differential pressures against its walls and floors. A safer alternative may be to fill the inside area of the building with granular material (a permanent loss of a lower level) or to allow water to enter into and equalize inside the lower level.

RESOURCE MANAGEMENT -
THE DIRECT ROLE OF THE STATE

The preceding sections in Part II indicate that the federal government plays the primary role in providing flood insurance and local government is actively involved in regulating development adjacent to Beebe Lake. The State, pursuant to Minnesota Statutes Chapter 105, regulates directly those actions affecting the course, current or cross section (i.e., the bed) of public waters and protected wetlands, as defined in Minnesota Statutes Section 105.37, Subd. 14. Beebe Lake has been identified as a public water (Basin 23P) in the Protected Waters Inventory for Wright County and, thus, falls under the jurisdiction of Minnesota Statutes Section 105.42.

A common response to rising lake levels is to: 1) artificially control the lake's level by constructing an outlet or pumping; 2) protecting existing structures by constructing temporary levees, placing fill around structures or elevating structures on-site with fill; and 3) constructing shoreline erosion protection measures. Pursuant to Minnesota Statutes Section 105.42, a state permit is required for the following specific activities below elevation 969.60', the Ordinary High Water Elevation (OHW) for Beebe Lake (this is not an all inclusive list of state permit requirements):

- Any action which would attempt to control the lake to prevent it from returning to its OHW;
- Any fill or obstruction placed below the OHW to protect a structure; or
- Placement of any shoreline protection measure which does not meet the following criteria:

Riprap shall be natural rock 12" in diameter or larger;

The finished side slope shall be no steeper than 3:1 (3' horizontal to 1' vertical);

A transitional zone or layer of gravel, small stone or fabric is placed between the slope or embankment material and the riprap; and

The shore protection measure does not extend more than 5' horizontally lakeward of the OHW.

(Minnesota Statutes Sections 105.41 and/or 105.42).

A DNR permit would be required: 1) to lower the lake below 969.60'; or 2) to control the lake at an elevation above 969.60', when:

- 1) Water is pumped in excess of 10,000 gallons a day or 1,000,000 gallons a year; or
- 2) The OHW of another public water or protected wetland is affected.

State Rules for managing public waters and protected wetlands do allow for controlling a land-locked waterbody up to 1.5' below its OHW when its in the public's interest to do so. State Rules balance the public's interest in protecting a public resource in a natural condition versus a landowner's (or

group of landowners) right to alter a statewide resource to protect existing development. This balancing of interests is paramount for any activity which changes the course, current or cross section of protected wetlands and public waters.

The following statements are excerpts from DNR Rules which address the above-noted "balancing of interests" concept:

Goals, Objectives and Standards

- Maintain natural flow and natural water level conditions to the maximum extent feasible;
- Encourage the construction of small upstream retarding structures for the conservation of waters in natural waterbasins and watercourses consistent with any overall plans for the affected water;
- Limit the artificial manipulation of water levels except where the balance of affected public interest clearly warrants the establishment of appropriate controls and it is not proposed solely to satisfy private interests;
- The project will involve a minimum of encroachment, change or damage to the environment including but not limited to fish and wildlife habitat, navigation, water supply, storm water retention and agricultural uses;
- Adverse effects on the physical and biological character of the waters shall be subject to feasible and practical measures to mitigate the effects;
- Where no natural or artificial outlet exists and the lake is for all practical purposes "landlocked", the control elevation shall not be more than 1½ feet below the ordinary high water mark; and
- Justification has been made of the need in terms of public and private interests and the available alternatives, including the impact on receiving waters and public uses thereof, through a detailed hydrologic study.

Those considering any action which would alter the course, current or cross-section of Beebe Lake should contact the DNR area hydrologist in St. Cloud at: DNR-Division of Waters, 3725 12th Street North, P.O. Box 370, St. Cloud, MN 56302, Phone: (612) 255-4278.

IMPLEMENTING MITIGATION MEASURES/INTRODUCTION

This report up until now has attempted to provide landowners and local government officials with the resource management information necessary to judge which mitigation strategies would be most successful on Beebe Lake. The Department's experience in similar flooding situations indicates that implementation of mitigation strategies is most successful when a local unit of government (i.e., below the level of state and federal government) takes the lead role. The remainder of this report will emphasize: 1) those non-local funding programs which may be available to assist local interests; and 2) institutional arrangements (both governmental and quasi-governmental) which are available to secure funding or direct mitigation strategies.

COST-SHARING ASSISTANCE

This section will give an overview of the non local funding sources that the Department of Natural Resources is aware of and have used to alleviate flooding problems in Minnesota. Some of these funding sources have been used more successfully than others, while potential funding sources (i.e. programs) are still under consideration at the state and federal level.

U.S. Army Corps of Engineers/Flood Control Assistance

The U.S. Army Corps of Engineers has two primary authorities for providing technical and financial assistance for constructing local flood control measures. Flood control measures can consist of "structural" measures, such as levees, dams, lake outlet structures, pumping stations, etc., and "non-structural" measures, such as flood proofing structures, acquisition/relocation of structures, etc. The two primary federal funding authorities are:

- 1) Small Projects - Continuing Authorities Program. This is an ongoing program established by Congress to provide a more timely response to local flood control, erosion and navigational problems. Funding decisions are made directly by the Corps of Engineers through established review procedures without direct congressional approval on a project-by-project basis. By virtue of the small projects connotation, federal financial assistance is limited to \$5,000,000 or less for each project; and
- 2) Congressionally Authorized Projects. The federal government, via the Corps of Engineers, can participate in "large" flood control projects where the federal cost would exceed \$5,000,000. The study and funding mechanism is time consuming and requires direct congressional approval at each stage of each project.

The Small Projects, Continuing Authorities Program has been successful in assisting many Minnesota communities. Two recent successful projects are the Lake Pulaski outlet and the City of Halstad ring levees. At the request of Wright County, the Corps of Engineers is conducting a small projects initial appraisal investigation for flood control on Beebe Lake. This cursory analysis of the flood problem will determine if potential damages warrant further analysis by the federal government.

It must also be noted that all federal assistance will be premised upon an acceptable local sponsor and non-federal cost-sharing. Generally, the local sponsor must provide the lands, easements and rights-of-way necessary to construct the project or approximately 35% of total project, whichever is greater. A political entity must sponsor the project and eventually enter into contractual agreements to insure all guarantees and cost-sharing commitments are met (the reader should refer to the next section on institutional arrangements).

If local interests should desire Corps of Engineers' flood control assistance, a written request should be submitted to: Flood Plain Management and Small Projects, Planning Division, St. Paul District Corps of Engineers, St. Paul, Minnesota 55101-1479. The Corps of Engineers will conduct an initial appraisal and assess federal interest and potential economic feasibility.

SMALL CITIES DEVELOPMENT PROGRAM

The Small Cities Development Program (SCDP) is the state-administered portion of the U.S. Department of Housing and Urban Development Community Block Grant Program. The SCDP is a competitive program for smaller general purpose local units of government to provide a suitable living environment and expanding economic opportunities, primarily for persons of low to moderate income. It must be stressed that the program is competitive and that application requests have traditionally exceeded the grant monies available.

This program is designed to address a broad range of community development needs, including: 1) housing grants to rehabilitate local housing stock; 2) public facilities grants; and 3) comprehensive grants, comprising a combination of housing and public facilities grants or other economic development components. Smaller general purpose local units of government, defined as cities and towns with populations under 50,000 and counties with populations under 200,000 can apply for SCDP grant funds.

The SCDP has been used successfully by a number of Minnesota communities to alleviate flooding problems. Examples include:

- St. Vincent Township, Kittson County: purchase of the right-of-way to construct permanent flood control levees, designed and cost-shared by the Corps of Engineers;
- City of Argyle: acquisition and relocation/demolition of flood prone structures, as part of an overall Corp of Engineers' permanent levee project. Approximately one-dozen structures will be acquired and relocated from the flood plain, as they could not be included within a levee system which will protect the City; and
- City of Austin: acquisition and relocation/demolition of approximately 75 frequently flooded structures.

It should be noted that use of the SCDP appears most probable (i.e., the application becomes more competitive) as the amount of non SCDP matching funds increases. Therefore, it is in the local sponsor's best interest to attempt to package a number of assistance programs if possible. This not only reduces the cost to the sponsoring local government/individual landowners but oftentimes one grant program can be used as offsetting matching funds for another grant program.

The SCDP is administered by the state's Department of Energy and Economic Development. An annual application cycle has been established. Currently, applications are due by the end of January. Potential applicants should contact the Department of Energy and Economic Development immediately so they can be notified of the deadline for submitting future applications. To qualify for funding, an applicant must meet one of the three following federal objectives:

- Benefit low and moderate income people;
- Eliminate slum or blight; or
- Eliminate threats to public health and safety.

Inquiries should be addressed to:

Department of Energy and Economic Development
Division of Community Development
9th Floor, American Center Building
150 East Kellogg Boulevard
St. Paul, Minnesota 55101
Phone: (612) 296-5005

State Assistance Programs

Until the 1987 Legislative Session, there were no ongoing statewide financial assistance programs designed specifically to alleviate flooding problems. Prior to 1987, the state had acted with emergency funds with cost-sharing projects to respond to high water problems. An example was the \$250,000 made available in 1986 by the Governor through the Legislative Advisory Committee. These funds were made available on a competitive basis to respond to ongoing high water problems. As expected, the requests for assistance outweighed the funds available (on the order of 2:1, for projects totalling \$2.3 million).

During the 1987 Legislative Session, the Department of Natural Resources sponsored a bill to cost-share local flood loss reduction programs. As proposed and passed, the State Flood Loss Reduction Act can cost-share up to a 50/50 match with a local government sponsor to implement flood loss mitigation measures (both structural and non-structural). The primary benefit is that increased state funding levels are now available for advance mitigation measures on a priority basis. The legislation would consider funding projects which alleviate lake flooding problems. Application forms will be available from the DNR in November, 1987. Technical guidance will be available to assist in formulating and evaluating damage reduction strategies.

The Standard Flood Insurance Policy

The State of Minnesota has encouraged the National Flood Insurance Program, primarily through the standard flood insurance policy, to fund advance hazard mitigation measures. The thought being that the NFIP will pay for insured losses as structures adjacent to land-locked basins are flooded (many of which sustain severe damage or near total loss). It is reasoned that, with the generally gradual rise of flood waters on land-locked basins and the likelihood

the water will continue to rise, it would be prudent and cost-effective to either relocate a potentially damaged structure from the site or elevate it in place. As the NFIP would be a primary beneficiary of these actions (i.e., reduced insurance payments), the state suggested the NFIP should consider bearing part of the cost for advance mitigation measures.

Unfortunately, the federal legislation for the National Flood Insurance Program prevents federal participation in these advance mitigation measures. This may be short-sighted, but the NFIP by legislation is presently put in a reactionary mode of only being able to pay for eligible, insured losses as they occur. The only ongoing hazard mitigation program currently administered by the Federal Emergency Management Agency is Section 1362 of the Flood Disaster Protection Act of 1973.

The Section 1362 Program, which is strictly a voluntary program, is reactionary in nature because damages must have already occurred prior to the submittal of an application to FEMA. This competitive, nationwide program is designed to acquire and relocate/demolish frequently flooded or severely damaged structures and to return the flood plain to an "open space" nature.

The program is of limited application to lake flooding situations and is too complex to discuss in any great detail in this report. It must be stressed though that only those structures covered with a flood insurance policy at the time of loss are eligible for the program. As mentioned, the program is competitive nationwide where application requests have far outweighed the funds appropriated by Congress. Section 1362 applications become more competitive as matching funds are proposed in the application.

Further information on the FEMA's Section 1362 Program can be secured from:

Federal Emergency Management Agency
175 West Jackson Blvd., 4th Floor
Chicago, Illinois 60604
ATTN: Flood Hazard Mitigation Officer

IMPLEMENTATION AUTHORITIES

The immediately preceding section dealt with non local funding sources for cost-sharing hazard mitigation measures. A focal point of this discussion was that a local sponsoring authority is necessary to enter into formal (contractual) arrangements with potential funding agencies. Generally, aside from the actions of individual landowners, basinwide mitigation strategies require at least one political entity to take the lead role if for no other reason than to secure the necessary funding.

The authorities and obligations for implementing comprehensive or basinwide mitigation strategies (and the securing of local or matching funds) does not lie solely with municipalities or counties, as the case may be for incorporated and unincorporated areas, respectively. State legislation has provided for establishing special purpose quasi-governmental districts or special taxing authorities which may be used for implementing mitigation strategies.

Experience has shown that city and county governments have been willing to take varying degrees of active participation in solving local high water problems. Therefore, the remainder of this section will discuss how existing local authorities, special districts and special taxing authorities can be used for implementing hazard mitigation measures.

Local Government Capabilities

Municipal and county government can: 1) appropriate general funds for hazard mitigation measures; and 2) act as a local sponsoring agency. It is totally at the discretion of the respective governmental body to determine their degree of participation. This is a local matter. The Department of Natural Resource's experience has shown that some governmental bodies have been hesitant to appropriate community-wide funds to benefit a select group of landowners (e.g., landowners in flood prone areas).

To bypass the issues of uniform local tax rates and providing community-wide funds for a select category of landowners, most counties, including Wright County, can establish "subordinate service districts" pursuant to Minnesota Statutes Chapter 375. Subordinate service districts, once established, allow a county to provide additional governmental services only within that service district. Importantly, the revenues to fund these additional government services come only from within the subordinate service district.

Subordinate service districts are initiated either by a resolution of the county board or by petition to the county board signed by ten percent of the qualified voters within the portion of the county proposed for the subordinate service district. The reader should refer to Minnesota Statute, Chapter 375 for a more detailed explanation of subordinate service districts.

Lake Improvement Districts

Pursuant to Minnesota Statutes Chapter 378, a lake improvement district (LID) is a local unit of government established by resolution of the county board. A LID provides the opportunity for greater landowner involvement in lake management activities by actions initiated at the local level of government.

As with the following discussion on the establishment of watershed districts, there is no upper or lower size limit for the area which may be included in a LID. Establishing a LID versus a watershed district is a matter of weighing the pro's and con's of each approach. Each lake improvement district may be delegated different levels of authority by the county board depending upon existing problems and proposed activities. It does allow those [landowners] closest to the situation to directly seek solutions to their problem. A county board may grant powers to LID to, amongst other things:

- Acquire, construct and operate a dam or other lake control structure;
- Undertake research projects;
- Conduct programs of water improvement and conservation;
- Construct and maintain water and sewer systems;
- Serve as local sponsors for state and federal projects or grants; and
- Provide and finance governmental services.

To finance LID projects, services and general administration, a county may:

- Assess costs to benefitted properties;
- Impose service charges;
- Issue general obligation bonds;
- Levy an ad valorem tax solely on property within the LID boundaries; or
- Any combination of the above.

The minimum guidelines and requirements for the formation of a LID are contained in (Minnesota Rules Part 6115.0920 - 6115.0980). These rules provide specific guidance on the content and issues to be addressed by the petition or county board resolution.

Specific questions pertaining to lake improvement districts can be directed to:

Minnesota Department of Natural Resources
Division of Waters
500 Lafayette Road, Box 32
St. Paul, MN 55155-4032
Phone: (612) 296-4800

Watershed Districts

Watershed districts are independent units of government established pursuant to Minnesota Statutes Chapter 112. Watershed districts are initiated following a formal petition to the state's Board of Water and Soil Resources. Once established, watershed districts can have broad powers including (but not limited to):

- Control or alleviation of damage by flood waters;
- Imposition of preventative or remedial measures for the control or alleviation of land and soil erosion and siltation of watercourses or bodies of water affected thereby; and
- Regulating improvements by riparian landowners of the beds, banks and shores of lakes, streams, and marshes by permit or otherwise in order to preserve the same for beneficial use.

Watershed districts are suited to resolving multiple water resource issues over a large area. As noted earlier, there is no upper or lower limit on the geographic area which may be included in a watershed district. Establishment of a watershed district requires development of an overall plan, adoption of formalized rules for operation of business and preparation of yearly reports.

Questions concerning watershed districts should be directed to:

Minnesota Board of Water and Soil Resources
90 W. Plato Blvd.
St. Paul, MN 55107
Phone: (612) 296-2840

APPENDIX A
SOIL TYPES AND CHARACTERISTICS

SOIL SURVEY FOR BEEBE LAKE

MAP SYMBOL	SOIL CLASSIFICATION	% SLOPE
Ba	Beach materials, sandy	
BuD	Burnsville soils	12-18
BuE	Burnsville soils	18-35
ByE	Burnsville-Hayden complex	18-35
Cw	Cordova and Webster silty clay loams	
Dn	Dundas silt loam	
Du	Dundas and Ames silt loam	
Gc	Glencoe silty clay loam	
HaC3	Hayden clay loam	6-12
HaD3	Hayden clay loam, severely eroded	12-18
HdC	Hayden fine sandy loam	6-12
HIB	Hayden loam	2-6
HIB2	Hayden loam, moderately eroded	2-6
HIC	Hayden loam	6-12
HIC2	Hayden loam, moderately eroded	6-12
HID	Hayden loam	12-18
HID2	Hayden loam, moderately eroded	12-18
HIE	Hayden loam	12-25
HIF	Hayden loam	12-35
HnE3	Hayden soils, severely eroded	18-25
Lb	Lake borders	
LuA	Le Sueur clay loam	0-2
Mh	Marsh	0-1
Mu	Muck, deep	0-2
NeB	Nessel silt loam	2-6
Pa	Peat and muck, deep	0-1
Pm	Peat and Muck, shallow over loam	0-1
TsB	Terril soils	2-6

SOIL SURVEY FOR BEEBE LAKE - WRIGHT COUNTY

Beach Materials, Sandy

Beach materials, sandy (0 to 6 percent slopes) (Ba) consists of sandy beaches that surround present lakes and the beds of former lakes. The areas vary in width. In places the sandy deposits are on low, narrow ridges or bars that have been pushed up by ice some distance back from the present margin of the lakes.

The soil material that makes up this land type varies, but it generally is dark colored to moderately dark colored coarse sand or loamy coarse sand and lacks distinct layers. The water table generally is high; its height depends on the season and closeness of the area to a lake. During years when precipitation is high, many areas are submerged. Reaction ranges from slightly alkaline to slightly acid.

This land type generally is low in fertility. Few areas are cropped. The vegetation is sparse stands of grass and willow.

Burnsville soils, 12 to 18 percent slopes (BuD).

The soils in this mapping unit generally have short, irregular slopes. Much of the acreage is in pasture or woods, and here the soil profile is similar to that described for the series. In cropped areas, however, the soils have lost from one-fourth to three-fourths of their original surface soil through erosion. In these areas the present plow layer is a mixture of grayish-brown sandy loam or loam formerly in the surface soil and brownish, finer textured material formerly in the subsoil. Depth to sand and gravel ranges from 10 to 20 inches, but in cropped areas small spots of gravel generally are on the surface.

Because of the slope, the erosion hazard on these soils is severe. In addition low moisture-storage capacity makes the soils droughty. These soils therefore are not suited to crops and are poor for pasture.

Burnsville soils, 18 to 36 percent slopes (BuE).

The soils in this mapping unit are on hills and ridges and the sides of ravines. Most of the acreage is in pasture or woods, and here the profile is like that described for the series. In areas cropped or overgrazed, the soils have lost as much as three-fourths of the original surface soil through erosion. Depth to sand and gravel ranges from 10 to 16 inches.

The slopes, shallowness of the soils over sand and gravel and the severe hazards of erosion and drought make these soils unsuited to crops and poor for pasture. The areas are best kept under a permanent cover of vegetation. Careful management is also needed.

Burnsville-Hayden complex, 18 to 36 percent slopes (ByE).

Soils in this complex are mostly on hills and ridges and in ravines. About 70 percent of this complex is Burnsville soils, and the remaining 30 percent is Hayden fine sandy loam and loam. Most of the acreage is in pasture or woods. Areas cropped or overgrazed have lost as much as three-fourths of their original surface soil through erosion.

The hazards of erosion and drought are severe on soils of this complex. It is best to keep a permanent cover of vegetation on the areas. Careful management is also needed.

Cordova and Webster silty clay loams (0 to 2 percent slopes) (Cw).

This mapping unit is in nearly level areas and in shallow drainageways. The Cordova soil is the most extensive and occupies most of the nearly level, broad areas.

Included with these soils in mapping are some small areas of Glencoe soils in depressions.

These Cordova and Webster soils require drainage for economic yields. If these soils are drained and kept in good tilth, yields of corn and soybeans are good. The soils are also suitable for small grains and pasture.

Dundas silt loam (0 to 3 percent slopes) (Dn).

This soil is in areas that have slight rises and shallow depressions.

Included with this soil are some small areas of Glencoe soils in deeper depressions.

This Dundas soil is fair to good for crops and good for pasture, but wetness is a problem. Artificial drainage is needed, though water moves slowly through the fine-textured subsoil and hinders drainage. Special practices are needed to improve the efficiency of drainage systems and to produce good yields.

Dundas and Ames silt loams (0 to 3 percent slopes) (Du).

This mapping unit is mostly in the northeastern part of the country. The soils are nearly level, and the areas have many low ridges and shallow depressions.

Dundas soil makes up more than 60 percent of this mapping unit. In plowed areas the surface layer of both soils is grayish in color.

Included with these soils in mapping are small wet areas of Glencoe soils in depressions.

These Dundas and Ames soils are fair to good for crops and good for pasture, but wetness is a problem. Artificial drainage is needed, though water moves slowly through the fine-textured subsoil and hinders drainage. Special cropping practices are needed to improve the efficiency of drainage systems and to produce good yields.

Glencoe silty clay loam (0 to 2 percent slopes) (Gc).

This is the only Glencoe soil mapped in the county. It is in depressions and drainageways.

Included with this soil are a few areas of a soil that has a calcareous surface soil.

Excess water severely limits use of this Glencoe soil. Undrained areas are poor for wild hay or pasture, and artificial drainage is necessary if this soil is cropped. Drained areas are good for corn and soybeans, but crops on them are susceptible to damage by frost.

Hayden clay loam, 6 to 12 percent slopes, severely eroded (HaC3).

This soil has lost nearly all of its original surface soil through erosion. The present plow layer is a brownish clay loam and consists mostly of material formerly in the subsoil. Depth to limy underlying material generally is about 30 inches. In a few places small gullies occur.

Because of erosion the content of organic matter in this soil is low, and thus infiltration of water is reduced and the supply of moisture lowered. In years of low rainfall this soil therefore is likely to be droughty. This soil also is in poor tilth, and cultivating it and preparing a seedbed in it is difficult.

This soil is poor for crops but is fair for pasture. It is subject to further erosion, and it therefore is not suitable for continuous cultivation.

Hayden clay loam, 12 to 18 percent slopes, severely eroded (HaD3).

This soil has lost nearly all of its original surface soil through erosion. The present plow layer is brownish clay loam and consists mostly of material that formerly was in the subsoil. Depth to limy underlying material is 24 to 36 inches. In places there are a few small gullies.

Mapped with this soil are a few areas of a soil where the plow layer is sandy clay loam and contains small pockets of sand. Also included are small areas of Glencoe and Webster soils in depressions in between complex slopes.

Because of erosion the content of organic matter in this Hayden soil is low, and thus infiltration of moisture is reduced and the supply of moisture is lowered. In years of low rainfall, this soil therefore is likely to be slightly droughty. This soil also is in poor tilth. Crusting makes it difficult to cultivate the soil and to prepare a seedbed. The hazard of further erosion is very severe.

This soil is not suitable for cultivation. It is best kept under a permanent cover of vegetation.

Hayden fine sandy loam, 6 to 12 percent slopes (HdC).

Most of this soil is in woods or pasture. Slopes generally are short and irregular. The subsoil is more sandy in the upper part than that in the profile described for the series.

Mapped with this soil are small areas that have a surface soil of sand and gravel and a finer textured subsoil. In areas where the slopes are very complex are small areas of Webster or Glencoe soils in depressions between the slopes.

This Hayden soil is fair for crops and pasture. It is slightly droughty, but if it is well managed, yields are good. Because this soil is sandy and has strong slopes, it is subject to severe erosion.

Hayden loam, 2 to 6 percent slopes (HIB).

The profile of this soil is similar to the one described for the series. The slopes generally are gently undulating. In places, however, the slopes are irregular, and in these there are small areas of moderately well drained and poorly drained soils in depressions between the slopes.

If this Hayden soils is well managed, it is good for crops and pasture. The slopes are mild, but the soil is subject to erosion and practices are needed for control of erosion.

Hayden loam, 2 to 6 percent slopes, moderately eroded (HIB2).

This soil generally has short, irregular slopes. From 3 to 6 inches of the original surface soils has been lost through erosion. The present plow layer is a mixture of dark grayish-brown material from the remaining surface soil and of brownish, finer textured material from the subsoil. Mapped with this soil, in areas where the slopes are complex, are small poorly drained soils in depressions between the slopes.

If this Hayden soil is well managed, it is good for crops and pasture. The hazard of further erosion is moderate.

Hayden loam, 6 to 12 percent slopes (HIC).

This soil generally has short, irregular slopes. Most areas are in woods or pasture or in places that have been cleared recently and put in crops.

Mapped with this soil are small areas of Webster or Glencoe soils in depressions between complex slopes.

This Hayden soil is good for crops and pasture. Because of the slopes, however, the hazard of erosion is severe if this soils is cropped.

Hayden loam, 6 to 12 percent slopes, moderately eroded (HIC2).

This soil has lost from 3 to 6 inches of its original surface soil through erosion. The present plow layer is grayish brown and consists of a mixture of loam from the remaining surface soil and of finer textured material that formerly was in the subsoil.

Mapped with this soil are small areas of Glencoe and Webster soils in depressions between irregular slopes.

Because of erosion the content of organic matter in this Hayden soil is low. As a result the soil is in poor tilth and productivity is lowered. This soil tends to crust, which slows penetration of water into the soil. Also, if this soil is cultivated and not protected, the hazard of further erosion is severe.

This soil is good for crops and pasture. Good management is needed for increase yields.

Hayden loam, 12 to 18 percent slopes (HID).

Most of this soil is in woods or pasture. It is 30 to 36 inches deep over limy underlying material. Runoff is greater than on less sloping soils. Consequently, though the capacity for storing moisture is fairly high, crops are likely to be damaged by lack of moisture during periods of low rainfall.

Mapped with this soil are small areas of Glencoe and Webster soils in depressions between irregular slopes.

This Hayden soil is fair for crops and good for pasture. The hazard of erosion is severe and limits suitability of the soil for crops. Intensive practices are needed to prevent further erosion.

Hayden loam, 12 to 18 percent slopes, moderately eroded (HID2).

This soil has lost from 3 to 6 inches of its original surface soil through erosion. Plowing has mixed dark grayish-brown material from the remaining surface soil with brownish, finer textured material from the subsoil to form the present plow layer. Depth to limy underlying material is 24 to 36 inches.

Mapped with this soil are small areas of Glencoe and Webster soils in depressions between irregular slopes.

The content of organic matter is low in this Hayden soil. As a result the soil is in poor tilth and tends to crust. Runoff is rapid, and crops are likely to be damaged from lack of moisture in dry periods.

This soil is fair to poor for crops and good for pasture. The severe hazard of erosion limits suitability for crops. Intensive practices are needed to prevent further erosion.

Hayden loam, 18 to 25 percent slopes (HIE).

This soil generally is about 24 to 36 inches over limy underlying material. Areas in woods or pasture are little eroded, but cropped areas have lost 3 to 6 inches of their original surface soil through erosion.

Mapped with this soil are several areas in which the surface soil is fine sandy loam. Also included are small areas of Glencoe and Webster soils in depressions between complex slopes.

Because of the slopes, the hazard of erosion on this Hayden soil is severe. Use of this soil for crops is therefore limited. This soil generally is not suited to tilled crops, but it is good for hay or pasture if well managed.

Hayden loam, 25 to 35 percent slopes (HIF).

This soil is on hills, ridges, and sides of ravines. The areas are mostly in woods or pasture. Cropped areas have lost from 3 to 6 inches of the original surface soil through erosion. Depth to limy underlying material is 24 to 36 inches.

Mapped with this soil are a few areas in which the surface soil is fine sandy loam. Also included are small areas of Glencoe and Webster soils in depressions between complex slopes.

Runoff is very rapid on this Hayden soil, and the hazard of erosion is severe. In periods of low rainfall, pastures dry up. This soil should never be tilled. It is best to keep the areas under a permanent cover of vegetation. Careful management also is needed.

Hayden soils, 18 to 25 percent slopes, severely eroded (HnE3).

These soils have lost nearly all of their original surface soil through erosion. The present plow layer is brownish in color and is mostly clay loam that formerly was in the subsoil. Depth to limy underlying material is 24 to 36 inches. Gullies occur in places.

Mapped with this soil are small areas of Glencoe and Webster soils in depressions between complex slopes.

The content of organic matter in this Hayden soil is low, and tilth is therefore poor. Runoff is rapid, and the hazard of further erosion is severe. Establishing a seedbed and maintaining a cover of vegetation on this soil is difficult. Consequently this soil is not suitable for cultivation. It is best to keep a permanent cover of vegetable on the areas and severely restrict use.

Lake Borders

Lake borders (0 to 5 percent slopes) (Lb) consists of wet, silty soil material around present lakes and the borders of former lakes. The soil material lacks distinct layers. In some places a thin layer of peat or muck overlies the surface. Most areas are nearly level, but because of gradual lowering of the level of the lakes during the time the material was deposited, some slopes are as much as 5 percent. Areas near present lakes are sometimes submerged during periods when the water level is high. The native vegetation was slough grass, sedges, reeds, and willows. The material in this land type is finer textured than that of Beach materials, sandy.

Lake borders has high fertility and moisture-supplying capacity. The soil material ranges from mildly alkaline to medium alkaline. Areas that are protected from overflow and adequately drained produce good yields of corn and soybeans. Undrained areas are poor for pasture.

Le Sueur clay loam, 0 to 2 percent slopes (LuA).

The profile of this soil is similar to the one described for the series. In some places there are small areas in which the soil is poorly drained.

This soil is productive and has few limitations to use. Row crops can be grown on it intensively under good management. It also is good for pasture, but its value for crops is greater.

Marsh

Marsh (0 to 1 percent slopes) (Mh) is in shallow lakes and ponds that are dry in places during years when precipitation is less than normal. A few areas have been drained. Most areas, however, are wet the year round. The vegetation consists of cattails, rushes, sedges, and other plants that tolerate wetness. The soil material is too wet to be classified.

Marsh is excellent for wildlife. The areas are poor for pasture, but wild hay can be cut in places along the edges of some marshy areas. If areas of Marsh were artificially drained, they could be used for crops and would be managed much the same as the Peat and mucks or as the Glencoe soils.

Muck, Deep

Muck, deep (0 to 2 percent slopes) (Mu) consists of very poorly drained, organic material made up of well-decomposed vegetation. It is in low wet areas along the edges of present lakes and ponds and bottom lands of streams, and also is in old lake bottoms.

The soil material is black to very dark brown in color. It is well decomposed.

Muck, deep, ranges from 12 inches to more than 12 feet in depth, but in most places it is about 3 to 6 feet deep. The underlying material generally is olive gray and silty, but in places it is sand. The soil material is slightly acid to slightly alkaline. Fertility is moderate, and the water-supplying capacity is high.

Undrained areas are seasonally ponded, and have marsh grasses, reeds, and sedges growing on them. Artificial drainage is necessary before the areas can be cropped. Wetness severely limits use.

Undrained areas of Muck, deep, are poor for pasture but provide some wild hay. If adequately drained and properly fertilized, Muck, deep, produces good yields of row crops and truck crops in favorable years. In some years, however, crops are seriously damaged by summer frost.

Nessel silt loam, 2 to 6 percent slopes (NeB).

The profile of this soil is similar to the one described for the series. In cultivated areas the plow layer is dark grayish brown. In a few areas the surface soil is loam. Small, wet depressions occupy a few areas.

Slopes are mild, but this soil is nevertheless subject to erosion. It is good for crops and pasture, and yields are good under good management.

Peat and muck, deep (0 to 1 percent slopes) (Pa).

This mapping unit is in wet, depressional areas throughout the county, but the largest areas are bogs in old lake bottoms. It consists of deposits of peat or muck that generally are 3½ to about 7 feet thick, but that are more than 20 feet thick in places. These deposits are underlain by material that ranges from silty clay to sand and gravel in texture.

Most areas of this mapping unit are wet and marshy part of the year, but they ordinarily dry out by midsummer. The areas are poor for pasture and hay, and drainage is needed if crops are grown. Large amounts of fertilizer that contains phosphate and potash are also needed. If this soil is adequately drained and properly fertilized, yields of corn and truck crops are good in favorable years. In some years crops are damaged severely by summer frost.

Peat and muck, shallow over loam (0 to 1 percent slopes) (Pm).

This mapping unit is in depressions and drainageways throughout the upland. It consists of deposits of peat or muck that are 1 to 3½ feet thick. These deposits are underlain by olive-gray loam to clay loam. Most of the peat is quite raw, but in areas that have been drained and cultivated the peat is more decomposed. In some areas a thin layer of mineral soil washed from nearby slopes covers the areas.

Artificial drainage is needed before this mapping unit is used for crops. If the soil is adequately drained and fertilized, yields of corn and truck crops are good in favorable years. In some years, however, crops are likely to be damaged by summer frost. Undrained areas are fair for pasture and hay.

Terril soils, 2 to 6 percent slopes (TsB).

This mapping unit occupies gentle slopes below steeper soils. In some areas small amounts of sandy material overlies overwash of finer texture, but otherwise the profile is similar to the one described for the series.

These soils are subject to moderate erosion. Nevertheless yields of crops and pasture are good under good management.

For more detailed information, see the Soil Conservation Service Soil Survey of Wright County, Minnesota data June, 1968.

APPENDIX B

BACKGROUND DATA ON WATER QUALITY, FISH
AND WILDLIFE AND DEVELOPMENT HISTORY

86-0023
 45 10 00 0 093 45 00.0 J
 LAKE: BEEBE 3 MI W OF HANOVER
 27171 MINNESOTA WRIGHT
 AREA: 127.5 HECTARE B 070318
 MEAN DEPTH: - M MAX DEPTH: 8.2 M
 21MINNL 800412 07010204 HQ
 0000 FEET DEPTH

/TYPA/AMBNT/LAKE
 INDEX
 MILES

INITIAL DATE	INITIAL TIME	MEDIUM	DEPTH-FT(SMK)	IDENT	NUMBER	76/06/05	76/06/12	76/06/19	76/06/26	76/07/03	76/07/10	76/07/17	76/07/24	76/07/31
00029	00078	FIELD	TRANSP	SECCHI	METERS	200	200	200	200	200	200	200	200	200
						1.07	1.07	1.07	1.07	.76	.76	.76	.76	.76

INITIAL DATE	INITIAL TIME	MEDIUM	DEPTH-FT(SMK)	IDENT	NUMBER	76/08/07	76/08/14	76/08/21	76/08/28	76/09/04	76/09/11	76/09/18	76/09/25	78/06/05
00029	00078	FIELD	TRANSP	SECCHI	METERS	200	200	200	200	200	200	200	200	201
						.76	.76	.76	.76	.76	.76	.76	.61	1.22

INITIAL DATE	INITIAL TIME	MEDIUM	DEPTH-FT(SMK)	IDENT	NUMBER	78/06/12	78/06/19	78/06/26	78/07/03	78/07/10	78/07/17	78/07/24	78/07/31	78/08/07
00029	00078	FIELD	TRANSP	SECCHI	METERS	201	201	201	201	201	201	201	201	201
						1.07	.91	.76	1.68	1.83	1.52	1.37	1.07	.91

INITIAL DATE	INITIAL TIME	MEDIUM	DEPTH-FT(SMK)	IDENT	NUMBER	78/08/14	78/08/21	78/08/28	79/07/13	79/09/09	80/06/01	80/06/16	80/06/22	80/06/30
00005	00008	VSAMPLOC	LAB	IDENT	% OF TOT	0	0	0	0	0	0	0	0	0
00029	00078	FIELD	TRANSP	SECCHI	METERS	201	201	201	123107	123396	202	202	202	202
00080	00625	COLOR	TOT KJEL	PT-CO	UNITS	.76	.76	.91	20	20	2.74	1.68	1.22	1.07
00665	74041	PHOS-TOT	WQF	SAMPLE	MG/L P UPDATED				1.000J	2.100J				
									.027	.159	870131	870131	870131	870131

INITIAL DATE	INITIAL TIME	MEDIUM	DEPTH-FT(SMK)	IDENT	NUMBER	80/07/09	80/07/14	80/07/20	80/07/30	80/08/05	80/08/10	80/08/19	80/08/27	81/06/03
00008	00029	LAB	FIELD	IDENT	NUMBER	0	0	123699	0	0	0	0	0	0002
00078	00080	TRANSP	COLOR	SECCHI	METERS	1.07	1.07	.91	.76	1.07	1.22	.76	.76	8.00
00098	00625	VSAMPLOC	TOT KJEL	PT-CO	UNITS			20	20	5K	5K	5K	5K	
00665	74041	PHOS-TOT	WQF	SAMPLE	MG/L P UPDATED			2.390J	.120	1.840J	1.104J	2.040J	.109	
						870131	870131	870213	870131	870131	870213	870213	870131	

INITIAL DATE	INITIAL TIME	MEDIUM	DEPTH-FT(SMK)	IDENT	NUMBER	81/06/10	81/06/18	81/06/23	81/06/29	81/06/29	81/06/29	81/06/29	81/06/29	81/06/29
00008	00010	LAB	WATER	TEMP	CENT	0	0	0	0	3	6	9	13	16
00011	00029	WATER	FIELD	TEMP	FAHN				129278	21.0	20.5	20.5	20.5	19.5
00078	00080	TRANSP	COLOR	SECCHI	METERS	8.00	6.50	6.50	69.8\$	69.8\$	68.9\$	68.9\$	68.9\$	67.1\$
00098	00300	VSAMPLOC	DO	DEPTH	METERS				10	10.5	2.00	3.00	4.00	5.00
00301	00403	DO	PH	SATUR	PERCENT				116.7\$	116.7\$	108.7\$	106.5\$	106.5\$	57.4\$
00410	00605	T ALK	ORG N	CACO3	N				7.8	140	1.410	.240	.006\$.006\$
00612	00619	NH3+NH4-	NH3-N	NH3-NH3	MG/L				1.650	.01K	.001	.001	.001	.06K
00625	00630	TOT KJEL	NO2&NO3	N-TOTAL	MG/L P				83.00					
00665	32211	PHOS-TOT	CHLRPHYL	A UG/L	CORRECTD				.06K					
32218	81903	PHEOPHTN	DPTH BOT	A	FEET				21.0					

STORET RETRIEVAL DATE 87/05/26

PGM=ALLPARM

PAGE: 10

86-0023
 45 10 00 0 093 45 00.0 3
 LAKE: BEEBE 3 MI W OF HANOVER
 27171 MINNESOTA WRIGHT
 AREA: 127.5 HECTARE B 070318
 MEAN DEPTH: - M MAX DEPTH: 8.2 M
 21MINNL 800412 07010204 HQ
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/TYPA/AMBT/LAKE

INDEX
 MILES

INITIAL DATE	INITIAL TIME	MEDIUM	DEPTH-FT(SMK)	IDENT	NUMBER	81/07/01	81/07/06	81/07/08	81/07/14	81/07/16	81/07/22	81/07/30	81/08/19	81/08/20
00008	LAB					0002	0001	0002	1300	0002	0002	1130	0002	1030
00029	FIELD					WATER								
00078	TRANSP	SECCHI				0	0	0	0	0	0	0	0	0
00080	COLOR	PT-CO					123641							
00625	TOT KJEL	N				202	201	202	203	202	202	203	202	203
00665	PHOS-TOT	MG/L P				5.50		4.00	.76	1.50	1.50	.91	1.50	.76
							25							
							2.280J							
							.104							
INITIAL DATE	INITIAL TIME	MEDIUM	DEPTH-FT(SMK)	IDENT	NUMBER	81/08/27	81/09/03	81/09/08	82/05/27	82/06/10	82/06/25	82/07/08	82/07/21	82/08/18
00029	FIELD					0002	0002	0002	1425	1300	0915	1540	0945	0930
00078	TRANSP	SECCHI				WATER								
						0	0	0	0	0	0	0	0	0
						202	202	202	203	203	203	203	203	203
						1.50	2.00	2.00	2.29	1.52	1.37	.76	.76	.61
INITIAL DATE	INITIAL TIME	MEDIUM	DEPTH-FT(SMK)	IDENT	NUMBER	82/08/31	82/09/15	83/06/03	83/06/28	83/07/20	83/08/10	83/09/01	84/06/13	84/07/06
00029	FIELD					1045	1615		1115	0930	0930		0003	0003
00078	TRANSP	SECCHI				WATER								
						0	0	0	0	0	0	0	0	0
						203	203	203	203	203	203	203	203	203
						.61	.76	2.90	1.07	.91	.76	.61	3.05	1.37
INITIAL DATE	INITIAL TIME	MEDIUM	DEPTH-FT(SMK)	IDENT	NUMBER	84/07/26	84/08/14	84/09/11	85/05/22	85/06/12	85/07/01	85/07/22	85/08/13	85/09/03
00029	FIELD					1100	1215	1235						
00078	TRANSP	SECCHI				WATER								
						0	0	0	0	0	0	0	0	0
						203	203	203	203	203	203	203	203	203
						.61	.69	1.07	3.05	1.07	.61	.61	.91	.61
INITIAL DATE	INITIAL TIME	MEDIUM	DEPTH-FT(SMK)	IDENT	NUMBER	86/05/27								
00029	FIELD					1230								
00078	TRANSP	SECCHI				WATER								
						0								
						203								
						4 11								
74041	WQF	SAMPLE				870108								

PIC DATA

PHYSICAL CHARACTERISTICS FOR LAKE: BEEBE

Lake Type: Panfish Lake
Dominant Forest/Soil Type: DECID/SAND
Size of Lake: 315 Acres
Maximum Depth: 27.0
Shorelength: 3.7 Miles
Median Depth: 15.0

Secchi Disk Reading (water clarity): 3.7 feet
Lake Contour Map Number: D0237 (available at cost from Documents Division)
(Phone: (612) 297-3000)

DEVELOPMENT CHARACTERISTICS FOR LAKE: BEEBE

Shoreland Zoning Classification: Recreational Development
Public Accesses in 1983: 1

<u>Development</u>	<u>Seasonal Homes</u>	<u>Permanent Homes</u>	<u>Total Homes</u>
1967	19	22	41
1982	18	51	69

DNR SECTION OF FISHERIES INFORMATION FOR LAKE BEEBE

Water Chemistry Survey Date: 7/12/1982

Water Color: Green
Cause of Water Color: Algae
Secchi Disk: 2.0
% Littoral: 45

Lake Description

Surface Water Area: 300
Management Class: CENTRARCHID
Ecological Type: CENTRARCHID

Accessibility: State owned access in Section 29 on north side of lake.

Area Fisheries Supervisor: Paul Diedrich
P.O. Box 158
Montrose, MN 55363
(612) 675-3301

NET CATCH DATA

GILL NETS

No. of sets: 6

Gill net survey date: 7/12/1982

<u>Species</u>	<u># Fish</u>	<u># Per Set</u>	<u>Total Pounds</u>	<u>Pounds Per Set</u>
White Sucker	12	2.0	25.30	4.22
Golden Shiner	6	1.0	0.40	0.07
Black Bullhead	143	23.8	92.50	15.42
Yellow Bullhead	18	3.0	9.80	1.63
Northern Pike	17	2.8	92.50	15.42
Yellow Perch	758	126.3	83.80	13.97
Walleye	12	2.0	50.00	8.33
Pumpkinseed Sunfish	1	0.2	0.00	0.00
White Crappie	19	3.2	4.80	0.80
Black Crappie	174	29.0	37.70	6.28

TRAP NETS

No. of sets: 6

Trap survey date: 7/12/1982

<u>Species</u>	<u># Fish</u>	<u># Per Set</u>	<u>Total Pounds</u>	<u>Pounds Per Set</u>
Carp	5	0.8	45.50	7.58
Golden Shiner	1	0.2	0.10	0.02
Black Bullhead	21	3.5	14.70	2.45
Yellow Bullhead	103	17.2	71.00	11.83
Northern Pike	1	0.2	1.00	0.17
Yellow Perch	22	3.7	2.10	0.35
Largemouth Bass	18	3.0	6.30	1.05
Pumpkinseed Sunfish	141	23.5	26.60	4.43
Bluegill Sunfish	338	56.3	72.00	12.00
White Crappie	52	8.7	14.80	2.47
Black Crappie	873	145.5	217.00	36.17
Hybrid Sunfish	8	1.3	1.60	0.27

FISH STOCKING DATA

<u>Year</u>	<u>Species</u>	<u>Size</u>	<u># Released</u>
1970	Northern Pike	FINGERLING	8,000
1971	Northern Pike	FINGERLING	10,000
1972	Northern Pike	FINGERLING	25,000
1973	Northern Pike	FINGERLING	20,000
1974	Northern Pike	ADULT	31
1974	Northern Pike	FINGERLING	35,500
1975	Walleye	FINGERLING	50
1975	Northern Pike	ADULT	120
1975	Northern Pike	FINGERLING	30,000
1976	Northern Pike	ADULT	47
1976	Northern Pike	FINGERLING	35,000
1976	Walleye	FINGERLING	1,391
1976	Northern Pike	ADULT	34

FISH STOCKING DATA (CONT'D)

<u>Year</u>	<u>Species</u>	<u>Size</u>	<u># Released</u>
1977	Northern Pike	FINGERLING	20,000
1978	Northern Pike	FINGERLING	36,000
1979	Northern Pike	ADULT	22
1979	Northern Pike	FINGERLING	16,800
1980	Northern Pike	ADULT	4
1981	Northern Pike	FINGERLING	1,000
1981	Walleye	FINGERLING	2,251
1982	Northern Pike	FINGERLING	94,320
1982	Northern Pike	ADULT	2
1983	Walleye	FINGERLING	1,378
1983	Northern Pike	FINGERLING	584
1983	Northern Pike	ADULT	17

PERMIT DATA FOR LAKE BEEBE

Summary of DNR Permit applications issued or denied as of June 1986 for Lake: BEEBE

<u>Permit Types</u>	<u>Number Issued</u>	<u>Number Denied</u>
Public (Protected) Waters Permits		
Encroachment	2	0
Sand Blanket	2	0
Excavation	1	0
General Appropriation Permits	0	0

APPENDIX C
CLIMATOLOGICAL DATA

Buffalo, MN Monthly Precipitation

####	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1107	1948	m	m	m	m	m	m	m	6.12	0.95	1.02	2.11	0.43	m
1107	1949	m	m	2.04	1.43	m	3.61	4.50	1.33	2.92	4.20	1.05	0.90	m
1107	1950	m	0.32	2.58	3.06	5.74	2.01	1.94	1.78	1.92	2.65	1.81	1.76	m
1107	1951	0.48	1.81	2.32	2.50	4.05	7.51	7.59	6.02	4.77	2.11	1.63	1.25	42.04
1107	1952	1.08	1.20	1.50	0.90	3.14	6.30	5.75	8.74	0.57	0.11	0.87	0.39	30.55
1107	1953	1.14	1.47	1.23	3.61	3.87	8.74	2.74	3.94	0.46	0.60	1.88	1.42	31.10
1107	1954	0.33	0.75	1.90	4.84	1.81	2.76	3.14	4.27	4.16	2.17	0.43	0.25	26.81
1107	1955	0.39	1.29	0.43	1.28	0.75	5.83	7.28	3.63	1.58	1.43	0.76	1.08	25.73
1107	1956	0.70	0.14	1.47	1.15	3.18	5.36	3.81	7.15	0.86	1.91	1.75	0.18	27.66
1107	1957	0.36	1.11	1.08	1.92	3.75	1.93	2.54	8.00	4.78	1.15	1.30	0.29	38.21
1107	1958	0.23	0.34	0.45	2.26	2.00	2.37	2.04	6.27	2.20	1.55	1.03	0.80	20.82
1107	1959	0.05	0.47	0.39	0.26	5.87	2.91	2.79	6.46	3.81	2.15	0.66	1.72	27.54
1107	1960	0.95	0.12	0.57	2.55	5.45	2.32	3.14	7.79	2.52	0.35	1.52	0.41	27.69
1107	1961	0.13	0.27	0.85	2.08	3.71	2.60	11.42	1.26	4.54	2.11	2.24	0.80	32.01
1107	1962	0.92	1.25	1.70	0.69	6.60	3.13	5.33	2.59	3.50	0.77	0.41	0.07	26.96
1107	1963	0.59	0.19	1.31	2.25	4.74	4.11	2.82	2.43	2.90	0.56	0.47	0.62	22.99
1107	1964	0.54	0.18	1.65	3.13	4.02	1.19	3.16	6.86	3.49	0.56	1.45	1.02	27.25
1107	1965	0.44	1.56	4.45	4.40	6.95	2.28	4.63	4.07	5.09	1.43	1.79	2.40	39.49
1107	1966	0.86	1.84	1.63	2.03	1.88	3.85	2.13	5.98	1.96	2.93	0.69	0.81	26.59
1107	1967	2.57	1.71	0.68	1.79	1.35	4.44	3.19	2.60	0.82	1.29	0.13	1.06	21.63
1107	1968	1.27	0.26	1.48	5.54	4.32	4.16	2.04	1.88	3.82	5.94	1.02	3.01	34.74
1107	1969	2.95	0.91	1.22	3.25	2.04	3.32	3.45	0.72	0.88	2.64	0.83	2.92	25.13
1107	1970	0.58	0.25	1.21	4.21	2.91	3.52	2.26	2.48	2.47	5.55	4.08	0.42	29.94
1107	1971	1.37	2.02	0.62	1.84	3.23	5.67	3.25	2.61	3.43	5.51	3.86	0.65	34.06
1107	1972	0.91	0.43	1.42	1.29	2.63	3.04	8.32	3.93	3.97	1.99	0.97	1.83	30.73
1107	1973	0.55	0.44	1.52	1.12	4.76	2.27	2.67	4.22	4.57	4.26	2.21	1.18	29.77
1107	1974	0.02	1.56	0.59	1.93	2.76	5.26	2.08	2.81	1.10	1.07	1.51	0.46	21.15
1107	1975	2.81	0.57	1.76	3.48	3.99	7.25	3.30	2.41	2.43	0.91	5.05	0.38	34.34
1107	1976	1.11	0.80	2.44	0.66	2.01	3.59	1.85	2.21	2.14	0.16	0.18	0.35	17.50
1107	1977	0.49	1.24	2.95	3.35	3.14	3.83	4.28	5.98	2.50	3.55	2.73	0.96	35.00
1107	1978	0.16	0.14	0.85	5.69	4.04	4.83	6.12	4.15	3.14	0.16	1.28	0.76	31.32
1107	1979	0.97	1.38	3.00	0.55	4.12	5.00	1.36	3.80	2.67	4.19	0.77	0.20	28.01
1107	1980	1.20	0.72	0.96	0.74	1.86	4.59	2.62	6.74	3.48	0.91	0.12	0.06	24.00
1107	1981	0.17	1.39	1.21	2.90	0.69	5.56	2.07	3.15	1.46	3.55	0.69	1.13	23.97
1107	1982	1.54	0.17	1.68	2.02	3.35	2.53	7.36	2.82	5.62	3.32	2.53	2.09	35.03
1107	1983	0.38	0.30	2.75	1.80	2.20	8.54	3.37	4.63	3.11	2.75	2.73	0.79	33.35
1107	1984	0.52	0.98	0.68	3.22	2.32	6.86	2.61	3.74	3.56	5.92	0.19	1.83	32.43
1107	1985	0.36	0.39	2.58	3.86	3.52	5.53	3.35	6.98	5.82	2.62	1.10	1.02	37.13
1107	1986	0.72	0.69	0.91	6.19	3.51	5.80	5.06	3.12	6.88	1.12	1.75	0.40	36.15

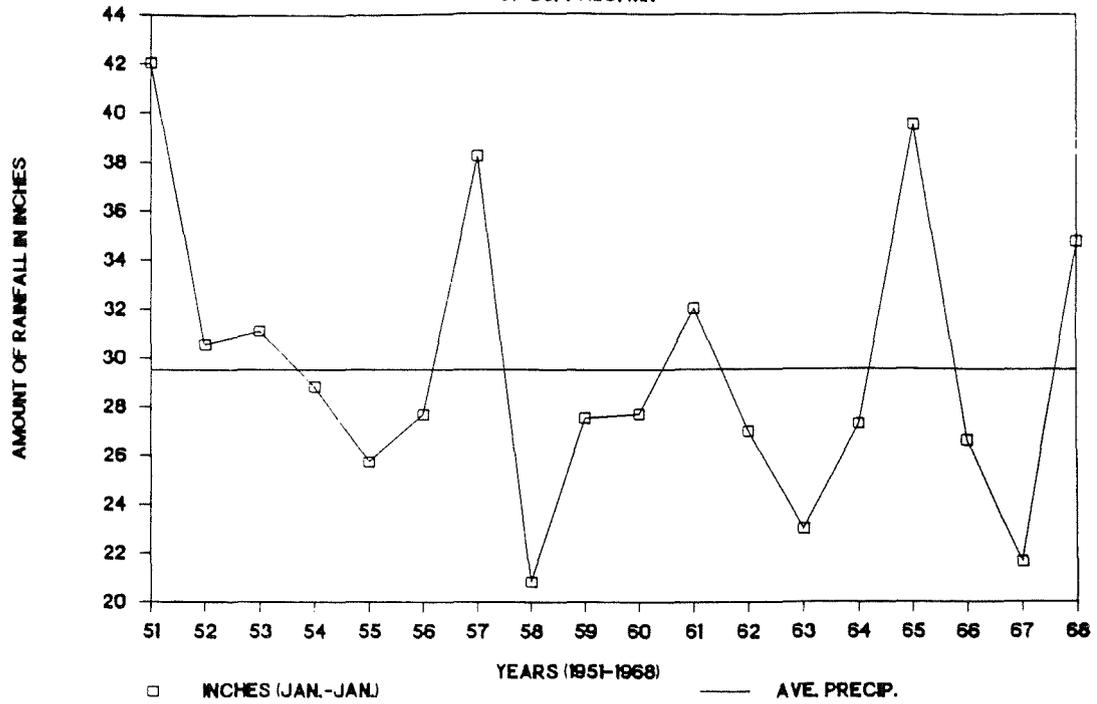
Note: Values in hundredths of inches: 'm' = missing; 'e' = estimated; '####' is the National Weather Service Coop Station Number.

All data was supplied to this State Climatology Office by the National Climate Data Center, NOAA, Asheville, NC, 28801. 'Certified Data' can only be supplied by NCDC directly.

State Climatology Office, Minnesota Department of Natural Resources - Waters, Jim Zandlo at (612) 296-4214.

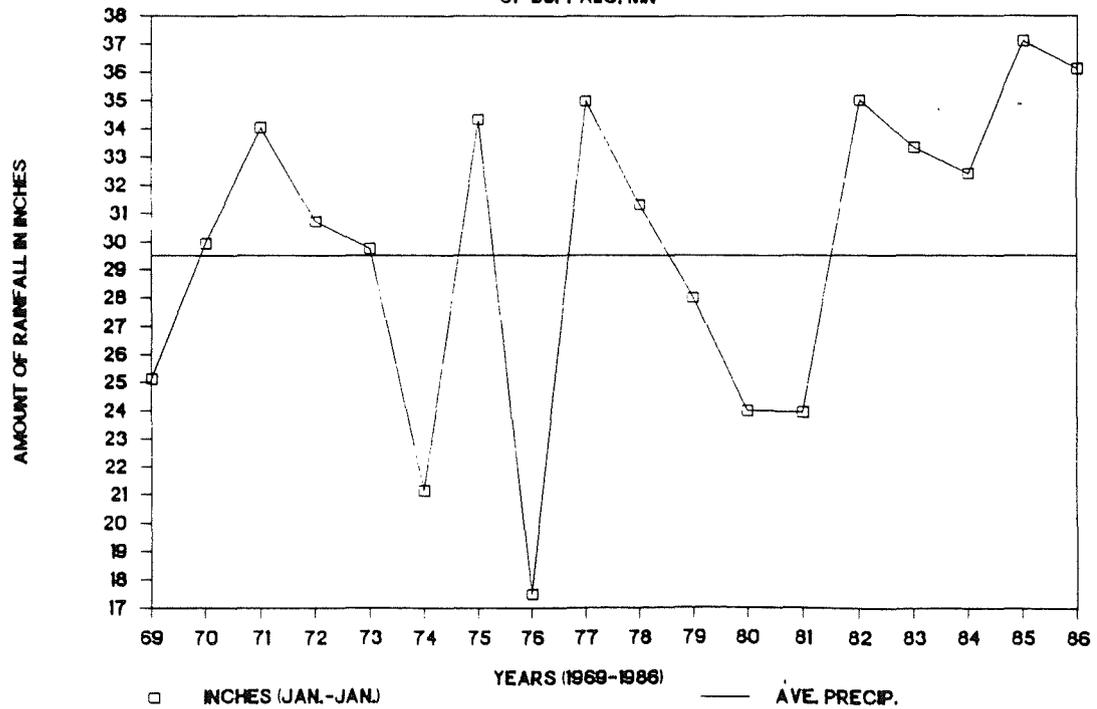
ANNUAL PRECIPITATION

OF BUFFALO, MN



ANNUAL PRECIPITATION

OF BUFFALO, MN



St. Cloud WSO Airport, MN Monthly Precipitation

###	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
7294	1887	0.90	1.01	0.14	m	m	m	m	m	m	m	m	m	m
7294	1888	m	m	1.60	m	m	m	m	m	m	m	m	m	m
7294	1890	m	m	m	m	m	m	m	2.20	m	m	m	m	m
7294	1893	1.00	0.90	0.90	5.74	2.62	0.54	3.67	2.41	0.81	1.68	0.81	1.36	22.44
7294	1894	0.81	0.00	2.55	4.93	8.54	4.15	0.51	0.90	2.12	1.95	0.72	0.69	27.87
7294	1895	0.48	0.70	0.24	2.30	3.99	2.55	3.16	2.28	3.84	0.00	0.94	0.00	20.48
7294	1896	1.05	0.18	3.05	6.31	2.57	5.00	2.32	1.66	2.59	4.30	2.76	0.00	31.79
7294	1897	2.75	1.40	4.53	1.56	1.96	6.77	12.81	2.48	4.18	1.69	0.60	0.28	41.01
7294	1898	0.00	1.78	1.75	0.32	2.96	3.73	1.83	3.34	2.28	4.17	1.85	0.00	24.01
7294	1899	0.30	1.05	2.22	2.22	3.79	2.78	4.51	7.91	0.95	7.94	1.10	0.36	35.14
7294	1900	0.27	0.45	1.40	0.81	0.20	2.05	4.28	9.28	7.12	2.39	0.58	0.86	29.69
7294	1901	0.42	0.00	1.34	2.00	1.21	4.67	2.38	1.54	3.25	0.76	0.50	0.23	18.30
7294	1902	0.30	0.00	0.35	0.88	2.79	2.92	4.75	2.32	2.19	1.63	1.53	1.43	21.09
7294	1903	0.20	0.33	2.75	3.74	5.46	1.28	10.53	2.64	5.20	2.80	0.25	0.55	35.73
7294	1904	0.35	0.18	1.06	1.37	2.95	3.89	5.87	6.00	3.02	5.01	0.08	0.39	30.17
7294	1905	0.49	0.36	0.60	2.06	5.47	7.42	5.41	6.96	3.38	3.13	1.41	0.00	36.69
7294	1906	1.20	0.26	1.03	1.68	6.50	7.61	3.17	3.42	4.33	3.22	1.15	0.54	34.11
7294	1907	1.80	0.78	0.75	0.21	3.53	5.05	2.22	3.55	5.15	1.67	3.57	0.26	28.54
7294	1908	0.29	0.69	1.44	3.21	6.77	6.82	2.55	1.60	2.74	1.64	1.09	0.47	29.31
7294	1909	1.56	1.21	0.14	1.57	3.34	4.84	3.08	2.43	4.06	0.71	2.10	1.63	26.67
7294	1910	0.65	0.46	0.18	1.52	1.90	1.85	0.63	3.90	2.53	0.47	0.31	0.24	14.64
7294	1911	0.55	0.37	0.87	2.19	5.86	5.28	3.33	3.56	3.41	4.87	1.65	0.75	32.69
7294	1912	0.26	0.10	0.28	2.96	9.68	2.29	5.23	4.79	1.78	0.68	0.01	0.82	28.88
7294	1913	0.42	0.37	0.48	2.91	4.26	3.05	9.49	2.61	4.12	2.27	1.23	0.00	31.21
7294	1914	0.88	0.35	0.95	2.42	2.79	8.35	0.90	3.37	6.49	1.59	0.23	0.05	28.37
7294	1915	0.33	1.29	0.54	2.83	3.97	m	4.26	1.62	3.41	2.62	2.13	0.70	m
7294	1916	2.16	0.37	1.38	1.92	5.86	6.04	3.21	4.65	2.98	1.71	0.00	0.74	31.02
7294	1917	1.85	1.09	2.98	2.69	1.02	4.65	3.35	2.61	1.39	1.04	0.05	0.44	23.16
7294	1918	0.48	0.27	0.72	1.79	4.14	1.64	4.43	3.21	0.84	3.23	2.99	0.72	24.46
7294	1919	0.30	2.22	1.17	2.53	2.85	5.30	3.83	2.10	0.80	2.18	m	0.42	m
7294	1920	1.61	0.66	3.14	1.53	4.61	10.56	0.75	0.89	3.87	2.62	m	0.76	m
7294	1921	0.29	0.00	0.80	1.21	2.07	3.18	2.86	1.70	6.10	0.80	1.02	0.52	20.55
7294	1922	1.88	2.94	1.39	1.25	2.01	4.50	0.86	1.16	0.74	2.37	4.16	0.20	23.46
7294	1923	1.42	0.25	0.20	2.66	2.49	5.17	3.26	1.00	0.93	0.42	0.57	0.17	18.54
7294	1924	0.14	0.35	0.95	3.26	1.80	5.17	1.49	4.76	4.63	0.76	0.52	1.04	24.87
7294	1925	0.39	0.37	0.34	2.16	1.07	4.96	4.63	1.29	2.46	0.44	0.50	0.51	19.12
7294	1926	0.98	0.44	0.89	0.08	0.98	4.67	4.31	7.22	10.72	1.22	1.53	0.32	33.36
7294	1927	0.41	0.31	1.73	3.31	2.98	3.04	2.74	2.18	2.55	1.97	1.93	1.75	24.90

<u>###</u>	<u>YEAR</u>	<u>JAN</u>	<u>FEB</u>	<u>MAR</u>	<u>APR</u>	<u>MAY</u>	<u>JUN</u>	<u>JUL</u>	<u>AUG</u>	<u>SEP</u>	<u>OCT</u>	<u>NOV</u>	<u>DEC</u>	<u>ANN</u>
7294	1928	0.40	0.88	0.39	2.31	1.34	3.61	4.62	5.28	4.28	2.15	0.81	0.71	26.78
7294	1929	0.93	0.50	1.19	1.40	2.10	1.19	2.37	1.97	6.60	2.11	0.67	0.57	21.60
7294	1930	0.82	0.96	0.73	0.59	3.61	2.89	2.17	1.46	3.10	1.43	1.78	0.08	19.62
7294	1931	0.07	1.35	1.30	0.96	1.81	2.94	1.37	2.65	1.56	3.54	4.02	0.31	21.88
7294	1932	1.02	0.26	0.73	1.16	4.32	3.55	3.94	2.52	0.78	1.46	1.51	0.23	21.48
7294	1933	0.48	0.27	0.84	0.46	4.22	1.96	5.75	0.42	1.36	1.46	0.54	0.43	18.19
7294	1934	0.74	0.05	0.82	0.25	1.01	3.89	1.30	1.84	6.12	2.83	1.32	0.82	20.99
7294	1935	0.89	0.27	1.28	2.02	1.97	4.41	4.02	6.30	0.90	2.18	0.57	0.95	25.76
7294	1936	0.79	1.10	1.30	2.25	4.05	0.80	0.94	4.98	2.15	0.54	1.89	1.53	22.32
7294	1937	1.04	0.76	0.37	3.18	5.72	2.43	2.43	5.12	1.26	1.03	0.49	0.33	24.16
7294	1938	0.41	0.64	2.07	3.62	6.80	4.29	4.87	2.84	3.16	0.34	1.43	0.67	31.14
7294	1939	1.26	1.20	0.27	1.96	2.72	6.91	2.74	3.17	1.39	1.22	0.00	m	m
7294	1940	0.26	0.84	1.93	2.48	2.21	2.84	3.39	3.61	1.07	2.66	3.14	0.57	25.00
7294	1941	0.86	0.95	0.72	2.08	5.23	6.19	1.23	5.83	5.02	3.28	0.01	0.86	32.26
7294	1942	0.02	0.26	1.94	1.87	4.47	3.21	3.45	3.28	4.89	0.38	0.16	1.11	25.04
7294	1943	0.77	0.67	1.61	0.87	6.18	2.90	3.16	1.36	0.68	2.30	1.54	0.01	22.05
7294	1944	0.63	1.37	1.07	3.48	5.11	5.57	5.19	3.67	2.55	0.07	1.11	0.41	30.23
7294	1945	0.87	1.29	2.07	1.91	2.08	6.58	4.22	1.96	3.06	0.33	1.60	1.74	27.71
7294	1946	0.43	1.14	0.64	1.00	4.41	5.73	1.86	0.77	4.19	4.24	1.35	0.85	26.61
7294	1947	0.31	0.23	0.63	4.40	2.38	3.55	1.75	2.90	1.63	1.10	2.15	0.03	21.06
7294	1948	0.16	1.42	1.89	2.09	0.32	4.38	2.86	2.89	2.13	0.51	1.74	0.39	20.78
7294	1949	1.61	0.21	1.76	0.97	2.04	3.77	5.93	1.43	2.34	2.28	1.13	0.94	24.41
7294	1950	2.12	0.31	2.44	3.32	5.54	1.33	1.72	0.46	1.79	3.76	1.98	1.80	26.57
7294	1951	0.35	2.76	2.41	2.26	2.87	7.85	4.73	4.95	2.75	3.14	1.54	1.65	37.26
7294	1952	1.33	0.70	1.97	0.92	2.25	9.08	3.40	6.95	0.07	0.07	0.47	0.13	27.34
7294	1953	0.92	1.61	1.19	3.52	2.83	9.34	2.01	3.86	0.99	0.51	1.55	1.40	29.73
7294	1954	0.49	0.57	1.62	5.31	4.46	6.90	3.13	2.94	3.96	2.23	0.38	0.21	32.20
7294	1955	0.57	1.58	0.73	1.17	0.88	2.90	8.00	5.43	2.10	1.99	1.26	1.35	27.96
7294	1956	1.01	0.22	1.13	2.01	2.69	5.46	4.79	7.55	1.88	1.08	2.34	0.33	30.49
7294	1957	0.40	1.10	2.03	0.90	4.58	8.54	2.07	6.35	3.88	0.94	1.28	0.38	32.45
7294	1958	0.69	0.23	0.69	2.03	2.05	2.25	2.63	6.95	4.97	1.44	1.75	0.16	25.84
7294	1959	0.20	0.58	0.10	0.34	5.70	2.42	2.64	4.36	2.20	1.85	0.30	1.69	22.38
7294	1960	0.92	0.09	0.75	1.81	4.29	2.68	2.35	4.47	1.71	0.32	1.31	0.55	21.25
7294	1961	0.07	0.38	0.57	2.18	2.77	2.60	3.15	2.58	2.96	2.11	0.68	0.80	20.85
7294	1962	0.67	1.40	1.12	1.13	8.01	2.93	6.20	3.21	3.71	0.19	0.44	0.13	29.14
7294	1963	0.43	0.40	1.39	2.91	5.79	2.51	2.04	5.90	3.40	0.60	0.76	0.66	26.79
7294	1964	0.18	0.04	1.22	3.31	3.62	1.30	1.71	6.66	1.38	0.19	0.98	0.58	21.17
7294	1965	0.48	0.91	3.43	3.44	6.78	6.43	4.66	4.65	4.94	0.94	1.55	1.11	39.32
7294	1966	0.70	1.17	1.53	1.66	2.22	3.18	3.51	4.67	0.95	1.41	0.49	0.79	22.28
7294	1967	1.99	0.75	0.39	1.05	0.82	7.00	0.59	4.72	1.43	1.14	0.14	1.12	21.14
7294	1968	0.86	0.21	1.17	4.51	2.80	6.98	1.95	2.13	4.74	5.80	0.58	1.95	33.68

<u>###</u>	<u>YEAR</u>	<u>JAN</u>	<u>FEB</u>	<u>MAR</u>	<u>APR</u>	<u>MAY</u>	<u>JUN</u>	<u>JUL</u>	<u>AUG</u>	<u>SEP</u>	<u>OCT</u>	<u>NOV</u>	<u>DEC</u>	<u>ANN</u>
7294	1969	2.52	0.69	0.47	3.48	2.16	2.27	2.81	2.16	1.71	1.29	0.38	2.04	21.98
7294	1970	0.24	0.18	1.05	3.01	2.52	3.43	3.26	1.73	1.66	5.10	2.73	0.24	25.15
7294	1971	0.86	1.53	0.31	1.66	3.86	6.49	2.28	2.79	3.12	6.16	2.56	0.39	32.01
7294	1972	0.55	0.47	1.56	1.59	3.30	1.91	7.26	4.94	1.64	2.54	0.74	1.31	27.81
7294	1973	0.52	0.31	1.40	1.65	2.89	2.92	2.94	4.27	2.80	3.13	1.64	0.73	25.20
7294	1974	0.09	0.83	0.88	1.16	3.26	4.36	2.25	3.20	1.97	1.58	1.29	0.54	21.41
7294	1975	2.39	0.40	1.75	3.69	3.02	5.78	0.21	4.83	2.27	1.08	3.24	0.28	28.94
7294	1976	0.85	0.83	1.78	0.92	0.93	4.84	1.92	0.60	1.37	0.44	0.14	0.31	14.93
7294	1977	0.58	0.98	3.03	3.17	3.57	3.48	4.27	6.10	2.34	2.93	3.74	1.40	35.59
7294	1978	0.19	0.17	0.81	3.49	3.20	6.04	4.43	2.88	4.59	0.14	0.95	1.02	27.91
7294	1979	1.28	1.67	3.02	0.74	5.17	6.34	1.21	4.88	1.58	4.36	0.62	0.31	31.18
7294	1980	1.17	0.84	0.76	0.48	1.62	6.06	1.28	7.01	5.99	0.71	0.20	0.22	26.34
7294	1981	0.44	1.10	1.05	3.29	1.40	6.65	1.92	0.00	1.26	4.40	0.45	1.04	23.00
7294	1982	0.97	0.13	1.75	0.97	3.91	2.53	3.90	3.37	4.38	4.52	2.31	1.72	30.46
7294	1983	0.61	0.13	2.60	1.57	2.39	9.52	2.21	3.48	6.55	3.09	3.11	0.92	36.18
7294	1984	0.67	0.87	0.65	4.16	2.02	8.11	2.94	2.57	3.39	5.84	0.17	1.81	33.20
7294	1985	0.43	0.23	1.70	3.83	2.81	5.28	2.80	4.57	9.48	1.28	1.43	0.57	34.41
7294	1986	0.72	0.83	0.89	5.55	2.36	3.75	7.54	5.18	6.03	0.49	1.05	0.35	34.74

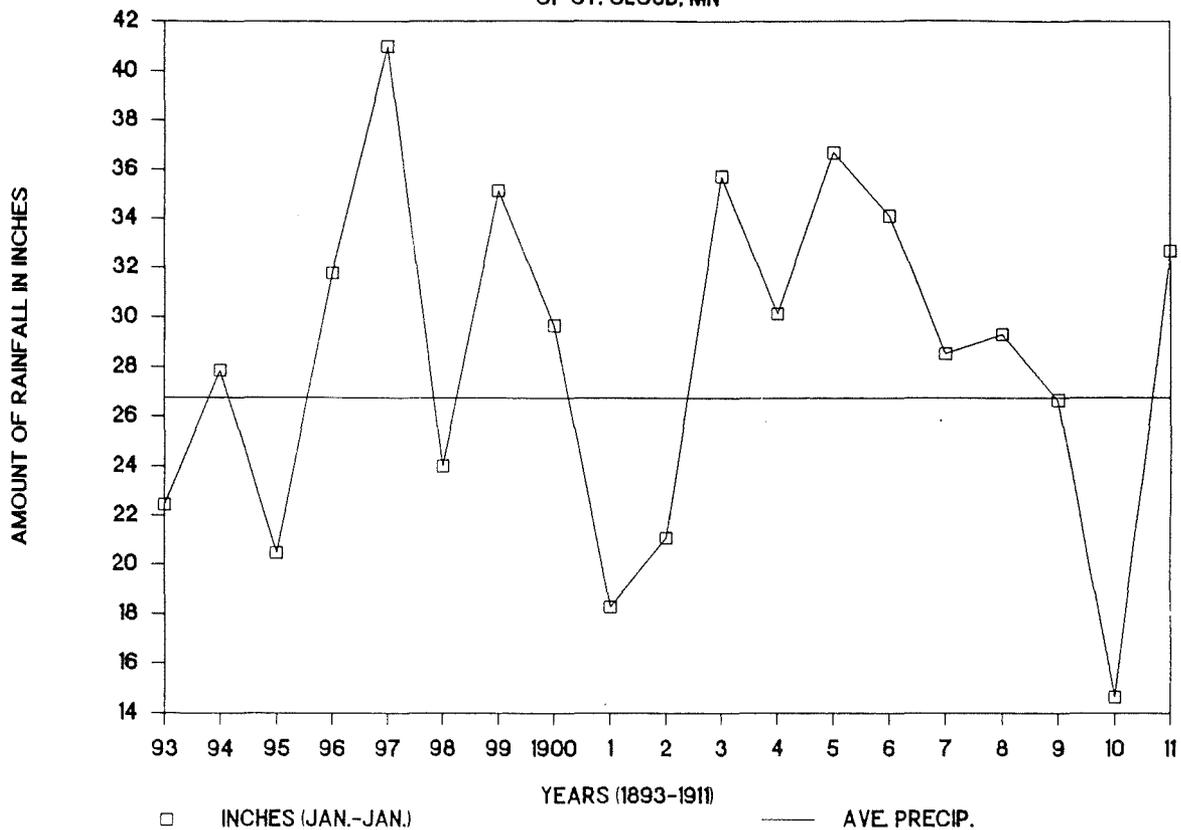
Note: Values in hundredths of inches; 'm' = missing; 'e' = estimated; '###' is the National Weather Service Coop Station Number.

All data were supplied to this State Climatology Office by the National Climate Data Center, NOAA, Asheville, NC, 28801. "Certified Data" can only be supplied by NCDC directly.

State Climatology Office, Minnesota Department of Natural Resources - Waters, Jim Zandlo, (612) 296-4214.

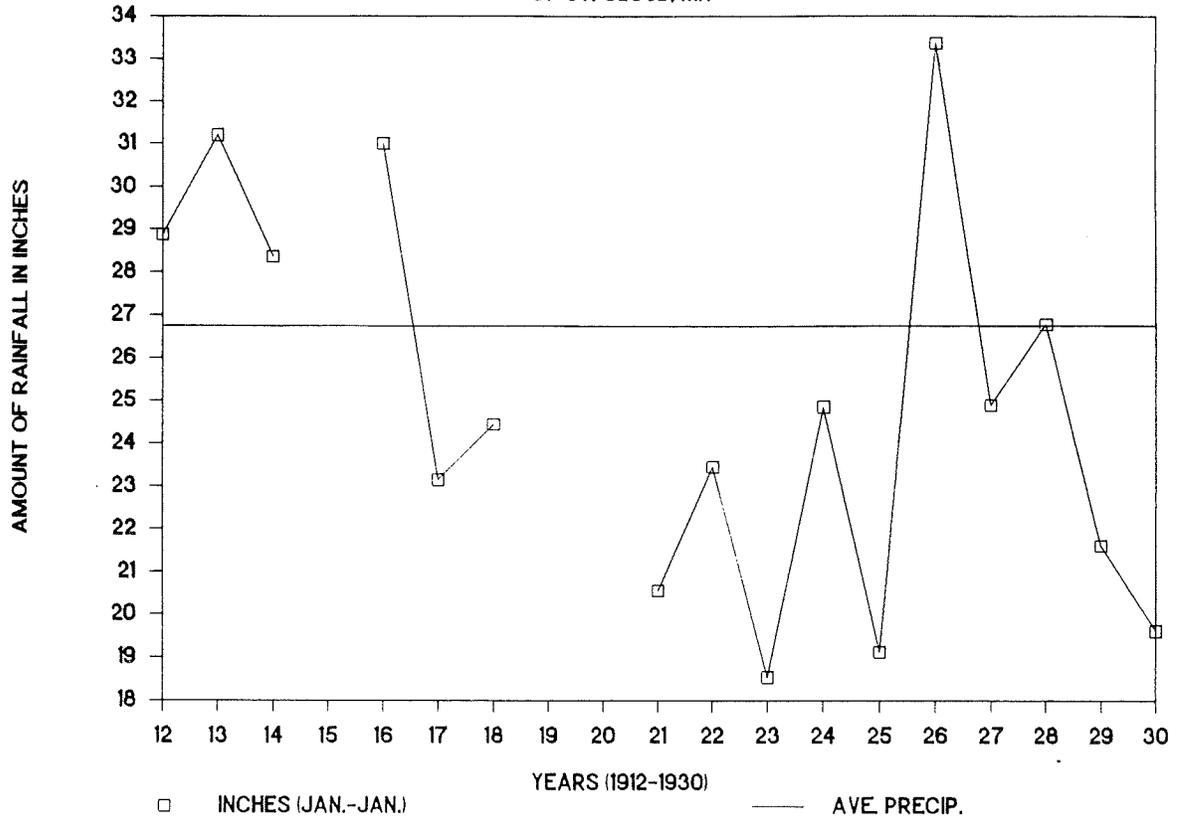
ANNUAL PRECIPITATION

OF ST. CLOUD, MN



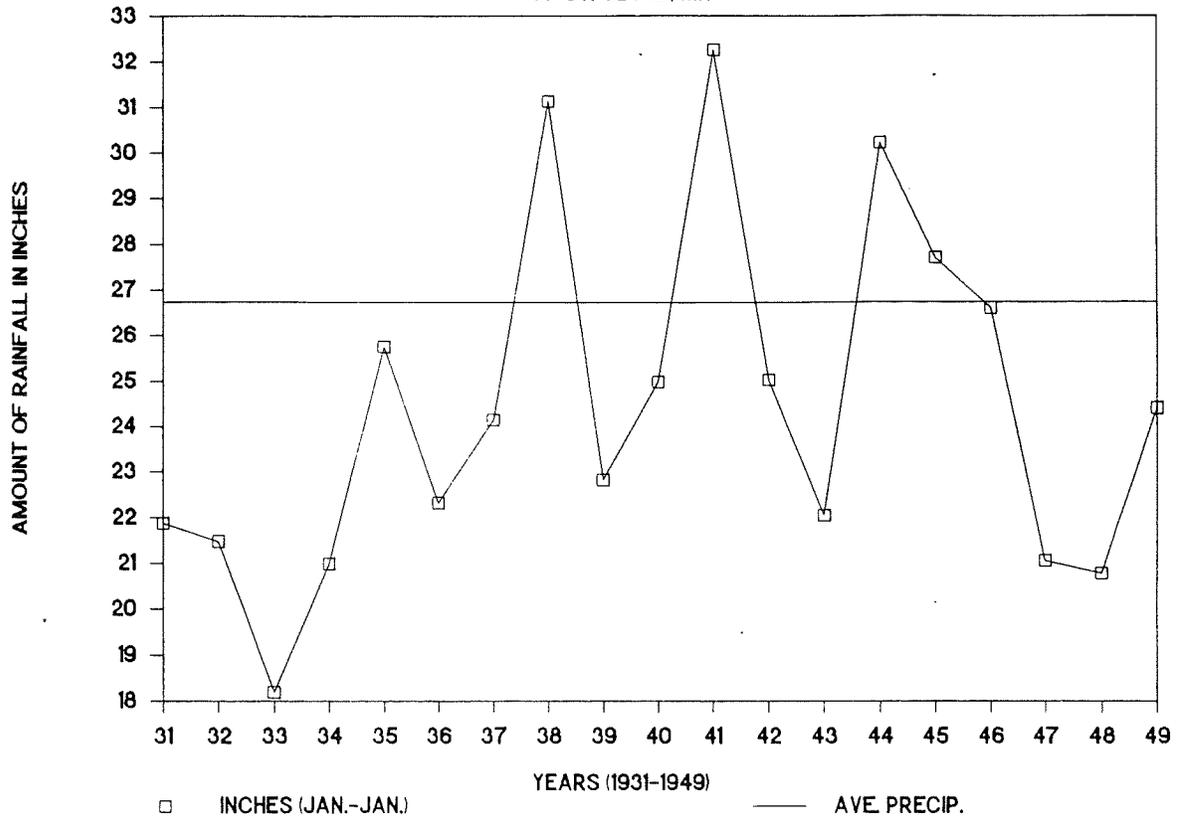
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OF ST. CLOUD, MN



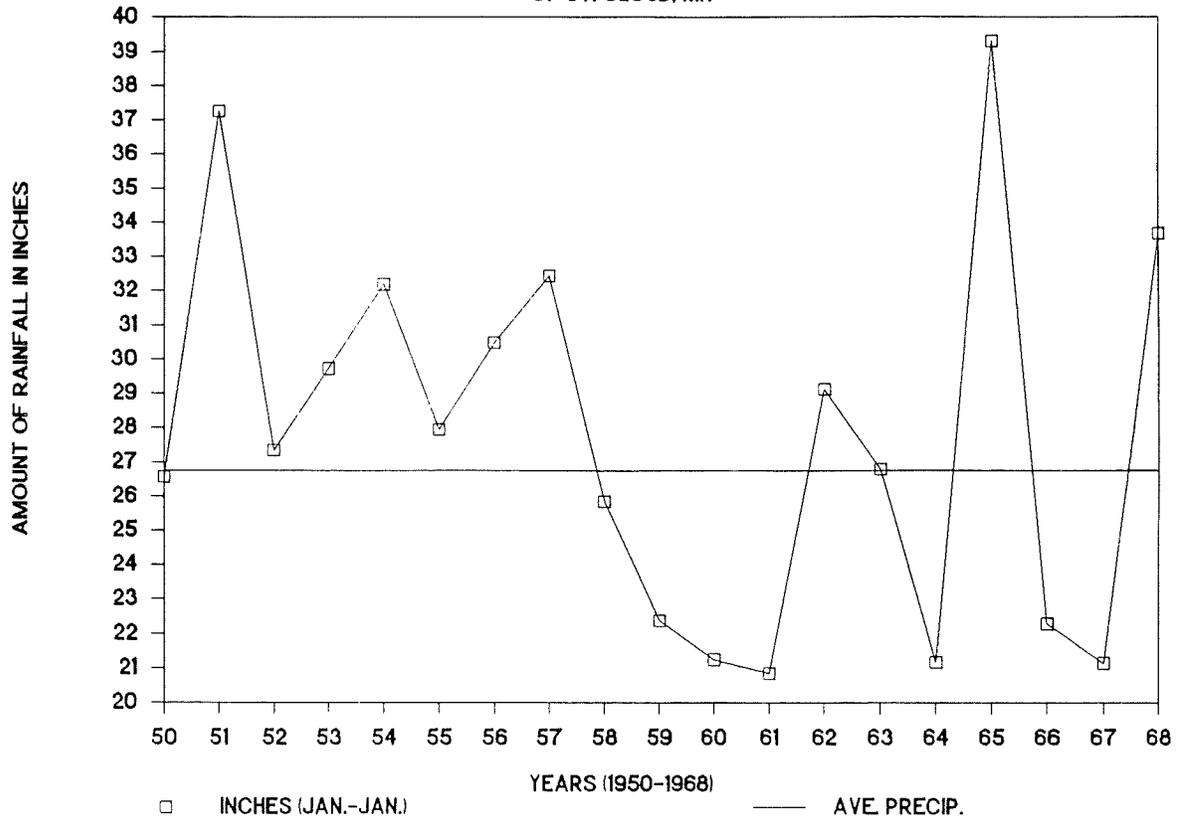
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OF ST. CLOUD, MN



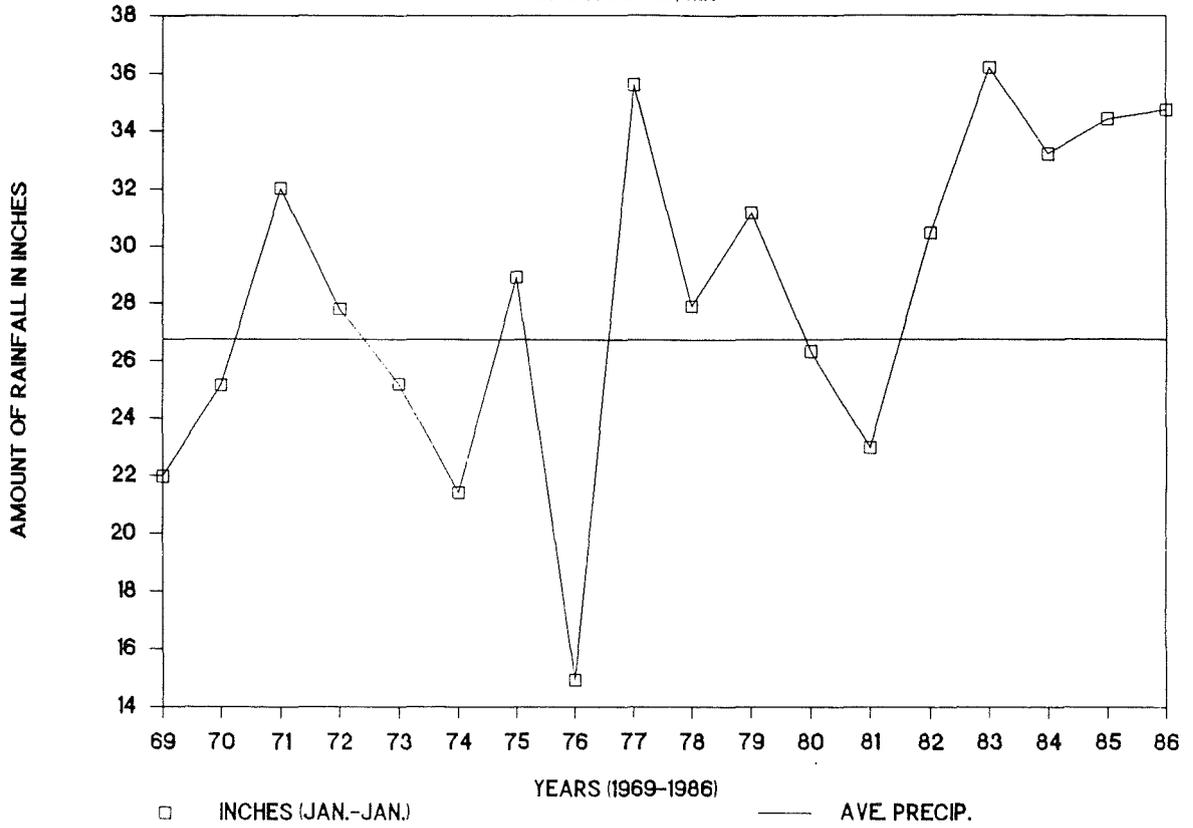
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OF ST. CLOUD, MN



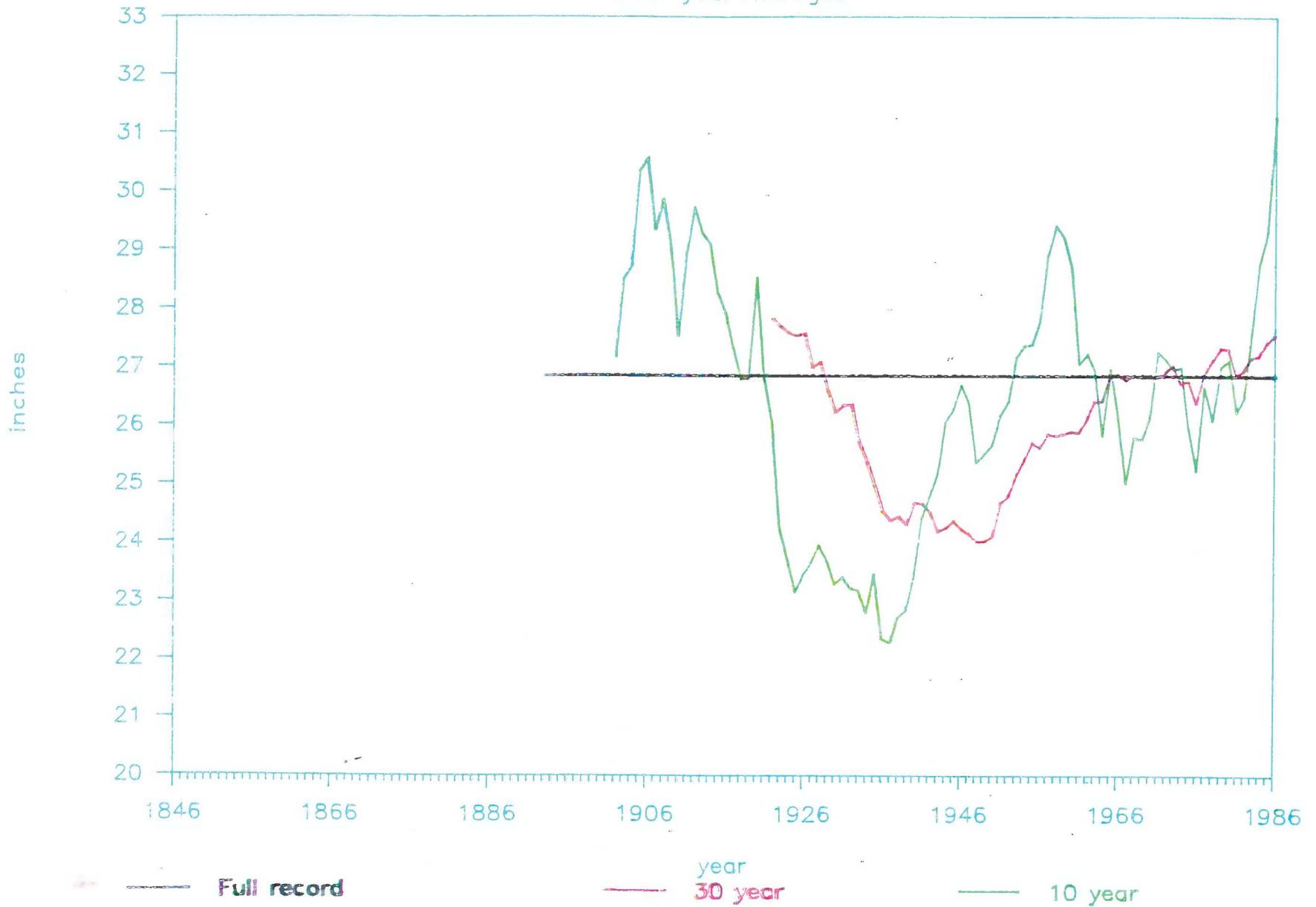
ANNUAL PRECIPITATION

OF ST. CLOUD, MN

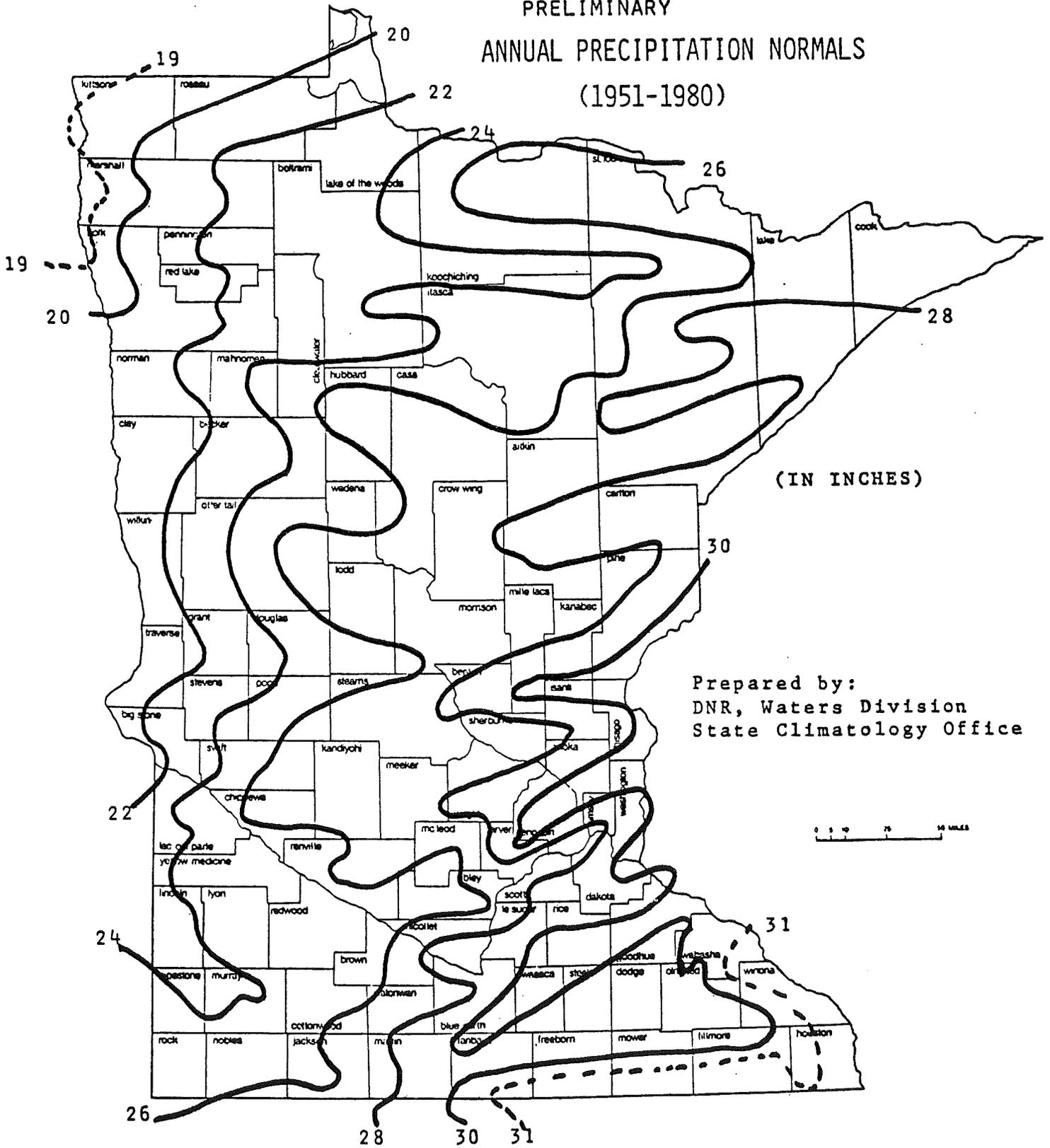


St. Cloud Annual Precipitation

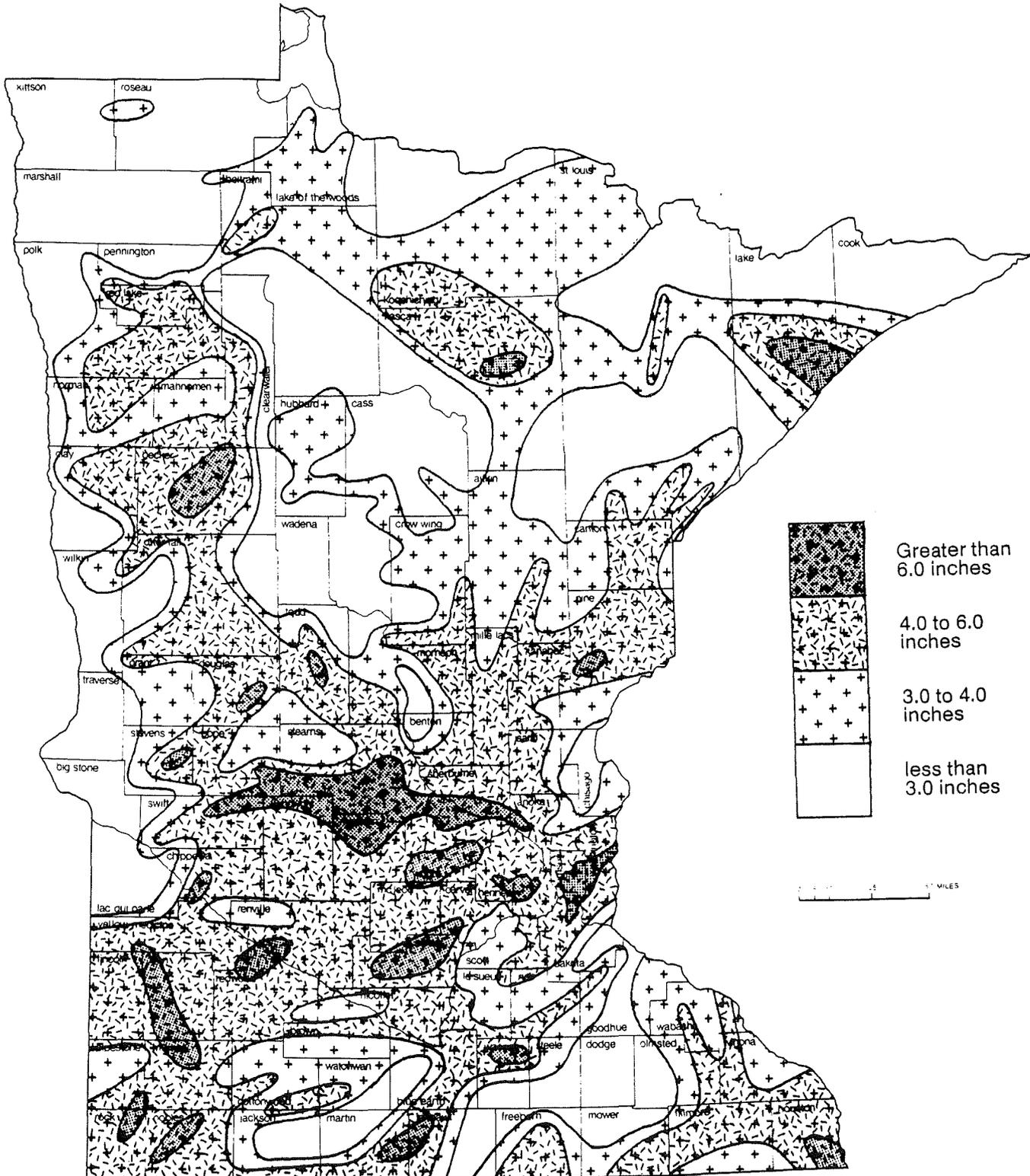
Multi-year Averages



PRELIMINARY
ANNUAL PRECIPITATION NORMALS
(1951-1980)

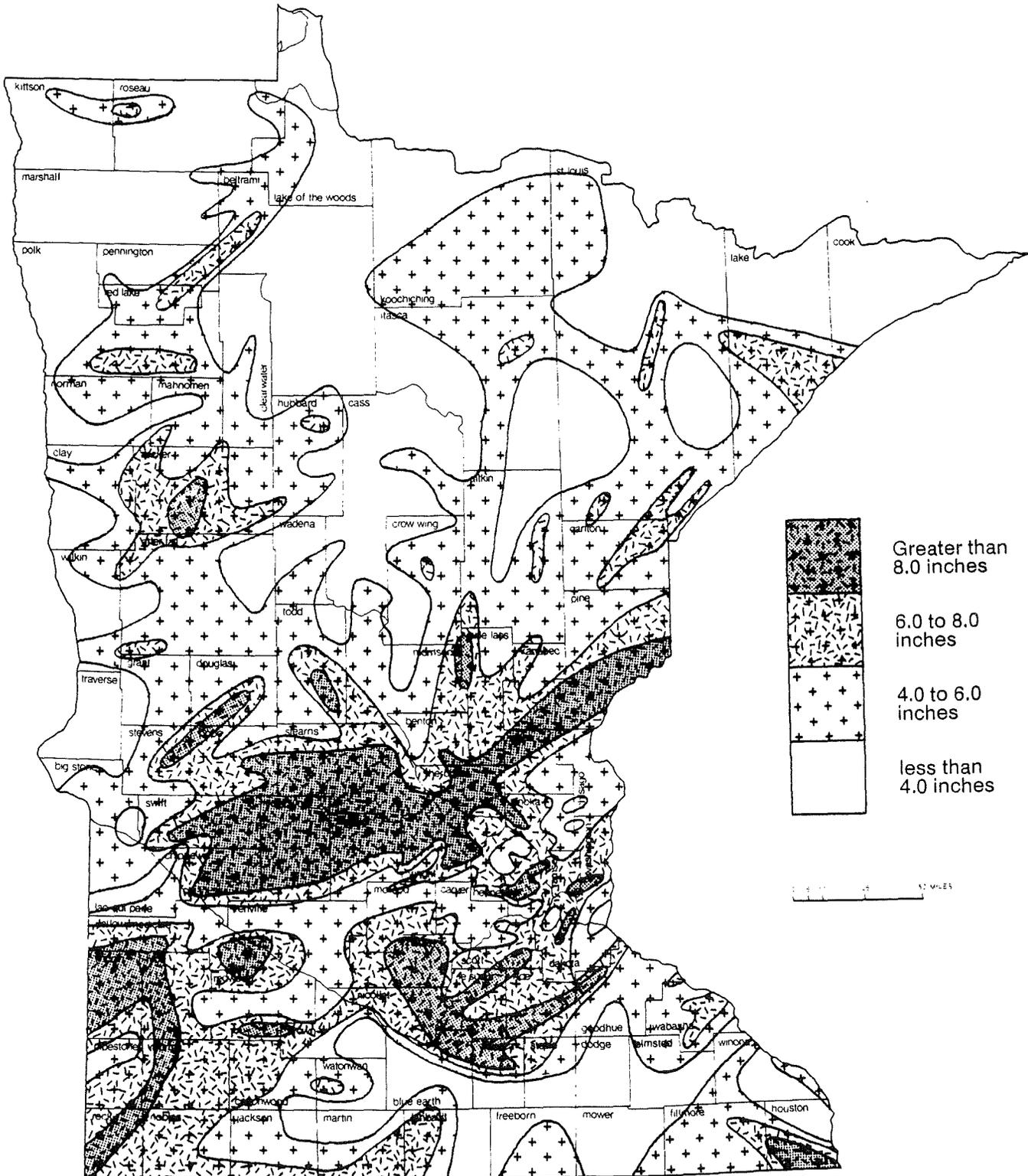


AVERAGE ANNUAL DEPARTURE FROM NORMAL PRECIPITATION FOR 1977 - 1986 (10 YEARS)



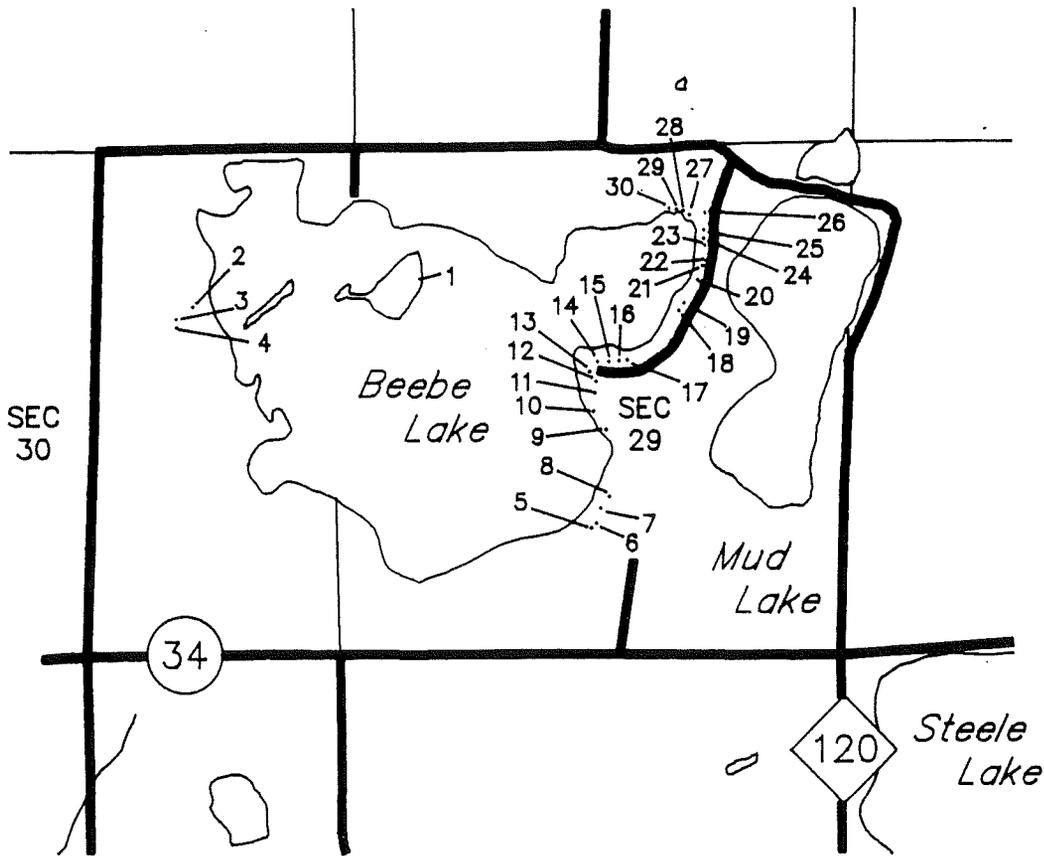
Prepared by: DNR, Division of Waters, State Climatology Office

AVERAGE ANNUAL DEPARTURE FROM NORMAL PRECIPITATION FOR 1982 - 1986 (5 YEARS)



APPENDIX D

FACT SHEET FOR EACH POTENTIALLY
DAMAGED STRUCTURE



DEPARTMENT OF NATURAL RESOURCES

DIVISION OF WATERS



Not to Scale

BEEBE LAKE WRIGHT CO.

Structure Number : 1
Name : Mortimer, Laura B. et al
Address : 2424 Pleasant South
Minneapolis, MN 55404

Legal Description : N. 1/2 Sec. 29, Twp. 120, R.24
Unplatted land, Gov't. Lot 9.
Pin Number: 207-200-292300 877.
NOTE: 1 out of 5 buildings owned.

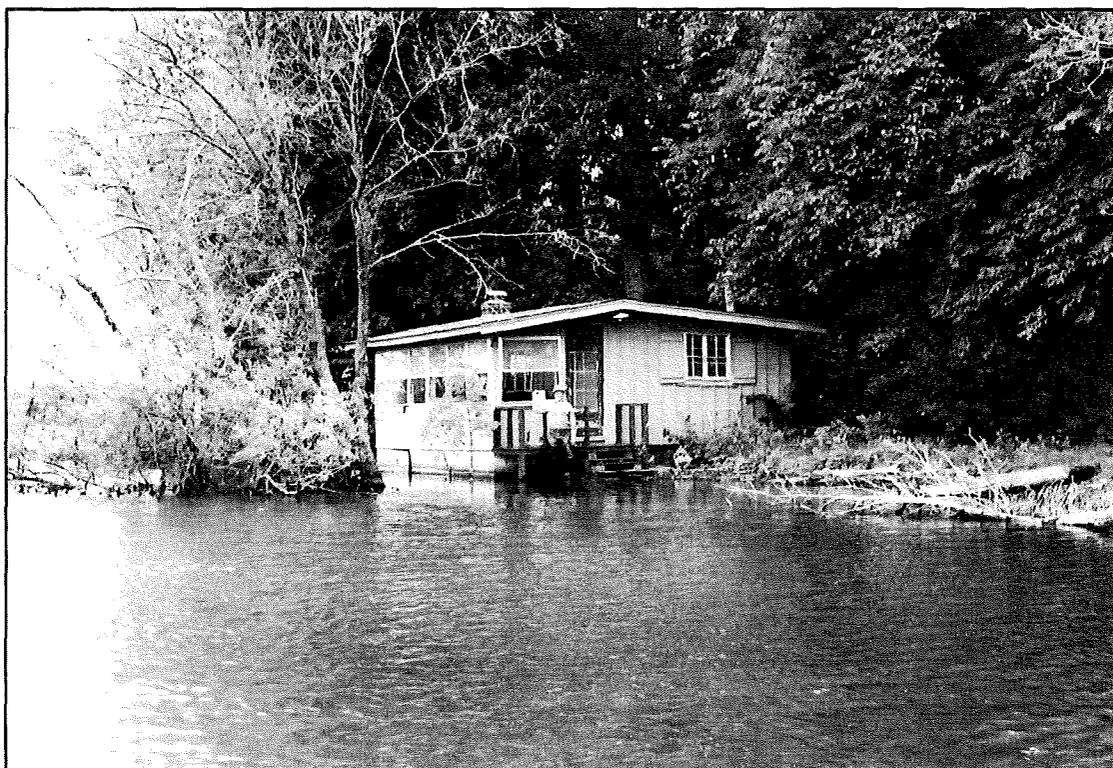
Walkout/1stFl Elev. : 970.81
Ground Elevation : 968.4

Basement : NO
Walkout : NO

Market Value

Buildings :	\$19,600.00
Land :	\$39,500.00
Total :	\$59,100.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 2
Name : Great Lake Enter. Inc.
Address : P.O. Box 519, Cooper Station
New York, NY 10003

Legal Description : N. 1/2 Sec. 30, Twp. 120, R. 24, Unplatted land,
Legal Description on file with the County
Assessor's Office. Consists of 3 abandoned cabins
Pin Number: 207-200-301300 877.

Walkout/1stFl Elev. : 973.10
Ground Elevation : 972.0

Basement : NO
Walkout : NO

Market Value

Buildings :	\$3,500.00
Land :	\$42,300.00
Total :	\$45,800.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 3
Name : Great Lake Enter. Inc.
Address : P.O. Box 519, Cooper Station
New York, NY 10003

Legal Description : N. 1/2 Sec. 30, Twp. 120, R. 24, Unplatted land,
Legal Description on file with the County
Assessor's Office.
Pin Number: 207-200-301300 877.

Walkout/1stFl Elev. : 973.50
Ground Elevation : 972.5

Basement : NO
Walkout : NO

Market Value

Buildings :
Land :
Total :

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 4
Name : Great lake Enter. Inc.
Address : P.O. Box 519, Cooper Station
New York, NY 10003

Legal Description : N/ 1/2 Sec. 30, Twp. 120, R. 24, Unplatted land,
Legal Description on file with the County
Assessor's Office.
Pin Number: 207-200-301300 877.

Walkout/1stFl Elev. : 973.70
Ground Elevation : 972.5

Basement : NO
Walkout : NO

Market Value

Buildings :
Land :
Total :

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 5
Name : Friesen, Jacob and Ardith
Address : Box 448
Hanover, MN 55341

Legal Description : S. 1/2 Sec. 29, Twp. 120, R. 24
Unplatted land, TR description in Book 255-35 on
file in the County Assessor's Office.
Pin Number: 207-200-294204.

Walkout/1stFl Elev. : 976.00
Ground Elevation : 974.7

Basement : YES
Walkout : YES

Market Value

Buildings :	\$66,900.00
Land :	\$18,400.00
Total :	\$85,300.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 6
Name : Johnson, Delores
Address : Rt. 3, Box 114B
Buffalo, MN 55313

Legal Description : S. 1/2 Sec. 29, Twp. 120, R. 24
Unplatted land, TR description in Book 200-549 on
file with the County Assessor's Office.
Pin Number: 207-200-294203.

Walkout/1stFl Elev. : 972.38
Ground Elevation : 972.2

Basement : YES
Walkout : YES

Market Value

Buildings :	\$59,800.00
Land :	\$20,000.00
Total :	\$79,800.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 7
Name : Beecher, Jon and Kae
Address : Rt. 3
Buffalo, MN 55313

Legal Description : S. 1/2 Sec. 29, Twp. 120, R. 24
Unplatted land, TR description in Book 247-107 on
file with County Assessor's Office.
Pin Number: 207-200-294202.

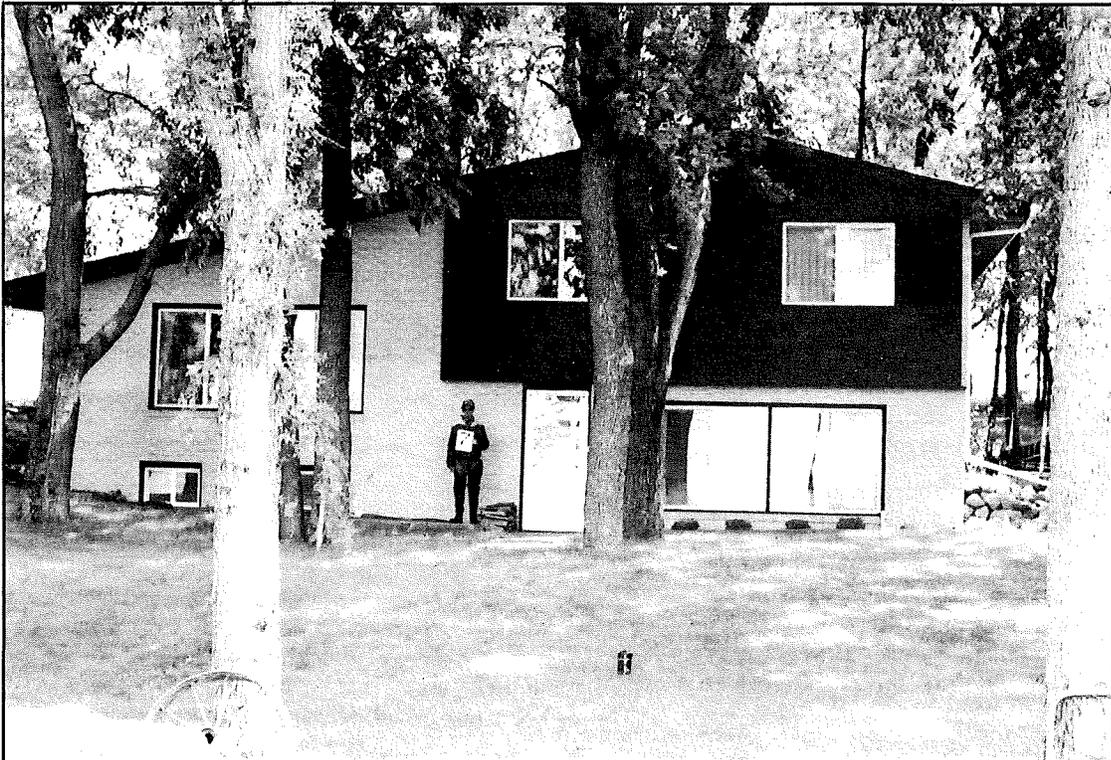
Walkout/1stFl Elev. : 974.32
Ground Elevation : 974.1

Basement : YES
Walkout : YES

Market Value

Buildings : \$61,900.00
Land : \$20,000.00
Total : \$81,900.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 8
Name : Mutterer, Burnadette L.
Address : Rt. 3, Box 114
Buffalo, MN 55313-1193

Legal Description : S. 1/2 Sec. 29, Twp. 120, R. 24
That part of Gov't. Lot 5 on file with the County
Assessor's Office.
Pin Number: 207-200-294206.

Walkout/1stFl Elev. : 973.53
Ground Elevation : 972.9

Basement : YES
Walkout : YES

Market Value

Buildings : \$78,200.00
Land : \$35,800.00
Total : \$114,000.00

Flood Insurance : YES



BEEBE LAKE WRIGHT CO.

Structure Number : 9
Name : Kent A. Mutterer
Address : Rt. 3, Box 114
Buffalo, MN 55313

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Legal Description on file with the County
Assessor's Office. Abandoned cabin.
Pin Number: 207-200-294200.

Walkout/1stFl Elev. : 973.90
Ground Elevation : 972.1

Basement : NO
Walkout : NO

Market Value

Buildings :	\$ 0.00
Land :	\$166,600.00
Total :	\$166,600.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 10
Name : Barthel, Harold and Alice
Address : 1537 Hansack Avenue N.E.
St. Michael, MN 55376.

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Unplatted land, Legal Description on file with the
County Assessor's Office.
Pin Number: 207-200-292402 877.

Walkout/1stFl Elev. : 973.05
Ground Elevation : 972.6

Basement : YES
Walkout : YES

Market Value

Buildings :	\$52,300.00
Land :	\$19,000.00
Total :	\$71,300.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 11
Name : Swanson, Richard L.
Address : 1539 Hansack Avenue N.E.
St. Michael, Mn 55376

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Unplatted land, Legal Description on file with the
County Assessor's Office.
Pin Number: 207-200-292401 877.

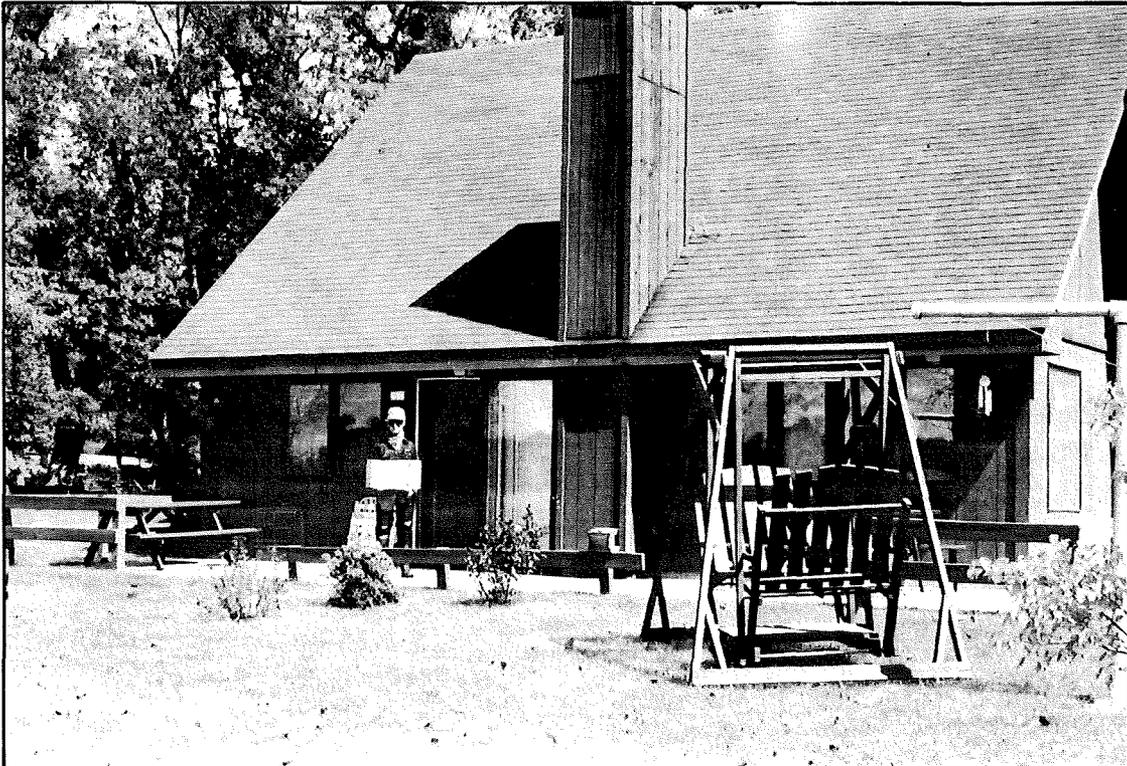
Walkout/1stFl Elev. : 971.16
Ground Elevation : 970.8

Basement : YES
Walkout : YES

Market Value

Buildings :	\$75,100.00
Land :	\$21,600.00
Total :	\$96,700.00

Flood Insurance : YES



BEEBE LAKE WRIGHT CO.

Structure Number : 12
Name : Keegal, Clarence et al
Address : 1543 Hansack Avenue N.E.
St. Michael, MN 55376

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Shorewood Garden
Lot 40, Shorewood Garden.

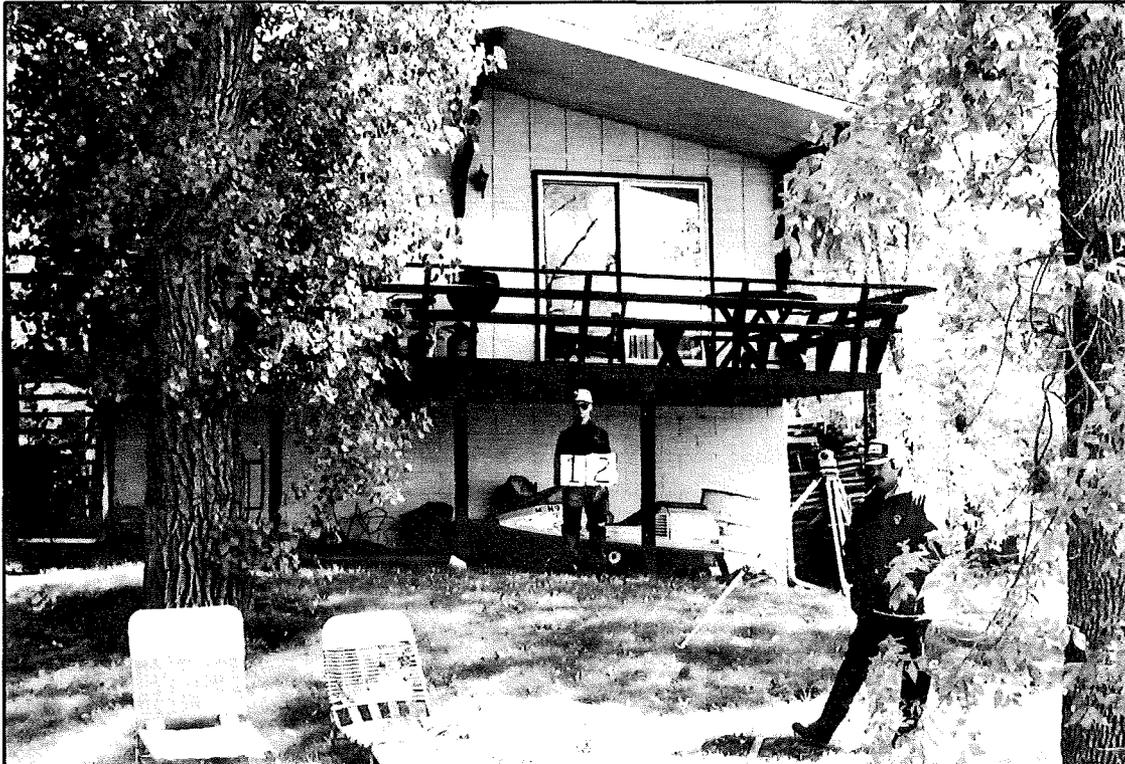
Walkout/1stFl Elev. : 981.10
Ground Elevation : 973.4

Basement : YES
Walkout : YES

Market Value

Buildings :	\$54,500.00
Land :	\$22,500.00
Total :	\$77,000.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 13
Name : Hedtke, Denver A. & B.
Address : 7840 Harold Avenue
Golden Valley, MN 55427

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Shorewood Garden
Lot 38, Shorewood Garden.

Walkout/1stFl Elev. : 974.87
Ground Elevation : 969.8

Basement : YES
Walkout : NO

Market Value

Buildings :	\$47,000.00
Land :	\$30,000.00
Total :	\$77,000.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 14
Name : Rytokonen, Dorothy A.
Address : 155 Hansack Avenue N.E.
St. Michael, MN 55376

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Shorewood Garden
Lot 37, Shorewood Garden.

Walkout/1stFl Elev. : 972.73
Ground Elevation : 972.1

Basement : YES
Walkout : YES

Market Value

Buildings :	\$35,100.00
Land :	\$18,500.00
Total :	\$53,600.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 15
Name : Mahoney, Daniel
Address : 1559 Hansack Avenue N.E.
St. Michael, MN 55376

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Shorewood Garden
Lot 36, Shorewood Garden.

Walkout/1stFl Elev. : 973.03
Ground Elevation : 972.4

Basement : YES
Walkout : YES

Market Value

Buildings :	\$40,100.00
Land :	\$16,300.00
Total :	\$56,400.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 16
Name : Lipa, Sandra L. et al
Address : 1563 Hansack Avenue N.E.
St. Michael, MN 55376

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Shorewood Garden
Lot 34, Shorewood Garden.

Walkout/1stFl Elev. : 975.10
Ground Elevation : 971.5

Basement : YES
Walkout : NO

Market Value

Buildings :	\$63,000.00
Land :	\$18,800.00
Total :	\$81,800.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 17
Name : Moen, Dale H. and Carole
Address : 1565 Hansack Avenue N.E.
St, Michael, MN 55376

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Shorewood Garden
Lot 33, Shorewood Garden.

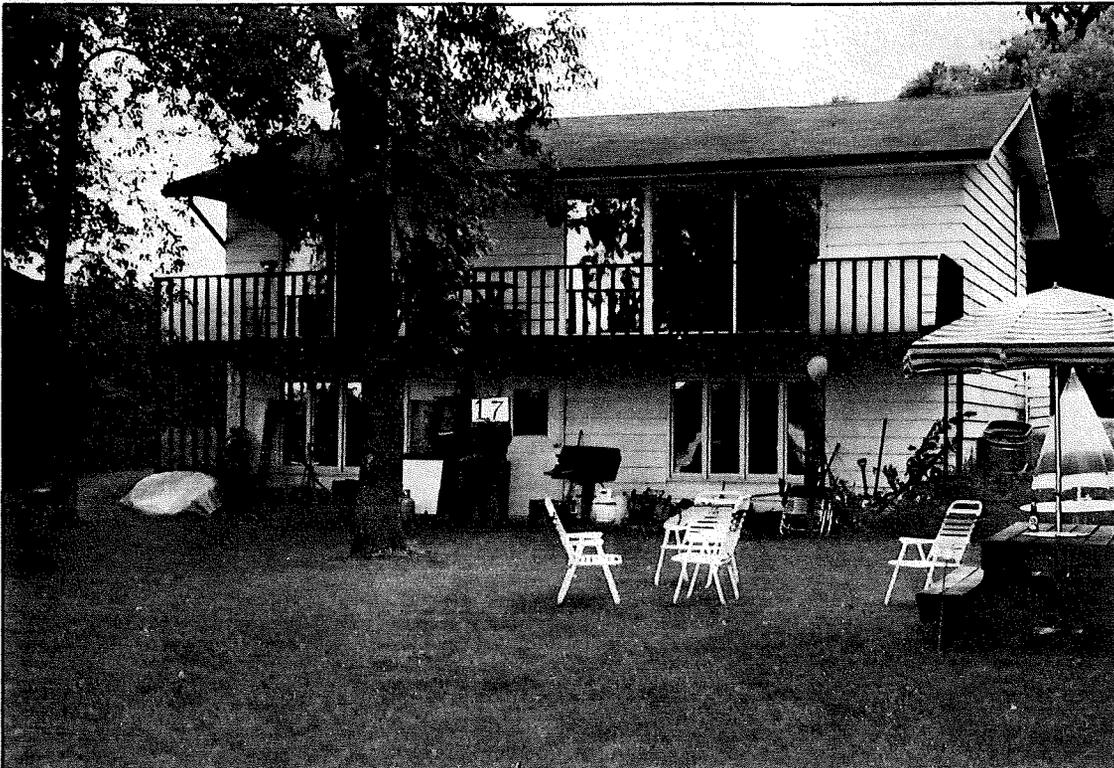
Walkout/1stFl Elev. : 970.20
Ground Elevation : 970.0

Basement : YES
Walkout : YES

Market Value

Buildings : \$45,000.00
Land : \$15,000.00
Total : \$60,000.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 18
Name : Johnston, Ralph R.
Address : 1669 Hansack Avenue N.E.
St. Michael, MN 55376

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Shorewood Garden
Lot 22, Shorewood Garden.

Walkout/1stFl Elev. : 971.59
Ground Elevation : 971.3

Basement : YES
Walkout : YES

Market Value

Buildings :	\$59,600.00
Land :	\$25,000.00
Total :	\$84,600.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 19
Name : Bucci, Nick & Ray Muccio
Address : 1683 Hansack Avenue N.E.
St. Michael, MN 55376

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Shorewood Garden
Lot 21, Shorewood Garden.

Walkout/1stFl Elev. : 970.69
Ground Elevation : 970.5

Basement : YES
Walkout : YES

Market Value

Buildings :	\$44,900.00
Land :	\$18,800.00
Total :	\$63,700.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 20
Name : Scherber, Jackie
Address : 1745 Hansack Avenue N.E.
St. Michael, MN 55376

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Shorewood Garden
Lot 17, Shorewood Garden.

Walkout/1stFl Elev. : 973.73
Ground Elevation : 973.5

Basement : YES
Walkout : YES

Market Value

Buildings :	\$34,200.00
Land :	\$17,500.00
Total :	\$51,700.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 21
Name : Ricker, Robert J.
Address : 5134 Baker Road
Minnetonka, MN 55343

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Shorewood Garden
Lot 15, Shorewood Garden.

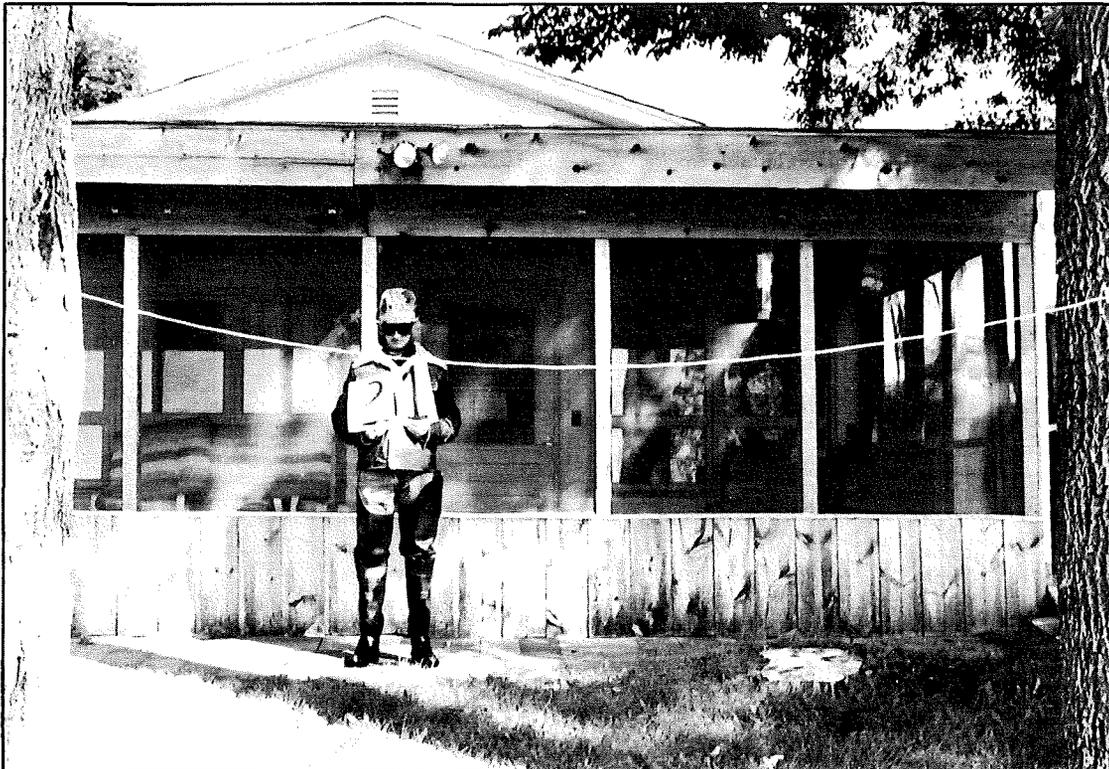
Walkout/1stFl Elev. : 972.20
Ground Elevation : 971.7

Basement : YES
Walkout : YES

Market Value

Buildings :	\$21,900.00
Land :	\$17,500.00
Total :	\$39,400.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 22
Name : Cassidy, James and Nancy
Address : 1787 Hansack Avenue N.E.
St. Michael, MN 55376

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Shorewood Garden
Lot 14, Shorewood Garden.

Walkout/1stFl Elev. : 972.70
Ground Elevation : 972.4

Basement : YES
Walkout : YES

Market Value

Buildings :	\$59,700.00
Land :	\$16,300.00
Total :	\$76,000.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 23
Name : Busch, Merrill J.
Address : 2120 Girard Avenue South
Minneapolis, MN 55405

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Shorewood Garden
Lot 12, Shorewood Garden.

Walkout/1stFl Elev. : 974.07
Ground Elevation : 973.8

Basement : YES
Walkout : YES

Market Value

Buildings :	\$37,800.00
Land :	\$16,500.00
Total :	\$54,300.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 24
Name : Matthews, Jack & Beverly
Address : Rt. 1, Box 86
St. Michael, Mn 55376

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Shorewood Garden
Lot 11, Shorewood Garden.

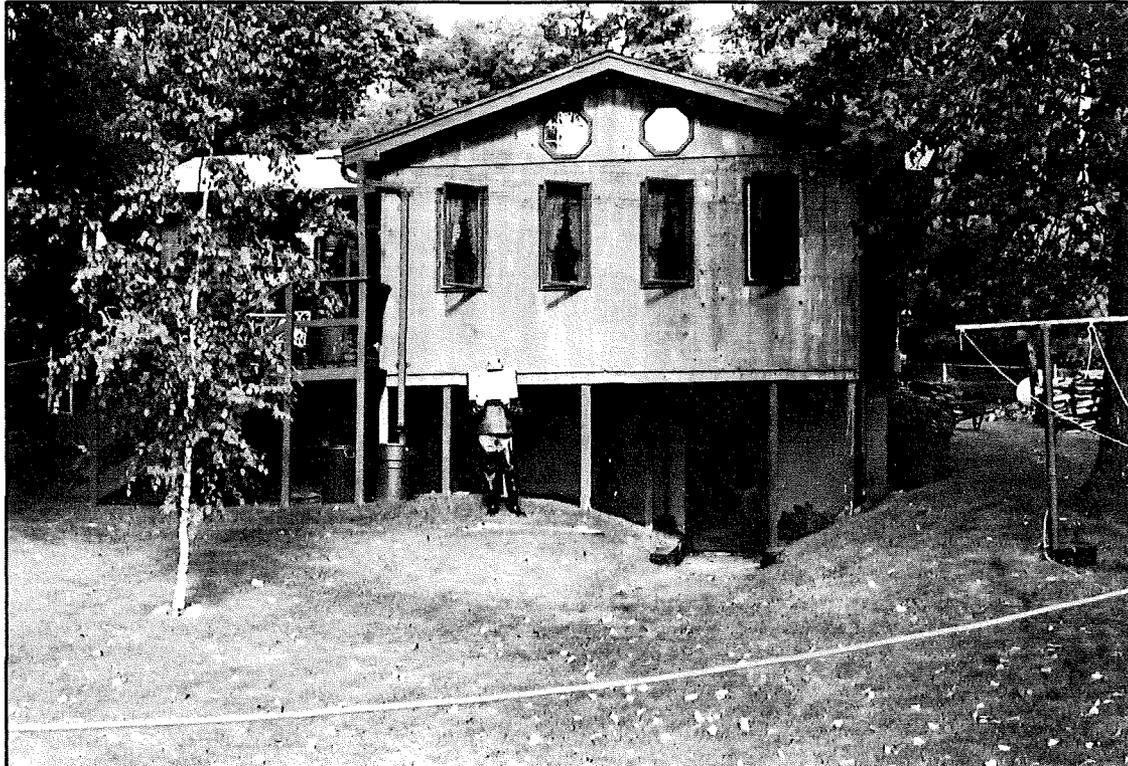
Walkout/1stFl Elev. : 971.63
Ground Elevation : 971.0

Basement : YES
Walkout : YES

Market Value

Buildings : \$40,800.00
Land : \$17,000.00
Total : \$57,800.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 25
Name : Enos, Jerel R. & Cheryl
Address : 1841 Hansack Avenue N.E.
St. Michael, MN 55376

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Shorewood Garden
Lot 10, Shorewood Garden.

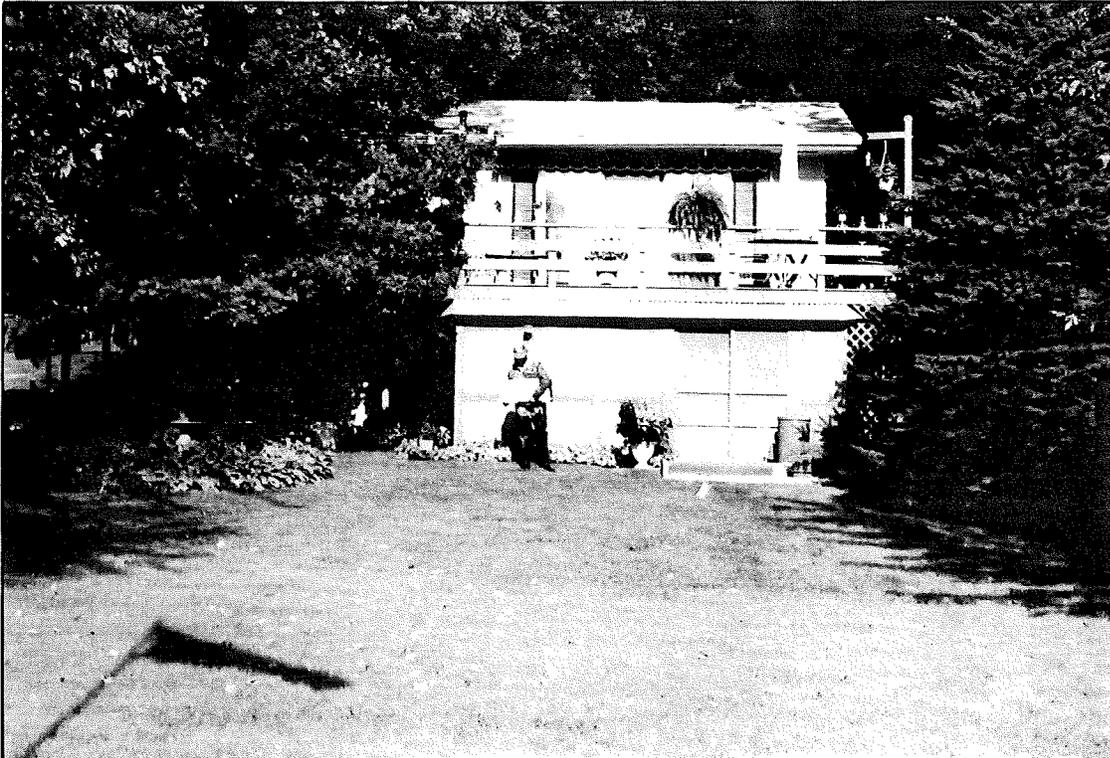
Walkout/1stFl Elev. : 972.42
Ground Elevation : 972.2

Basement : YES
Walkout : YES

Market Value

Buildings : \$40,400.00
Land : \$17,000.00
Total : \$57,400.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 26
Name : Hewitt, Robert L. & Linda
Address : 111 Hwy. # 25 North
Buffalo, MN 55313

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Shorewood Garden
Lot 5, Shorewood Garden.

Walkout/1stFl Elev. : 974.92
Ground Elevation : 973.2

Basement : YES
Walkout : YES

Market Value

Buildings :	\$50,700.00
Land :	\$9,000.00
Total :	\$59,700.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 27
Name : Weigler, John Jr. et al
Address : 2119 8th Street South
Minneapolis, Mn 55454

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Unplatted land, TR description in Book 268-486 on
file with the County Assessor's Office.
Pin Number: 207-200-291205 877.

Walkout/1stFl Elev. : 969.25
Ground Elevation : 967.2

Basement : NO
Walkout : NO

Market Value

Buildings :	\$12,400.00
Land :	\$12,000.00
Total :	\$24,400.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 28
Name : Flatau, Alvin et al
Address : 914 West 82nd Street
Bloomington, MN 55420

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24, That part of
Gov't. Lot 3, legal description on file with the
County Assessor's Office.
Pin Number: 207-200-291204 877.

Walkout/1stFl Elev. : 970.65
Ground Elevation :

Basement : NO
Walkout : NO

Market Value

Buildings :	\$13,200.00
Land :	\$14,000.00
Total :	\$27,200.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 29
Name : Hutera, Walter Life Est.
Address : 188 Bevins Lane
North St. Paul, MN 55109

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24
Unplatted land, TR description in Book 188-92 on
file with the County Assessor's Office.
Pin Number: 207-200-291202 877.

Walkout/1stFl Elev. : 966.97
Ground Elevation : 970.2

Basement : YES
Walkout : YES

Market Value

Buildings :	\$20,600.00
Land :	\$17,500.00
Total :	\$38,100.00

Flood Insurance : NO



BEEBE LAKE WRIGHT CO.

Structure Number : 30
Name : Pyle, Roger and Marlene
Address : 7611 20th Street N.E.
St. Michael, MN 55376

Legal Description : N. 1/2 Sec. 29, Twp. 120, R. 24, That part of
Gov't. Lot 3, Legal Description on file with the
County Assessor's Office.
Pin Number: 207-200-291203 877.

Walkout/1stFl Elev. :
Ground Elevation : 974.3

Basement : YES
Walkout : YES

Market Value

Buildings :	\$63,600.00
Land :	\$28,000.00
Total :	\$91,600.00

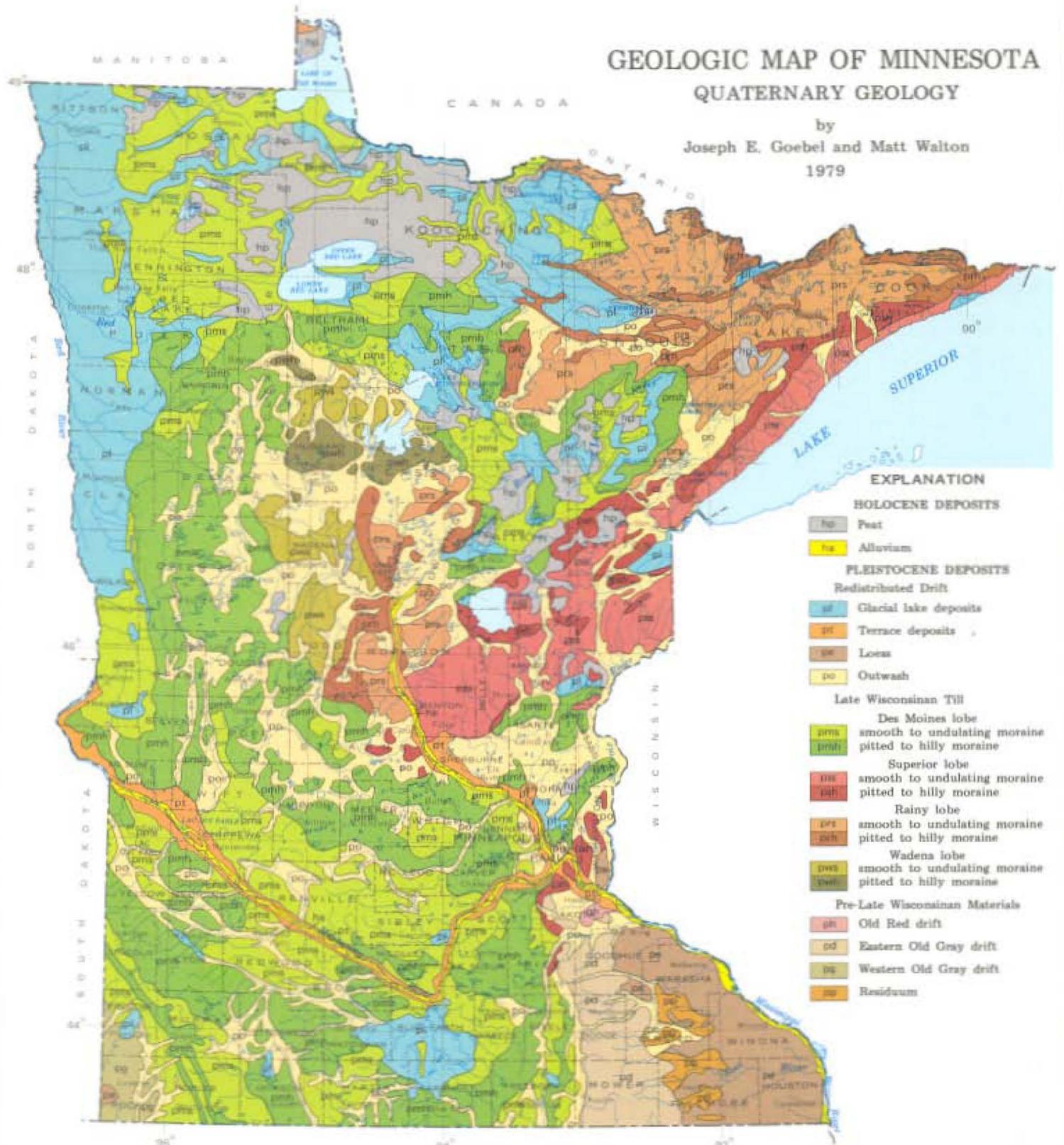
Flood Insurance : NO



APPENDIX E
GEOLOGIC MAP OF MINNESOTA

GEOLOGIC MAP OF MINNESOTA QUATERNARY GEOLOGY

by
 Joseph E. Goebel and Matt Walton
 1979



EXPLANATION

HOLOCENE DEPOSITS

- ho Peat
- al Alluvium

FLEISTOCENE DEPOSITS

Redistributed Drift

- gl Glacial lake deposits
- td Terrace deposits
- lo Loess
- po Outwash

Late Wisconsinan Till

- Des Moines lobe
 smooth to undulating moraine
 pitted to hilly moraine
- Superior lobe
 smooth to undulating moraine
 pitted to hilly moraine
- Rainy lobe
 smooth to undulating moraine
 pitted to hilly moraine
- Wadena lobe
 smooth to undulating moraine
 pitted to hilly moraine

Pre-Late Wisconsinan Materials

- Old Red drift
- Eastern Old Gray drift
- Western Old Gray drift
- Residuum

SCALE 1:3,168,000
 1 inch = 50 miles



QUATERNARY GEOLOGY OF MINNESOTA

The Quaternary Period comprises the "Great Ice Age" or Pleistocene Epoch, which began about 2 million years ago and ended only about 10 thousand years ago. It also includes the Holocene or Recent Epoch, which spans the last 10 thousand years. By comparison with bedrock formations in Minnesota, which range from about 100 million to more than 3,500 million years in age, Quaternary formations represent only a very small part of the state's geologic history. However, glacial drift spread by Pleistocene ice sheets covers most of Minnesota and ranges to hundreds of feet in thickness, so that Quaternary geology is the major influence on topography, soils, water, and land uses—in short, the environment of Minnesota.

Quaternary geologic units are unconsolidated sedimentary materials deposited by water, wind and plant growth, and by glacial ice and meltwaters. This map portrays the distribution of Quaternary formations. Outcrops of bedrock, which are common only in the northeast and along larger river valleys in the south, are not shown on this map.

HOLOCENE DEPOSITS

hp PEAT—Accumulations of partially decayed vegetation, especially mosses, reeds and sedges, in wet, poorly-drained areas. Peat is valuable as an organic soil conditioner and chemical feedstock and as a potential energy resource. It is a very poor base for roads and other construction.

ha ALLUVIUM—Sand and gravel, locally interbedded with silt, clay and organic material, deposited on present floodplains. Sand and gravel deposits, copious shallow ground water and flat terrain make alluvial plains attractive for urban and industrial development, but they are flood-prone, and sensitive to pollution. They are valuable for agriculture and wildlife.

PLEISTOCENE DEPOSITS

There were four major ice advances in North America during the Pleistocene Epoch: the Nebraskan, Kansan, Illinoian and Wisconsinan Glaciations. Each lasted tens of thousands of years and was followed by a warmer period when the ice melted. Each deposited sediments, called drift, over vast areas. Drift deposited during the last stage of the Wisconsinan Glaciation covers most of Minnesota and conceals evidence of older ice advances except in the southeast and southwest corners of the state.

Redistributed Drift

Some drift deposited by glaciers was quickly eroded, transported and redeposited by water and wind in lakes, on floodplains and on land beyond the margin of the ice.

pl GLACIAL LAKE DEPOSITS—Clay, silt and sand with local gravel bars and beaches deposited on the beds and margins of extensive lakes that existed when outlets for meltwater were blocked by ice or by glacial deposits which have now eroded away. Major glacial lakes were: Lake Agassiz in northwestern and north-central Minnesota, Lakes Upham and Aitkin northwest of Duluth, and Lake Minnesota south of Mankato. Due to the prevalence of fine silt and clay, glacial lake deposits present drainage and construction problems and tend to be poor ground-water sources. They form extensive areas of flat farmland, notably the Red River Valley.

pt TERRACE DEPOSITS—Stratified sand and gravel with some interbedded silt and clay occurring along stream valleys above the level of present floodplains. During glacial melting, streamflow was larger than at present, and floodplains were built up by glacial sediments. Recent streams have cut into older floodplains leaving remnants as terraces. Terrace tops are commonly flat and well drained. They are attractive for residential and industrial development, but they also contain valuable sand and gravel resources.

pe LOESS—Eolian silt and fine sand blown from unvegetated drift exposed along major glacial streams. Loess is shown on the map for areas where it is commonly more than 2 meters (6.5 feet) thick. Excellent agricultural soils are formed in loess.

po OUTWASH—Sand, silt and gravel carried from glaciers by meltwater and spread over wide areas. The deposits are typically sorted into discontinuous and interfingering beds of silt, sand and gravel called stratified drift. Outwash plains have flat topography, sandy soils, and many gravel deposits. Shallow ground water is commonly abundant for irrigation.

Late Wisconsinan Drift Deposited Directly From Glaciers

The ice of each glaciation accumulated in northern Canada and moved southward in a complex series of tongue-like extrusions or lobes. Near the center of ice accumulation, the moving ice scoured the land surface down to hard bedrock and picked up a load of rock fragments and soil. Farther from the center the ice deposited this drift from its base. Areas of ice-scoured, exposed bedrock occur mainly in northeastern Minnesota; deposition predominated throughout the rest of the state. Drift deposited directly from ice is called till. In general, till is an unsorted mixture of all sizes of rock from boulders to clay and "rock flour." It tends to be stiff, stony and impervious. Till of different lobes differs in composition depending on the geology "upstream" along the path of the advancing ice.

Till deposited from the base of an ice lobe forms a smooth to undulating blanket called a ground moraine. Such till is stiff and compact; it yields little ground water.

Till deposited at ice margins or from stagnating masses of melting ice forms irregular pitted to hilly topography with many ponds and lakes. These landforms are called end moraines, recessional moraines and stagnation moraines. These deposits may contain pockets of sand, gravel and boulders with some local ground water.

pms **pmh** DES MOINES LOBE TILL—Smooth to undulating moraine (pms) and pitted to hilly moraine (pmh). The Des Moines lobe is the most recent glacial lobe. It advanced through the Red River Valley into Iowa. Sublobes extended eastward into the St. Louis River basin and northeastward across Minneapolis and St. Paul, incorporating drift from earlier lobes. Des Moines lobe till is typically clay-rich. It is mainly composed of gray (olive-brown where oxidized) calcareous silt and clay, with lesser amounts of sand and gravel. Shale and limestone are diagnostic.

psa **psh** SUPERIOR LOBE TILL—Smooth to undulating moraine (psa) and pitted to hilly moraine (psh). Ice of the Superior lobe moved out of the Lake Superior basin in several pulses, spreading westward across the Mille Lacs area and southward across the Minneapolis-St. Paul area. It interacted with the partly contemporaneous Rainy lobe along the Laurentian Divide. Superior lobe till is generally reddish-brown, sandy to stony, and non-calcareous; it contains abundant fragments of volcanic, granitic, gabbroic and metamorphic rocks, red sandstone and conglomerate. Where it incorporates earlier lake deposits, it is locally silty or clayey.

prs **prh** RAINY LOBE TILL—Smooth to undulating moraine (prs) and pitted to hilly moraine (prh). The Rainy lobe moved southward into Minnesota along a broad front from Lake of the Woods almost to Lake Superior, where it met ice from the Lake Superior basin along the Laurentian divide and moved southwestward. It advanced to the vicinity of Little Falls overriding drift and perhaps encountering ice remaining from the earlier Wadena lobe. Part of the Rainy lobe drift area was later overridden by the St. Louis sublobe of the Des Moines lobe. Rainy lobe till is grayish brown (moderate brown where oxidized), non-calcareous and generally sandy with abundant fragments of granitic, metamorphic and greenstone volcanic rocks.

pws **pwh** WADENA LOBE TILL—Smooth to undulating moraine (pws) and pitted to hilly moraine (pwh). The Wadena lobe was the earliest of the Late Wisconsinan glacial lobes. A large remnant of its till and outwash survives in north-west-central Minnesota in an area that was not overridden by any of the three later lobes. A large drumlin field indicates movement of ice from the north or a little east of north. Wadena lobe till is gray (yellowish brown where oxidized) and calcareous with fragments of igneous and metamorphic rocks, some limestone and little or no shale.

Pre-Late Wisconsinan Materials

At one time or another, prior to the Late Wisconsinan, all of Minnesota must have been covered by glaciers. Evidence is concealed beneath Late Wisconsinan drift except in the southwestern and southeastern corners of the state where there are deposits of weathered and stream-dissected drift that are older than Late Wisconsinan and could be Illinoian or Kansan in age.

ph OLD RED DRIFT—Moderate to dusky-brown till and outwash found mainly in Dakota and southern Washington Counties. Fragments of gabbro, felsite and red sandstone are notable. Some exposures show a distinct weathered profile overlain by younger drift.

pd EASTERN OLD GRAY DRIFT—Moderate yellowish-brown weathered silty till and outwash. It contains fragments of igneous and metamorphic rocks, limestone and sandstone, but lacks shale. It appears to underlie Old Red Drift in southern Dakota County.

pg WESTERN OLD GRAY DRIFT—Dark-gray, strongly weathered, clayey, stream-dissected till and outwash with fragments of quartzite, granite and limestone.

po RESIDUUM—Soils of uncertain age and origin, including some old weathered drift and loess, on weathered pre-Quaternary rocks.

REFERENCES

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