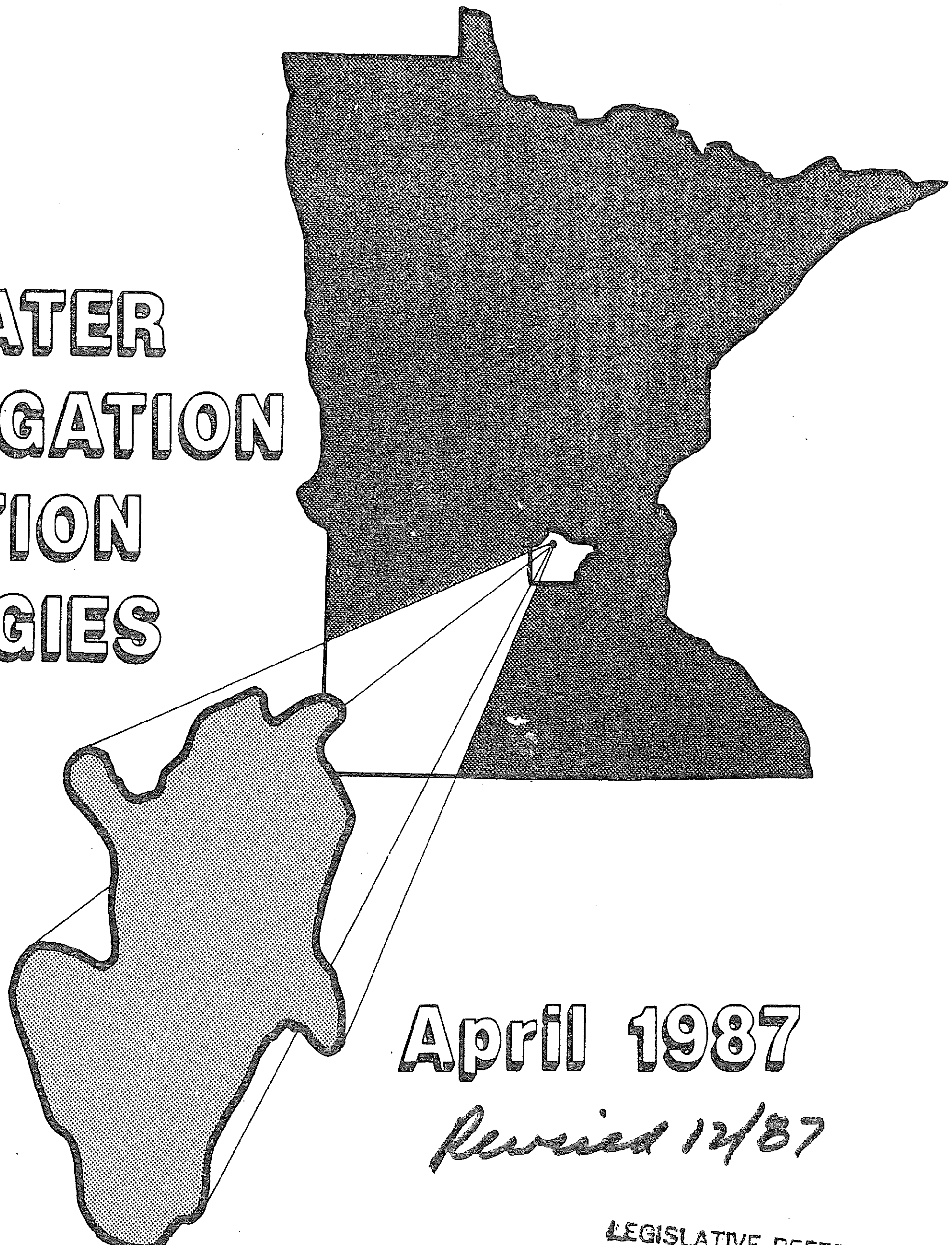
INDIAN LAKE

(Wright County, 86-223)



HIGH WATER INVESTIGATION MITIGATION STRATEGIES

April 1987

Revised 12/87

Minnesota
Department of Natural Resources
Division of Waters

HIGH WATER INVESTIGATION

AND

MITIGATION STRATEGIES

FOR

INDIAN LAKE

BASIN #86-223

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 mitigation strategies for high water problem lakes. 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

This report was prepared under a Hazard Mitigation Assistance Grant from the Federal Emergency Management Agency with matching funds from the Department of Natural Resources, Division of Waters. This report would not have been possible without the special assistance of the Wright County Assessors Office.

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INTRODUCTION

Indian Lake is located in northwestern Wright County, Minnesota, approximately 45 miles northwest of the Twin Cities metropolitan area. The Lake is 5 miles northeast of the City of Annandale, and most of its area is within Sections 1 and 12 of Township 121 North, Range 27 West (Plate 1).

Indian Lake is one of over 50 landlocked lakes within glaciated terrain in Minnesota that, in recent years, have been experiencing high water 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.

Indian Lake is situated in glacial moraine deposits associated with the Des Moines lobe glaciation which overlie the St. Croix moraine complex. In recent years, the Lake level began to rise after heavy rainstorms, and by September 22, 1986, the lake rose to within 1.82' of its Ordinary High Water Level (OHW elevation 1014.7', 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.

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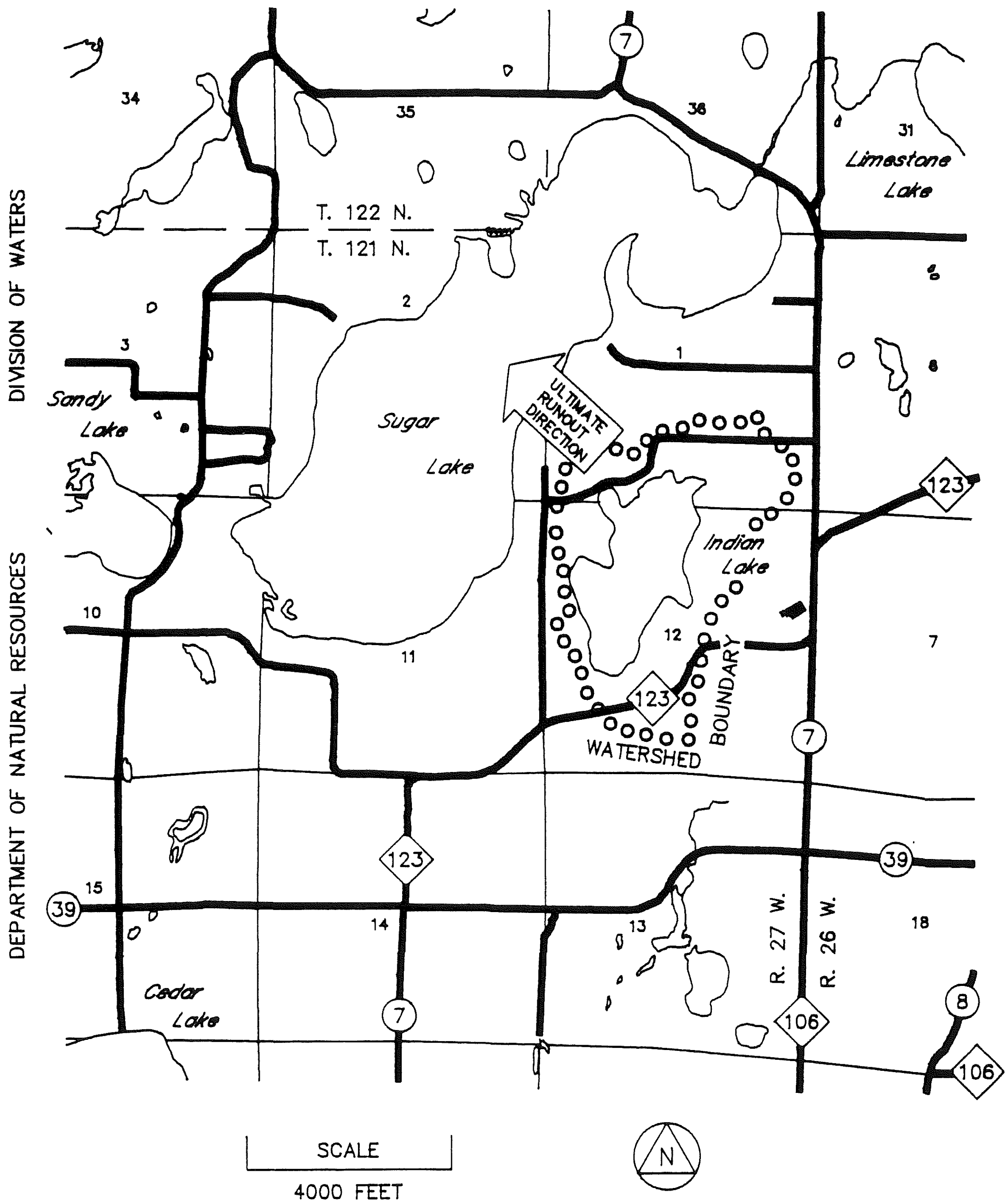
[1]National Geodetic Vertical Datum of 1929 is used for all elevations included in this report.

PLATE 1



DEPARTMENT OF NATURAL RESOURCES DIVISION OF WATERS
T. 122 N.
T. 121 N.
R. 27 W.
R. 26 W.
Sugar Lake
Sandy Lake
Limestone Lake
Indian Lake
Cedar Lake
ULTIMATE RUNOUT DIRECTION
WATERSHED BOUNDARY
34
35
36
31
2
3
1
8
10
11
12
7
15
14
13
18
7
123
39
106
8
SCALE
4000 FEET
N

SUMMARY AND CONCLUSIONS/RECOMMENDATIONS

Water Level Data (See Part 1)

-In September of 1986 Indian Lake was at elevation 1011.65', an elevation 3.05' below the Lake's Ordinary High Water Level of 1014.7'. Indian Lake's water level reacts to both surface runoff and ground water inflow.

-There is a correlation between the area's annual precipitation and Indian Lake's water level. During the last 5-year period, there has been an excess of 28.94" of precipitation above the normal annual precipitation for this general area. This has resulted in significant surface and ground water inflow and caused the current high water problem.

-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 Indian Lake were to rise to elevation 1019.65', 16 additional structures would be flooded with 1986 assessed market values totalling $306,100. At this elevation, it is estimated a minimum $285,895 of damage would occur.

-Methodologies do not exist which can predict what Indian Lake's maximum elevation will be in the future. The major factor on limiting potential increases in Indian Lake's level would be if the Lake should reach its natural runout elevation of 1021.1'.

-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 Indian Lake will: 1) rise above elevation 1013.4' on December 1, 1987; or 2) will exceed elevation 1016.4' by December 31, 1991. Conversely, there is a one-percent probability the lake will: 1) fall below elevation 1010.9' by December 1, 1987; or 2) fall below elevation 1010.0' by December 31, 1991. There is a 50% probability (a 50/50 chance) that Indian Lake will be at elevation 1012.1' on December 1, 1987 and elevation 1013.0' 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 Indian 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 adjacent to the Lake's shoreline. The County can properly regulate new development with its existing state-approved shoreland regulations with one recommended revision/addition. 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 1018.7').

-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 <u>all</u> landowners and renters in the unincorporated area of Wright County. A structure and/or its contents can be insured. Landowners or renters adjacent to Indian Lake should explore purchasing flood insurance.

-Landowners can take emergency measures to protect existing development. The safest method is either relocating a structure to natural ground above the potential flood level or elevating a structure at its existing site on fill to a minimum recommended flood protection elevation. 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 lake. These programs include the U.S. Army Corp 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.

-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 authorites 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 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

Indian Lake is located in glacial moraine deposits associated with Des Moines Lobe glaciation which overlie the St. Croix moraine complex. The glacial drift consists of calcareous silty till with buried sand and gravel deposits. An extensive outwash (sand and gravel) plain extends west from the southwest corner of Sugar Lake, 1 mile west of Indian Lake. The glacial deposits are approximately 150 feet thick in the area and are underlain by pre-Cambrian igneous and metamorphic rocks.

Drillers logs from wells in the immediate vicinity of the lake show 20-80 feet of till at the surface. The upper 20 feet is oxidized ("yellow clay") while the underlying till is unoxidized ("blue clay"). Beneath the till is a sand deposit, where most of the wells terminate. One well on the south side of the Indian Lake which penetrates the sand shows it to be ±75 feet thick at this location. Indian Lake is probably situated entirely in till, although it is possible that the bottom of the Lake intersects the buried sand deposit.

Soils

The soils surrounding Indian Lake are loam, clay loam, or silty clay loam developed over silty or calcareous glacial till. There are some sandy beach soils at the northeast end of the Lake. The Lake bottom and lakeshore sediments consist primarily of sand.

HYDROGEOLOGIC SETTING

The primary water-bearing units in the area are buried sands and gravels within the till and surficial outwash sands west of Sugar Lake. Wells in the area obtain water from these deposits. The direction of ground water flow would be expected to be to the north towards Sugar Lake and Silver Creek, but local flow systems may exist around Indian Lake. Indian Lake is in contact with glacial till, implying slow rates of ground water seepage into and out of the Lake. If the buried sand deposit does intersect the Lake bottom, a more direct lake-ground water connection would exist. However, even at the slower rates of seepage through glacial till, the contribution to Indian Lake's water budget can be significant, especially if a ground water mound develops on the down-gradient (north) 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.

WATERSHED

The total watershed area for Indian Lake is approximately 442 acres (Plate 1 on Page ii). The watershed of 442 acres minus the Lake's water surface area of about 135 acres equals 307 acres or a total watershed area to lake area ratio of about 2½ to 1.

This effective watershed to lake area ratio of about 2½ to 1 is marginally 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. During the last several years, the area has been experiencing periods of above normal precipitation and it is not surprising to see a rise in the lake water level.

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

A field survey completed on June 22, 1984, indicates that the surface water of Indian Lake would ultimately runout to the northwest and into Sugar Lake if the lake would reach elevation 1021.1' (See Plate 1 on Page ii).

WATER QUALITY

The Department of Natural Resources completed lake surveys including water quality information for Indian Lake in 1960, 1971, 1974 and 1983. Indian Lake is a moderately hard-water, eutrophic lake and is typical of other lakes in the area. A healthy diversity of aquatic vegetation grows to a depth of 8 feet over more than 50% of the lake's area. Levels of epilimnetic total phosphorus were moderate on all sampling dates. There are no other direct measurements of nutrient enrichment.

Water quality problems have included occasional winterkills in severe winters and a toxic algal bloom in 1949. Water clarity at mid-summer remains relatively good - apparently the biological productivity is dominated by aquatic weeds. These weeds aid in the maintenance of dissolved oxygen in the water column but grow very densely in areas. Indian Lake has experienced recent water level increases but the effects cannot be assessed due to the lack of recent time-series data. 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 (1960, 1971, 1983) classify Indian Lake in ecological and management terms as Centrarchid (Largemouth Bass). The fish population of the Lake as indicated from the surveys includes northern pike, largemouth bass, black and white crappies, bluegills, sunfish, a few walleyes, yellow perch, golden shiners, white suckers and a high number of black bullheads. The Lake historically has had a low northern pike population which has increased to an average abundance in recent years, while a high number of bluegills have resulted in a stunted condition for their species. In addition, the Lake has a tendency to winterkill in severe winters (perhaps once in ten years). After a severe winterkill, it may be necessary to stock selected fish species.

The Department of Natural Resources has not performed a wildlife field survey for Indian 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 2 and 3)

Actual Annual Precipitation:

1982-1986

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

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

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

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 yearly average precipitation = 31.64"/year

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

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

PLATE 2

ANNUAL PRECIPITATION

OF BUFFALO, MN

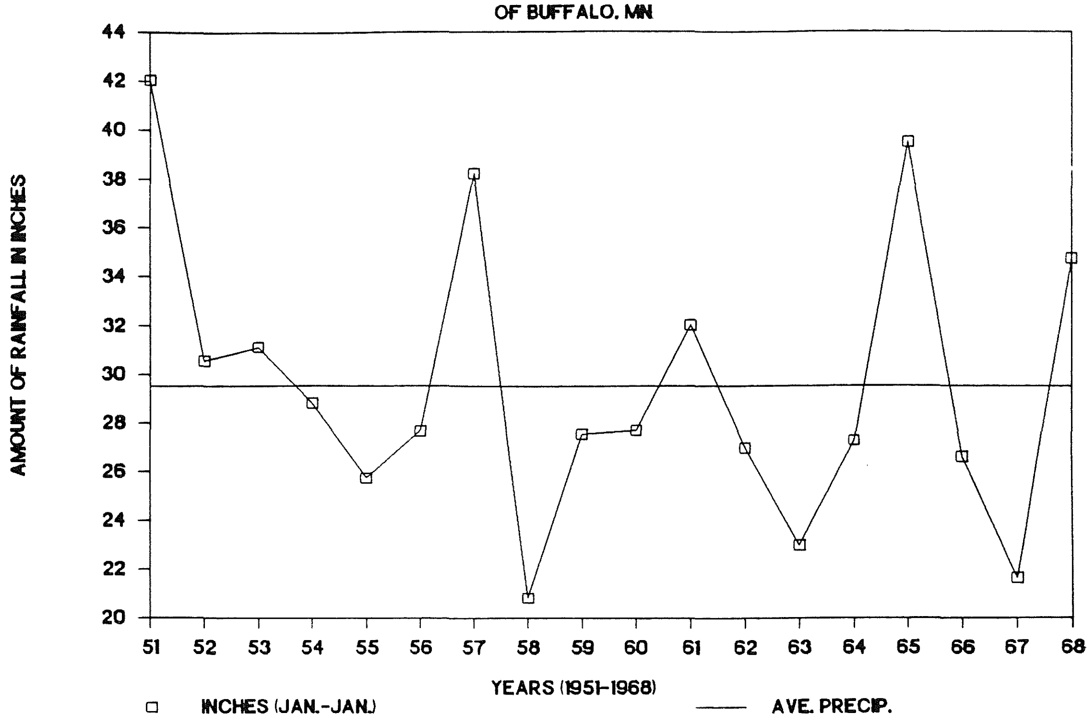
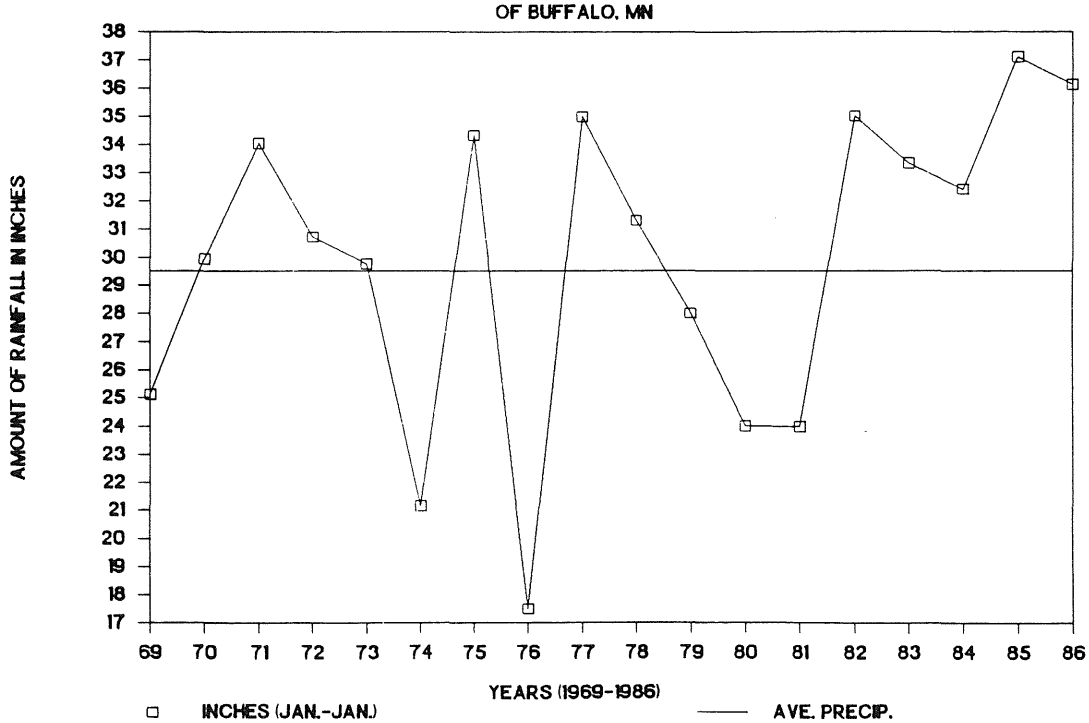


PLATE 3

ANNUAL PRECIPITATION

OF BUFFALO, MN



WATER LEVEL HISTORY

The Department of Natural Resources' Indian Lake file contains a number of fairly reliable surface water elevations dating from 1951 through May 31, 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 Indian Lake's water level. From 1982 through 1986 (last 5 years), the area has received an additional 28.94 inches of precipitation over the normal annual precipitation of 29.03 inches. The water level of the Lake (1012.88') on September 22, 1986 was within 1.82' of the Lake's Ordinary High Water Level (1014.7') 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 4 and 5). These long-term precipitation variations could continue into the future and Indian Lake's water surface elevation will respond accordingly. Because above normal periods of precipitation of longer duration than the current period (last several years) have occurred in the past, the current period may continue for several more years resulting in continued increasing lake levels.

CHART 1

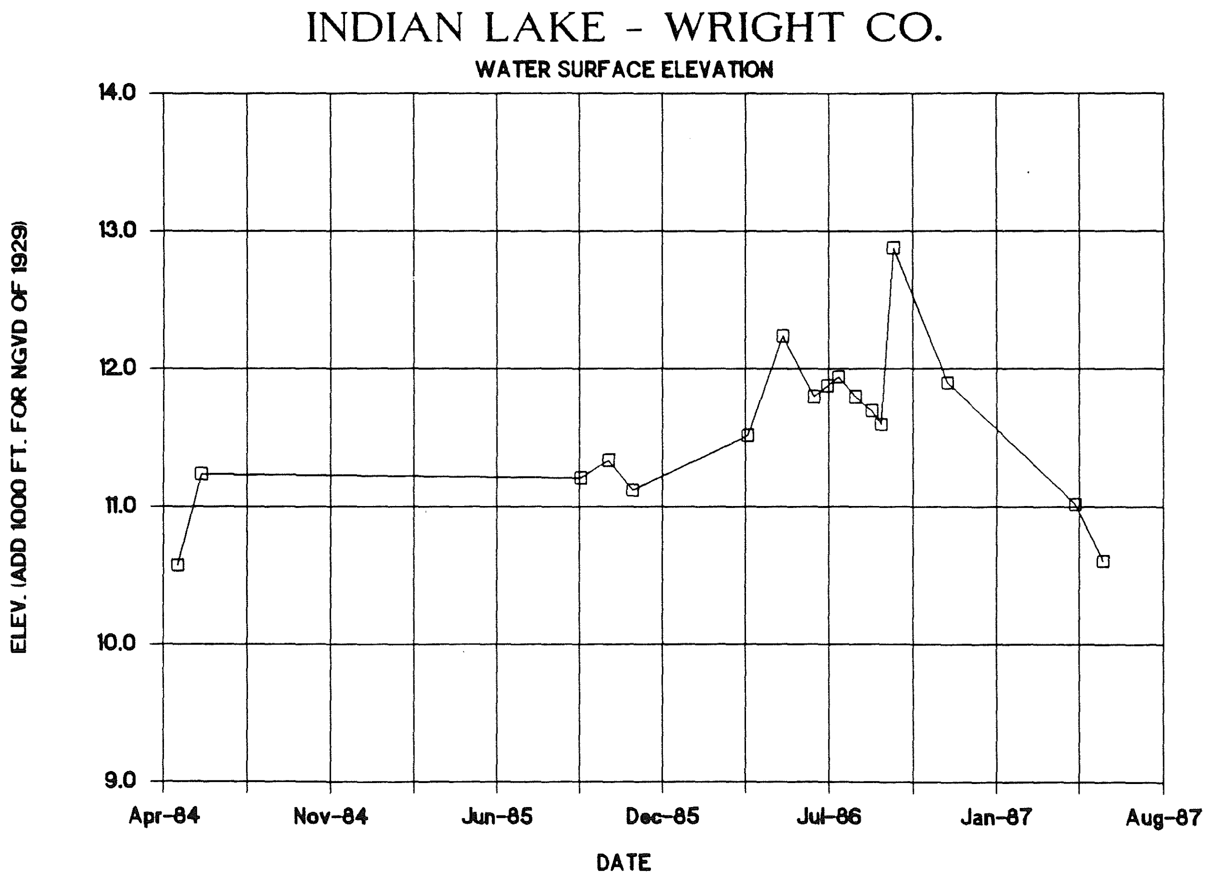


Table 1

WATER LEVEL HISTORY

Date	Water Level	Source
1951	1003.00	USGS Quadrangle Map
1974	1009.00	USGS Quadrangle Map
5/15/84	1010.58	DOW Field Survey
6/12/84	1011.24	DOW Field Survey
9/11/85	1011.21	Gage
10/15/85	1011.34	Gage
11/13/85	1011.12	Gage
4/1/86	1011.52	Gage
5/13/86	1012.24	Gage
6/19/86	1011.80	Gage
7/5/86	1011.88	Gage
7/19/86	1011.94	Gage
8/7/86	1011.80	Gage
8/27/86	1011.70	Gage
9/7/86	1011.60	Gage
9/22/86	1012.88	DOW Field Survey
11/25/86	1011.90	DOW Field Survey
4/28/87	1011.02	Gage
5/31/87	1010.61	Gage

Note: See Appendix E for more Lake Level Readings.

PLATE 4

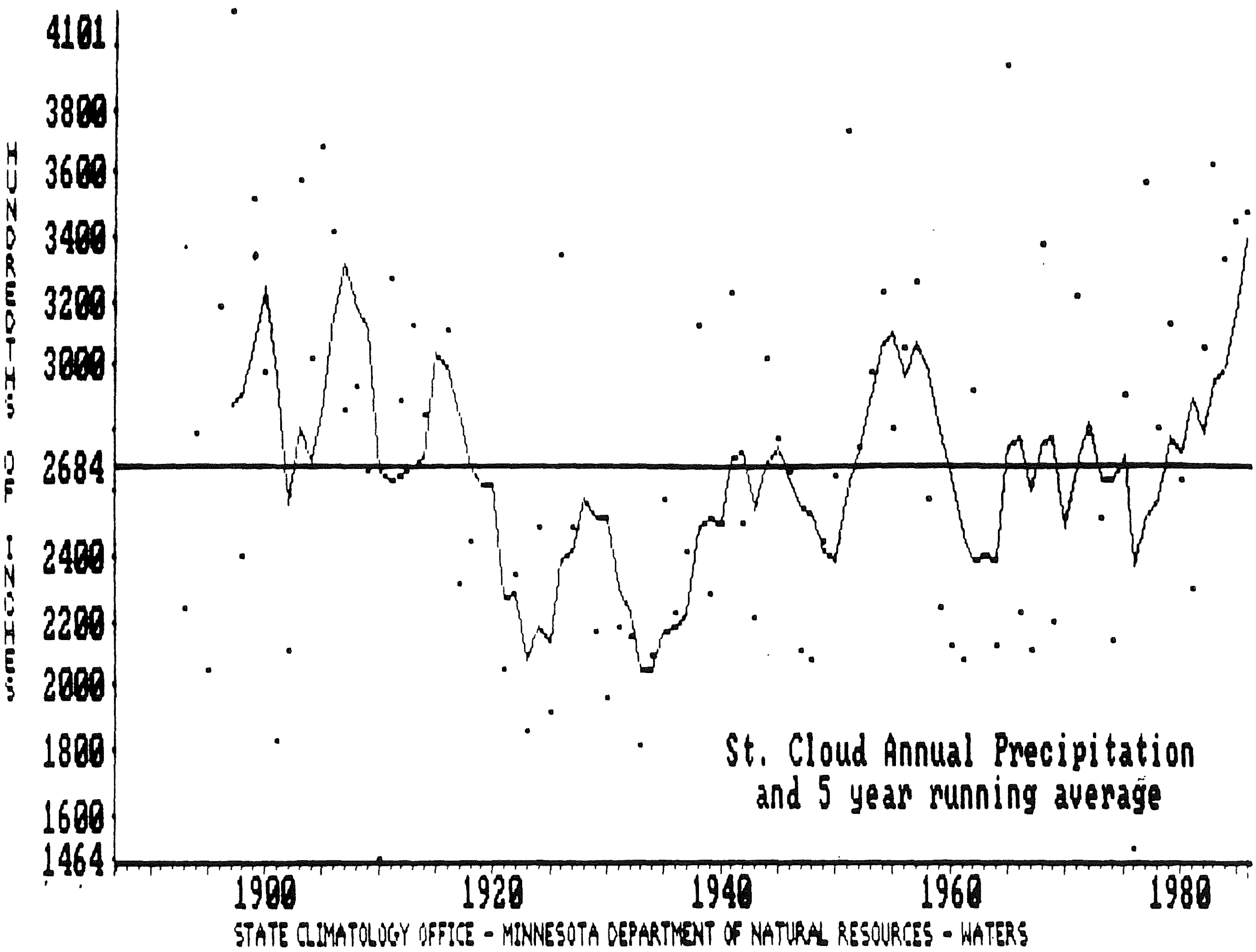
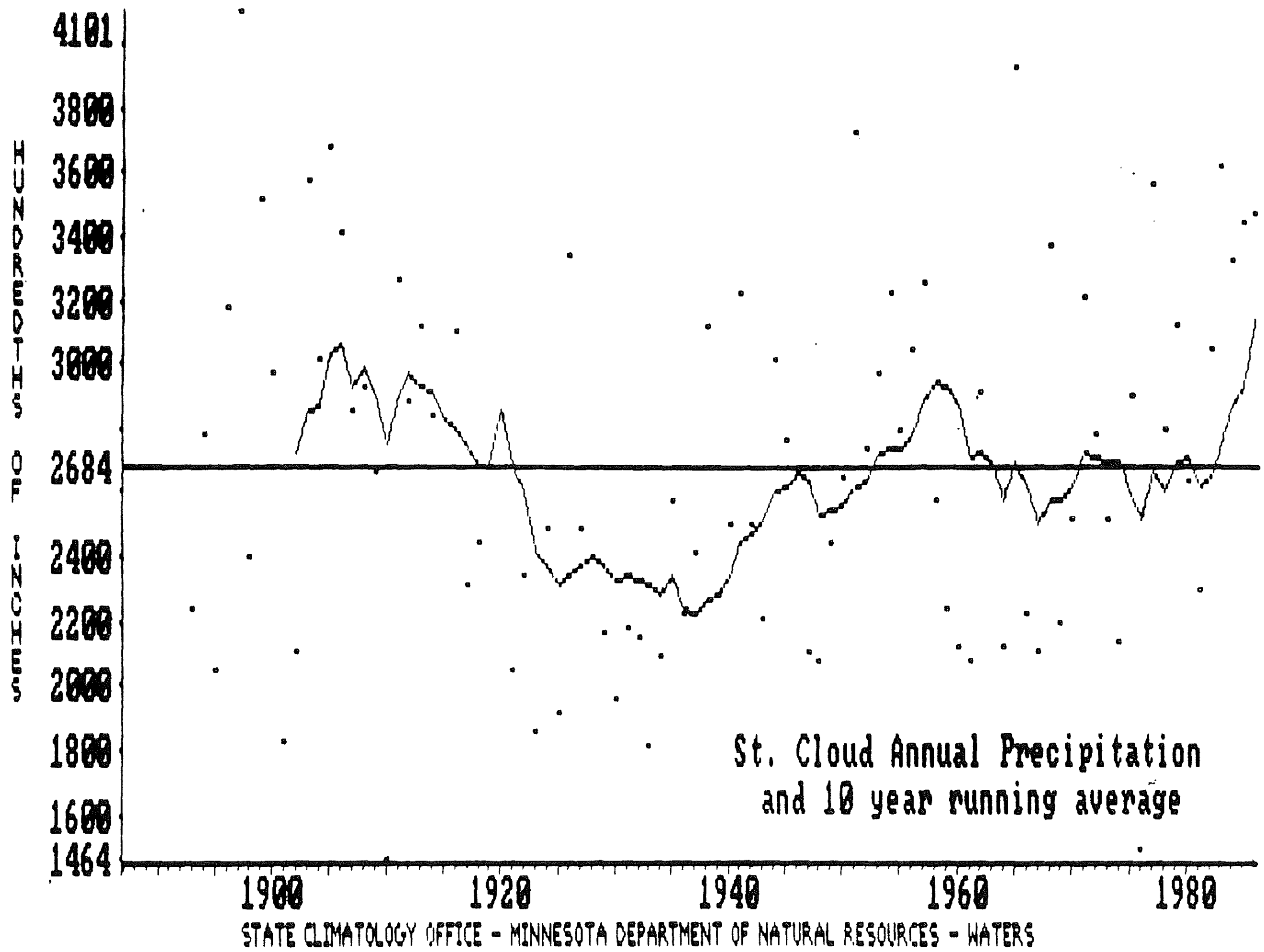

4101
3800
3600
3400
3200
3000
2684
2400
2200
2000
1800
1600
1464
HUNDREDTHS OF INCHES
1900
1920
1940
1960
1980
St. Cloud Annual Precipitation
and 5 year running average
STATE CLIMATOLOGY OFFICE - MINNESOTA DEPARTMENT OF NATURAL RESOURCES - WATERS

PLATE 5



HUNDREDTHS OF INCHES
4101
3800
3600
3400
3200
3000
2684
2400
2200
2000
1800
1600
1464
1900
1920
1940
1960
1980
St. Cloud Annual Precipitation
and 10 year running average
STATE CLIMATOLOGY OFFICE - MINNESOTA DEPARTMENT OF NATURAL RESOURCES - WATERS

ORDINARY HIGH WATER LEVEL (OHW)

The Ordinary High Water Level (OHW)[2] for Indian Lake has been determined by the Department of Natural Resources, Division of Waters in accordance with Minnesota Statute § 105.37, Subdivision 16. OHW data were obtained from field surveys completed on June 22, 1984, and the subsequent analysis indicated the OHW to be at elevation 1014.7'.

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 Level. 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

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[2] According 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 is 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 Indian Lake's fluctuations have been closely related to how much precipitation falls at the Lake. Precipitation patterns historically have 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, five-years, etc.

The probability of different scenarios of future water level conditions can be estimated from historical precipitation data and ground water 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 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 Indian Lake, the WATBUD model was calibrated for the period September, 1985 through November, 1986 using monthly precipitation from St. Cloud and pan evaporation data from Becker. The recorded Lake level of 1011.9'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 Indian Lake would rise above elevation 1013.4' on December 1, 1987 and a one-percent probability the Lake will exceed elevation 1016.4' on December 31, 1991. These elevations are still many feet below the ultimate runout of 1021.1'. Conversely, probabilities exist which state the likelihood the lake elevation may fall. There is a one-percent probability Indian Lake may fall below elevation 1010.9' by December 1, 1987 and a one-percent probability the Lake may fall below elevation 1010.0' on December 31, 1991. The modeling results also suggest a 50-percent probability (a 50/50 chance) that the Lake will be at elevation 1012.1' on December 1, 1987 and 1013.0' in approximately 5-years.

The above-noted modeling concerned itself with longer periods of total precipitation and did not attempt to determine the impacts of major storm events which occur relatively quick and are not cyclical. 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 1011.9', the 100-year, 24 hour duration event of 5.7 inches of precipitation would result in a Lake level increase of 0.9 feet to elevation 1012.8' and the 100-year, 10 day runoff of 7.2 inches would result in a lake level increase of 1.6 feet to elevation 1013.5'.

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 Indian Lake. These base data were collected in August of 1986 when the Lake was at elevation 1011.65'. While the potential maximum elevation of Indian Lake is unknown, it was felt surveying structures within an approximate 5-6' vertical elevation above elevation 1011.65' would identify those structures most immediately subject to flood damage.

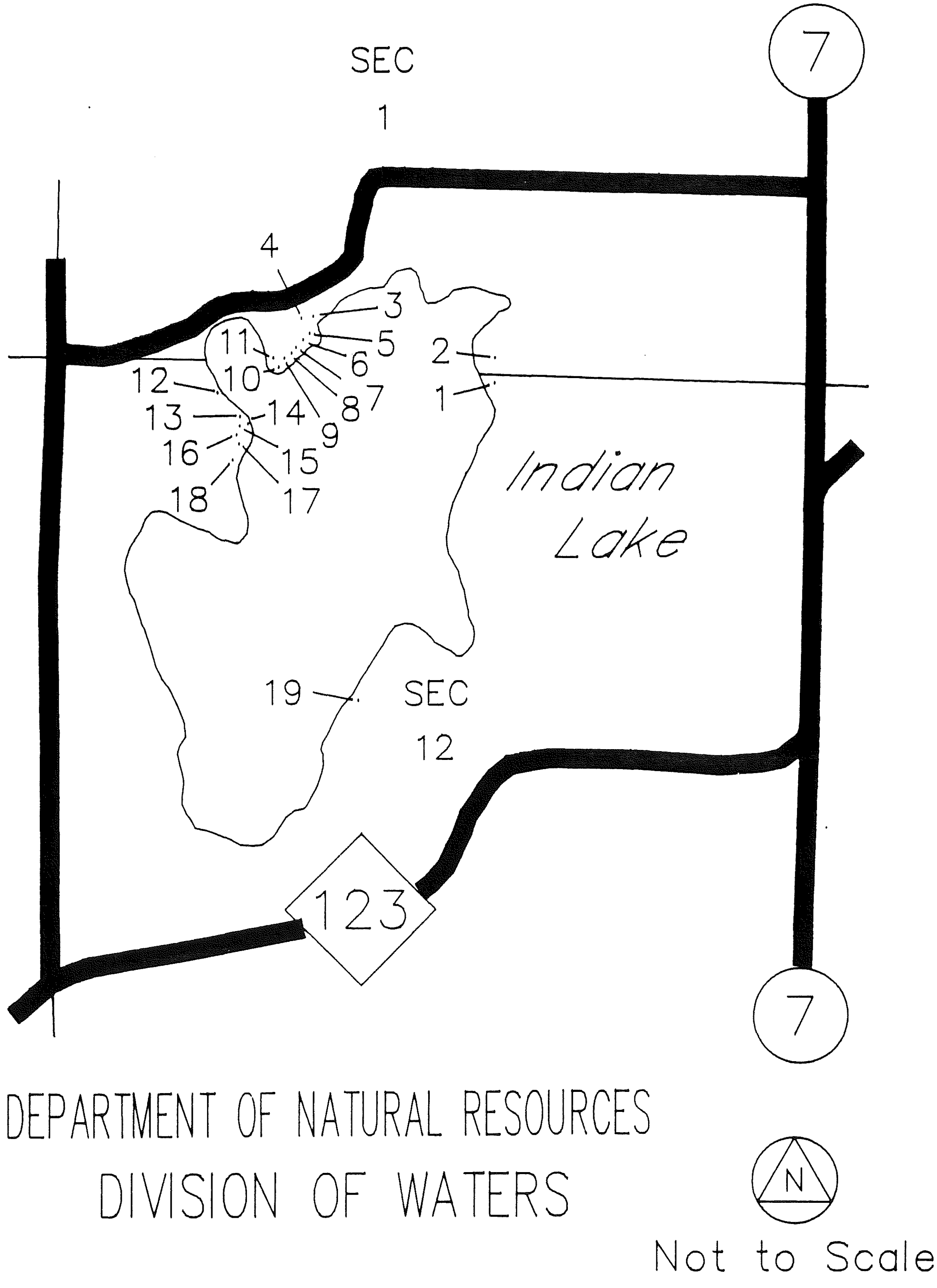
The example below shows a generic fact sheet that was completed for each structure surveyed. The elevations were determined from instrument surveys. Plate 6 on the following page shows the location of each structure surveyed. Appendix D contains the actual fact sheet for each structure surveyed with 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	:	1013.17'
Ground Elevation	:	1010.80'
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 6


SEC
1
7
4
3
5
2
11
6
12
10
8
7
1
13
14
9
16
15
18
17
Indian
Lake
19
SEC
12
123
7
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATERS
N
Not to Scale

Potential structural losses for Indian 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 1011.65' and 1019.65' would be $306,100.

> 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 1019.65', an estimated $285,895 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 14 and 15 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 or 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 27-30 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[2]	First Floor Level	Walkout Level[3]	Ground Level at Base of Crawlspace or Basement	Potential Damages/ Row Totals: Market Value	Potential Damages/ Row Totals: Actual Damages[4]	Potential Damages/ Cumulative Row Totals: Market Value	Potential Damages/ Cumulative Row Totals: Actual Damages[4]
Structures below elevation 1011.65[1] presently flooded	5	$ 100	1012.66	N/A	1010.70				
	11	100	1013.17	N/A	1010.80				
	12	13,000	1018.20	1011.20	N/A				
New damages between elevations 1011.66 and 1012.65	18	$13,300	1014.43	N/A	1011.90				
	1	7,900	1012.08	N/A	N/A	$ 54,100	$ 26,600	$ 67,100	$ 26,600
	10	13,100	1016.13	N/A	1012.30				
	7	19,800	1015.51	N/A	1012.60				
New damages between elevations 1012.66 and 1013.65	6	$33,400	1015.74	N/A	1012.70				
	13[5]	24,900	1019.85	1012.85	N/A	$ 74,200	$ 20,775	$141,300	$ 47,375
	3	11,300	1014.67	N/A	1012.90				
	14	4,600	1013.62	N/A	N/A				
New damages between elevations 1013.66 and 1014.65	9	$11,600	1016.30	N/A	1013.70				
	8	13,400	1016.47	N/A	1013.80				
	17	12,900	1017.26	N/A	1014.30	$ 68,500	$ 40,795	$209,800	$ 88,170
	4	14,800	1017.30	N/A	1014.30				
	16	15,800	1019.16	N/A	1014.50				
New damages between elevations 1014.66 and 1015.65	19	$39,700	1018.73	1014.73	N/A	$ 39,700	$ 31,265	$249,500	$119,435
New damages between elevations 1015.66 and 1016.65	No new structures at this elevation	N/A	N/A	N/A	N/A	N/A	$ 75,460	$249,500	$194,895
New damages between elevations 1016.66 and 1017.65	2	$45,600	1023.79	1016.79	N/A	$ 45,600	$ 29,895	$295,100	$224,790
New damages between elevations 1017.66 and 1018.65	No new structures at this elevation	N/A	N/A	N/A	N/A	N/A	$ 28,330	$295,100	$253,120
New damages between elevations 1018.66 and 1019.65	15	$11,000	1018.79	N/A	N/A	$ 11,000	$ 32,775	$306,100	$285,895

[1] Indian Lake's water surface elevation was 1011.65' in August of 1986, which was the time the structure elevation data were collected.
[2] 1986 assessed market value supplied by County Assessor.
[3] With the exception of #19, 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/basement 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 a flooded/abandoned structure, 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 of 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] Twenty-five percent additional damage will occur when water enters any structure with a second level above elevation 1019.65'. The first structure where this would occur is #13 at elevation 1019.85'. 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, catastropic 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 Indian Lake can purchase flood insurance through Wright County's eligibility in the National Flood Insurance Program (NFIP). Actually, <u>all</u> property owners and renters in the unincorporated areas of Wright County can purchase flood insurance <u>regardless of whether or not the property is located in an identified flood hazard area</u>. This latter point must be stressed because a review of Wright County's Flood Insurance Rate Map (Plate 7) indicates a flood hazard delineation has <u>not</u> been provided for Indian Lake. The significance of a lack of a flood hazard delineation will be discussed in greater detail on Pages 37-39 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;
- The removal of a flood damaged structure from a site;
- A "loss in progress" (5-day waiting period); and
- Special loss adjustment procedures for continuous lake flooding.

PLATE 7

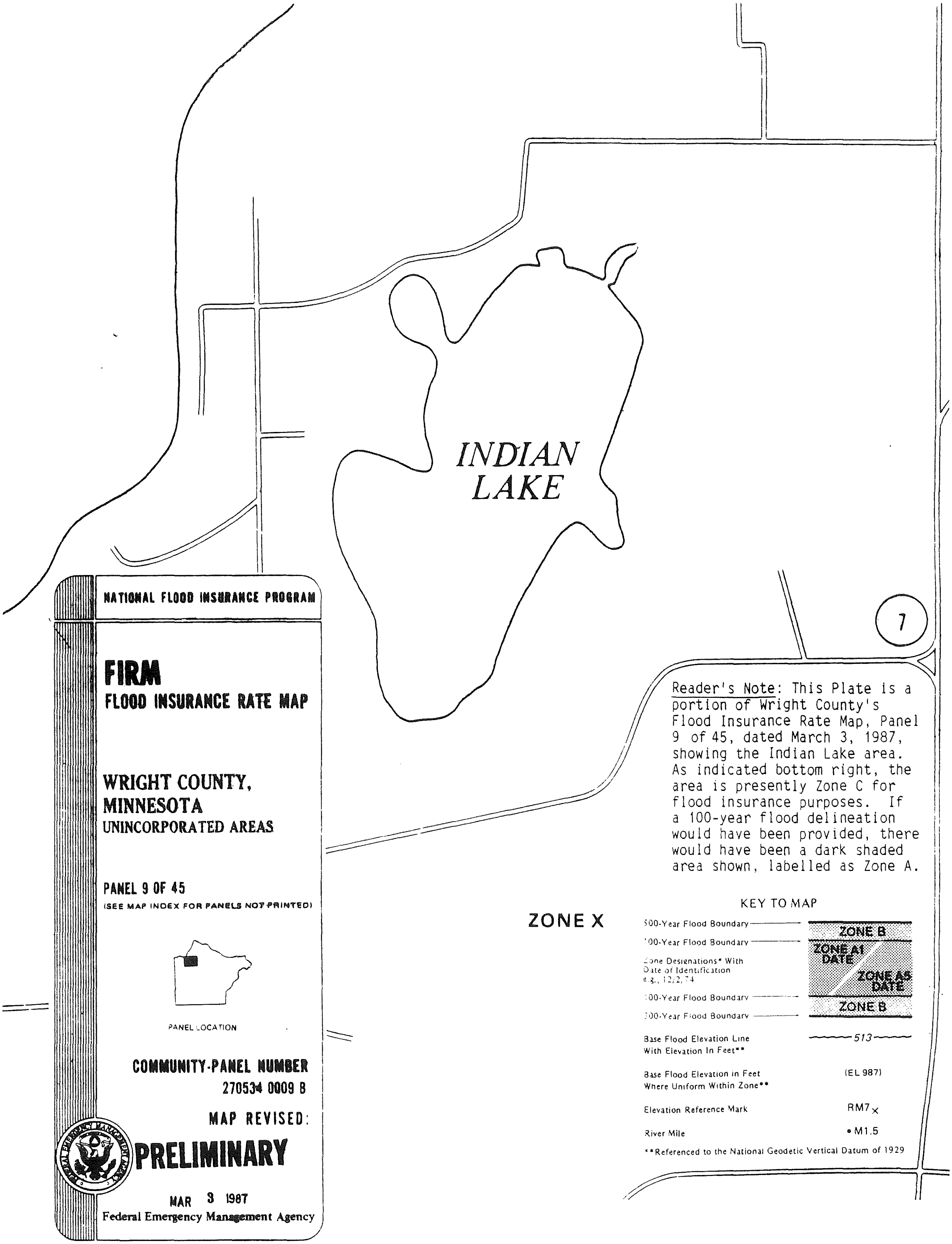

INDIAN
LAKE
7
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
WRIGHT COUNTY,
MINNESOTA
UNINCORPORATED AREAS
PANEL 9 OF 45
(SEE MAP INDEX FOR PANELS NOT PRINTED)
PANEL LOCATION
COMMUNITY-PANEL NUMBER
270534 0009 B
MAP REVISED:
PRELIMINARY
MAR 3 1987
Federal Emergency Management Agency
Reader's Note: This Plate is a portion of Wright County's Flood Insurance Rate Map, Panel 9 of 45, dated March 3, 1987, showing the Indian 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.
ZONE X
KEY TO MAP
00-Year Flood Boundary
00-Year Flood Boundary
one Designations* With
ate of Identification
00-Year Flood Boundary
00-Year Flood Boundary
ZONE B
ZONE A1 DATE
ZONE A5 DATE
ZONE B
Base Flood Elevation Line With Elevation In Feet**
513
Base Flood Elevation in Feet Where Uniform Within Zone**
(EL 987)
Elevation Reference Mark
RM7
River Mile
M1.5
**Referenced to the National Geodetic Vertical Datum of 1929

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 delination 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	Additional 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 Indian 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 Indian Lake.

It must be pointed out that a flood insurance policy only covers a structure and its contents. The Department of Natural Resources' 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 14 and 15 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 Indian Lake. If the Lake should continue to rise, a dampening effect would occur as the lake reaches its runout elevation at elevation 1021.1'. 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 Indian 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 1011.9' Indian Lake would bounce 0.9' upward during a 100-year, 24 hour rainfall event and 1.6' upward to elevation 1013.5' 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 Department of Natural Resources' recommendation that, at a minimum, any landowner with a structure within 2'-3' of the Lake's current water surface elevation should strongly considering purchasing 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 Indian 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 some finishing materials on walls and floors and most contents. A basement was defined, though, as a space subgrade <u>on all four sides</u>. 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 areas of the County.

As noted earlier, the current Flood Insurance Rate Map for Wright County does not show a flood delineation (i.e., Zone A) for Indian Lake. This means that: 1) technically, Wright County does not now have to apply the provisions of its floodplain ordinance to new development bordering Indian 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 Indian Lake.

The obvious question is what prudent course of action should Wright County take when regulating new development adjacent to Indian 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 <u>recorded</u> water level for Indian Lake is at 1012.88', and it must be noted that the Ordinary High Water Level has been established at 1014.7'. 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 1014.7'. The regulatory elevation for Indian Lake is then 1014.7' + 4', or 1018.7', 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 minmum, must be designed to elevation 1018.7'; 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 1018.7'.

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 the purchase of flood insurance may be advisable;

2) Flood insurance in a mapped Zone A (approximate 100-year floodplain) would be <u>mandatory</u> 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 un-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 Indian 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 Indian Lake with the adoption of an elevated road access requirement. New access roads should be elevated to the identified flood protection elevation.

The County must assess whether using elevation 1018.7' under its current shoreland regulations is a proper <u>long-term</u> 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 obvious concern is that future development would be constructed at elevation 1018.7' (2.4' below the runout elevation of 1021.1') and the Lake would rise above 1018.7', causing significant or total loss due to the potentially long period of inundation. The Department of Natural Resources must point out that the safest course of action would be to establish a flood protection elevation at a point above the runout (e.g., elevation 1022.0').

Adding a flood delineation on the County's FIRM would primarily act as a consumer awareness device for potential purchasers 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 1018.7'.

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 crawl spaces, 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 8 and 9 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 <u>emergency protection measures</u>.

1) A structure has been damaged to 50-percent or greater 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 1018.7' (or to a higher elevation if the County wishes to adopt one).

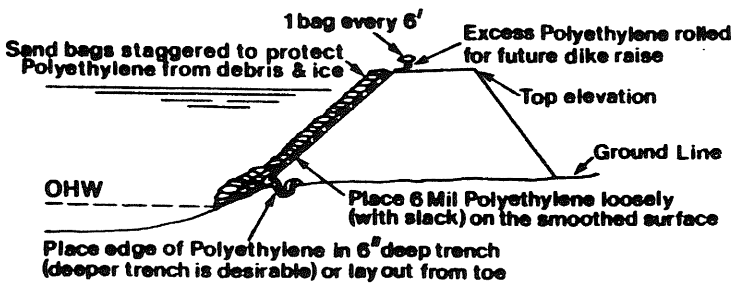
The reader is requested to pay special attention to the discussion of levees and filling around structures on Plates 8 and 9 on the following pages. Levees are temporary measures and should not be considered as a permanent solution. In no case should a structure protected by a levee be used for human 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

PLATE 8
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

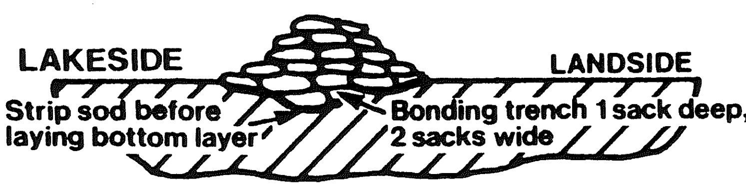
GENERAL DESIGN CONSIDERATIONS

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.

SANDBAGGING

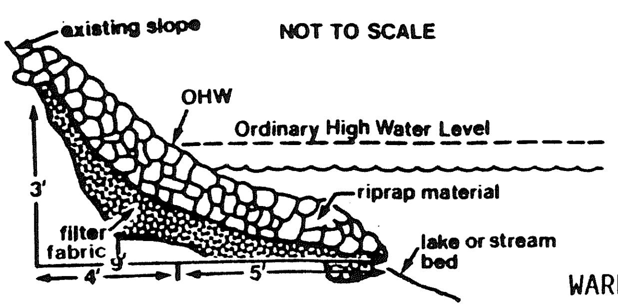


SECTION

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: Polyethelyne 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.

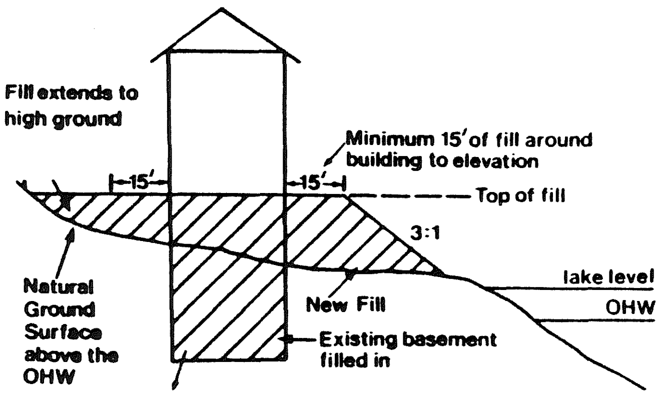
WARNING: Fill placed below the Ordinary High Water Level may require a permit.

PLATE 9

FLOOD PROTECTION MEASURES

TYPE OF PROTECTION

ELEVATED STRUCTURE (PERMANENT)

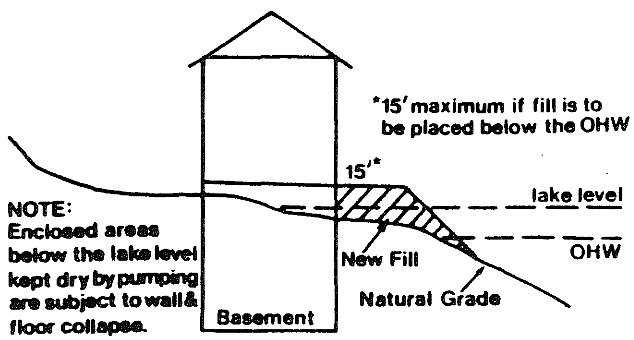


NOTE: Enclosed areas below the lake level intentionally kept dry by pumping are subject to wall and floor collapse.

GENERAL DESIGN CONSIDERATIONS

- 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



- 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.

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.

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 preceeding 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 Indian 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. Indian Lake has been identified as a public water (Basin 223) 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 1014.7', the Ordinary High Water Level for Indian 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.

A DNR permit would be required: 1) to lower Indian Lake below 1014.7'; or 2) to control the Lake at an elevation above 1014.7', 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 <u>any activity</u> 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 Level; 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 Indian 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 Indian Lake. The Department of Natural Resources' experience in similar flooding situations indicates that implementation of mitigation strategies is most successful when a local unit of government 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 that have been used to alleviate flooding problems in Minnesota. Some of these funding sources have been used more successfully than others, while potential funding sources 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. It is likely that any future requests for Corps of Engineers' assistance at Indian Lake would be through the Small Projects - Continuing Authorities program.

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

The state until this last legislative session has acted with emergency funds when responding to high water problems. An example of this 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).

The Department of Natural Resources sponsored a statewide cost-share flood loss reduction program in the 1987 Legislative Session. The primary benefit is that increased state funding levels would be available for advance, pre-flood mitigation measures on a priority basis. The Legislature did fund the DNR's proposed legislation by: 1) making approximately $2,000,000 of bonding money available for a portion of the local share (i.e., cost) of a number of proposed Corps of Engineers' flood control projects; and 2) establishing an approximate $430,000 cost-share program for locally initiated structural and non-structural flood loss reduction measures.

The cost-share program is to be administered by DNR. Projects must be funded 50/50 by State and non-State funds, respectively. Application forms will be available from the DNR in November of 1987. The cost-share program is broad based in that applications can be submitted for most any structural or non-structural project which reduces potential flood losses.

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 <u>at the time of loss</u> 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 preceeding 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.

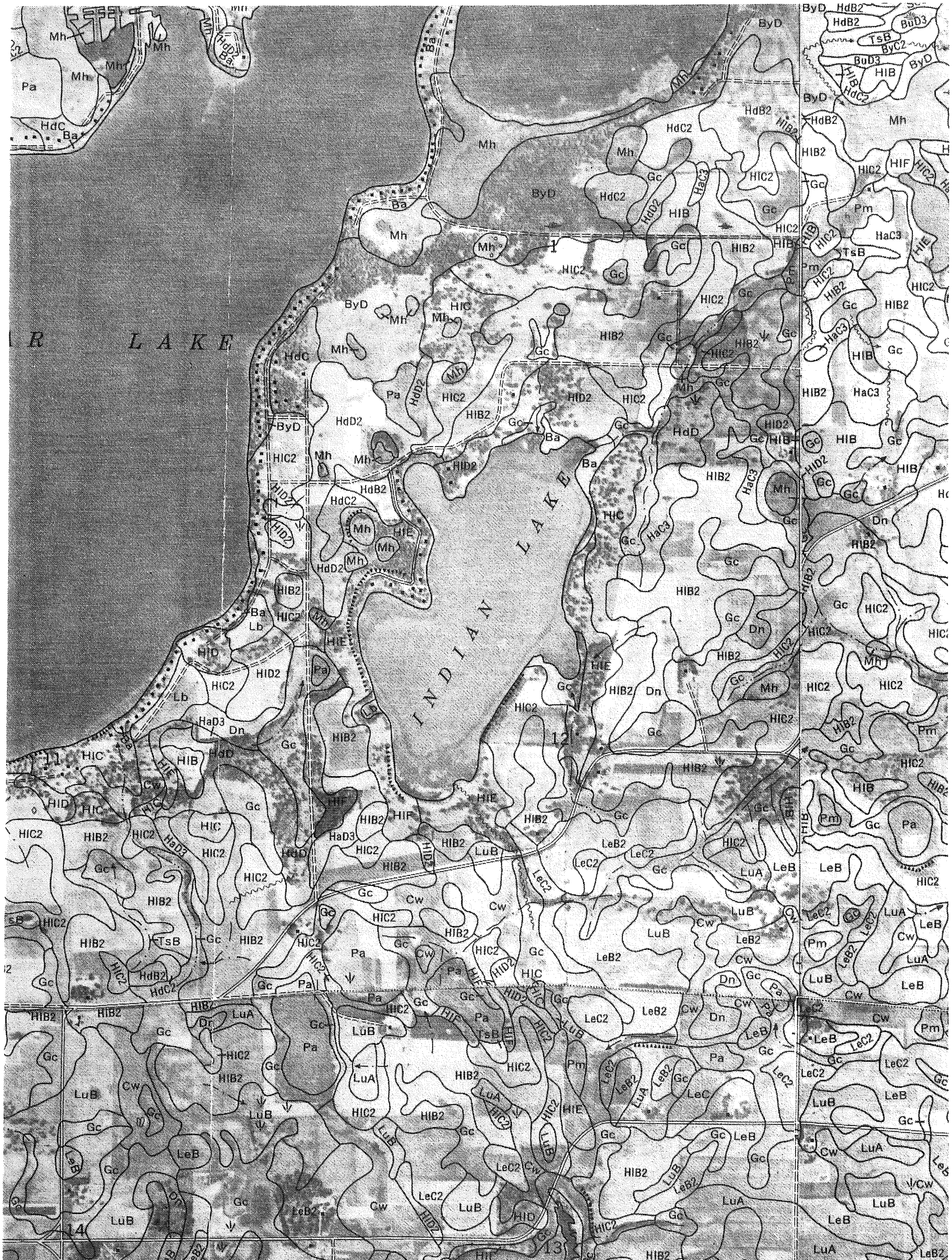
Watershed districts are suited to resolving multiple water resource issues over a large area. As noted earlier, there is no upper or lower limit on the geographic area which may be included in a watershed district. Establishment of a watershed district requires development of an overall plan, adoption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


R LAKE
INDIAN LAKE
1
11
12
13
14

SOIL SURVEY FOR INDIAN LAKE

MAP SYMBOL	SOIL CLASSIFICATION	% SLOPE
Ba	Beach materials, sandy	
BuB	Burnsville soils	0-6
BuC	Burnsville soils	6-12
BuD	Burnsville soils	12-18
BuD3	Burnsville soils, severely eroded	12-25
ByC2	Burnsville-Hayden complex, moderately eroded	6-12
ByD	Burnsville-Hayden complex	2-6
Cw	Cordova and Webster silty clay loams	
Dn	Dundas silt loam	
Gc	Glencoe silty clay loam	
HaC3	Hayden clay loam	6-12
HaD3	Hayden clay loam, severely eroded	12-18
HdB	Hayden fine sandy loam	2-6
HdB2	Hayden fine sandy loam, moderately eroded	2-6
HdC	Hayden fine sandy loam	6-12
HdC2	Hayden fine sandy loam, moderately eroded	6-12
HdD	Hayden fine sandy loam	12-18
HdD2	Hayden fine sandy loam, moderately eroded	12-18
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
LeB	Lester loam	2-6
LeB2	Lester loam, moderately eroded	2-6
LeC2	Lester loam, moderately eroded	6-12
LuA	Le Sueur clay loam	0-2
LuB	Le Sueur clay loam	2-6
Mh	Marsh	
Pm	Peat and Muck, shallow over loam	0-1
TsB	Terril soils	2-6

SOIL SURVEY FOR INDIAN 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, 0 to 6 percent slopes (BuB).

The soils in this mapping unit generally have short, irregular slopes. The surface soil ranges from sandy loam to loam. Depth to sand and gravel ranges from 12 to 24 inches.

In most areas large stones and boulders are on the surface and in these soils. Near Sugar Lake in the northwestern part of the county, however, the soils lack such stones and boulders and are underlain by stratified sand and gravel.

The soils in this unit are droughty and subject to erosion. They are fair for small grains and pasture, but in most years they are too droughty for good yields of corn.

Burnsville soils, 6 to 12 percent slopes (BuC).

Soils in this mapping unit generally have short, irregular slopes. Most areas are in pasture or woods and are only slightly eroded. The surface soils is sandy loam and loam. Depth to sand and gravel ranges from 14 to 24 inches. Small, wet depressions are in areas that have complex slopes.

The soils in this unit are droughty and are subject to severe erosion. They are fair for small grains and pasture, but because of the low moisture-supplying capacity, crops and pasture are damaged by drought during dry periods. The soils are also too droughty for corn in most years.

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.

Burnsville soils, 12 to 25 percent slopes, severely eroded (BuD3).

Most areas of these soils consist of short, irregular ridges and sharp breaks. Nearly all of the original surface soil has been removed through erosion. The present plow layer is mostly yellowish-brown sandy loam and loam formerly in the subsoil. Depth to sand and gravel ranges from 10 to 14 inches. In many areas small spots of gravel are on the surface. Some areas are cut by gullies of various sizes.

These soils are subject to further erosion and are droughty. Consequently they are not suited to crops and are poor for pasture. A permanent cover of vegetation is best kept on the soils, and careful management is needed.

Burnsville-Hayden complex, 6 to 12 percent slopes, moderately eroded (ByC2).

These soils generally have short, irregular slopes. About 65 percent of the acreage is Burnsville sandy loam and loam, and about 20 percent is Hayden fine sandy loam. The remaining 15 percent is Hayden loam and small areas of sand and gravel. Most of the acreage is in pasture or woods and is only slightly eroded. In cropped areas, however, the soils have lost as much as three-fourths of their original surface soil through erosion.

The soils in this complex are droughty. The erosion hazard is severe. Consequently these soils are not well suited to cultivation. A permanent cover of vegetation is best kept on these soils, and careful management is needed.

Burnsville-Hayden complex, 12 to 18 percent slopes (ByD).

The soils in this complex generally have short, irregular slopes. About 65 percent of the acreage is Burnsville sandy loam and loam, and about 20 percent is Hayden fine sandy loam. The remaining 15 percent is Hayden loam and small areas of sand and gravel. Most of the acreage is in pasture or woods and is only slightly eroded. In cropped areas, however, the soils have lost as much as three-fourths of their original surface soil through erosion.

The soils in this complex are droughty. The erosion hazard is severe. A cover of permanent vegetation is best kept on these soils, and careful management is 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.

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, 2 to 6 percent slopes (HdB).

This soil generally has short, irregular slopes. Its subsoil is more sandy in the upper part than that in the profile described for the series.

Mapped with this soil are small areas of a soil that contains pockets of sand or loamy sand and that has a finer textured subsoil with a depth of 18 inches. Also included are small areas in depressions between complex slopes.

This Hayden soil is fair to good for crops and pasture. It is sandy and is low in content of organic matter. Consequently the moisture-supplying capacity is somewhat restricted, and in most years crops lack sufficient moisture for good yields. Even though the slopes are mild, this soil is subject to erosion, and practices for the control of erosion are needed.

Hayden fine sandy loam, 2 to 6 percent slopes, moderately eroded (HdB2).

This soil generally has short, uneven slopes. The subsoil is more sandy in the upper part than that in the profile described for the series. Plowing has mixed material from the subsoil with the remaining surface soil to form the present plow layer of grayish-brown fine sandy loam.

Mapped with this soil are small areas that have a thin layer of sand or loamy sand of 18 inches. In areas where the slopes are very irregular, small areas of poorly drained soils are between the slopes.

This Hayden soil is fair to good for crops and pasture. It is sandy and its content of organic matter is low. Consequently it is slightly droughty and is subject to erosion. Nevertheless if this soil is well managed, yields are good.

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 fine sandy loam, 6 to 12 percent slopes, moderately eroded (HdC2).

This soils has lost 3 to 6 inches of its original surface soil through erosion. The present plow layer is grayish-brown fine sandy loam. The subsoil is more sandy than that in the profile described for the series.

Mapped with this soil are some small areas of sand and gravel. In areas where the slopes are irregular, small areas of Glencoe and Webster soils are in depressions between the slopes.

This Hayden soil is well suited to pasture but not so well suited to crops. It is sandy, and its content of organic matter is low. The moisture-supplying capacity is therefore limited and productivity is lowered. The hazard of further erosion is severe if these soils are cultivated and not protected.

Hayden fine sandy loam, 12 to 18 percent slopes (HdD).

Most of this soil is in woods or pasture. Its subsoil is somewhat more sandy in the upper part than that in the profile described for the series.

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

This Hayden soil is fair for crops and good for pasture. It is sandy, has moderately steep slopes, and lacks sufficient moisture for increased yields. Also the hazard of erosion is severe, and intensive practices are needed to prevent further erosion.

Hayden fine sandy loam, 12 to 18 percent slopes, moderately eroded (HdD2).

This soil has lost 3 to 6 inches of its original surface soil through erosion. Plowing has mixed material from the subsoil with the remaining surface soil to form the present plow layer, a grayish-brown fine sandy loam. The subsoil is more sandy than that in the profile described for the series. In some areas there are small gullies.

Mapped with this soil are small areas of sandy and gravel. In some areas slopes are very irregular, and here small areas of Glencoe and Webster soils are in the depressions between the slopes.

This soil is fair for crops and good for pasture. Productivity is limited because the soil is low in content of organic matter and lacks sufficient moisture for plants. The hazard of further erosion is severe and limits suitability of this soil for crops. Intensive practices are needed to prevent further erosion.

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

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 ares 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 (HlB2).

This soil generally has short, irregular slopes. From 3 to 6 inches o 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 (HlE).

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 it 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 (HlF).

Ths 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.

Lester loam, 2 to 6 percent slopes (LeB).

This soil has a profile similar to the one described for the series. Slopes generally are undulating, but in some places they are very irregular.

Included with this soil are small areas of moderately well drained and poorly drained soils in small depressions between irregular slopes.

This soil is well suited to all crops generally grown in the county. Slopes are mild. Nevertheless this soil is subject to erosion, and care is needed for control of erosion.

Lester loam, 2 to 6 percent slopes, moderately eroded (LeB2).

This soil generally has short, irregular slopes. It has lost 3 to 6 inches of its original surface soil through erosion. The present plow layer is a mixture of dark-colored material from the remaining surface soil and of brownish, finer textured material formerly in the subsoil.

Mapped with this soil are small areas of a poorly drained soil in depression between uneven slopes.

This Lester soil is good for crops and pasture. The hazard of further erosion is moderate.

Lester loam, 6 to 12 percent slopes, moderately eroded (LeC2).

This soil generally has short, irregular slopes. From 3 to 6 inches of the original surface soil has been removed through erosion. The present plow layer is grayish brown and is a mixture of material from the remaining surface soil and of finer textured material formerly in the subsoil. It is in poor tilth and its productivity is lowered as the result of loss of organic matter through erosion. In places there are small, wet depressional areas.

This soil is good for crops and pasture. If it is cultivated and not protected, the hazard of further erosion is severe.

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.

Le Sueur clay loam, 2 to 6 percent slopes (LuB).

The profile of this soil is similar to the one described for the series. In places the areas are hummocky and small wet depressions are between the slopes.

This soil is good for crops or pasture. Even though the slopes are gentle, this soil is subject to erosion if it is not protected.

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.

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 overlie 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

APPENDIX B

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

86-0223
45 18 30.0 094 01 37.0 3
LAKE: INDIAN 2 MI W OF SILVER CREEK
27171 MINNESOTA WRIGHT
AREA: 52.2 HECTARE M 070317
MEAN DEPTH: - M MAX DEPTH: 7.0 M
21MINNL 860906 07010203
0000 FEET DEPTH

/TYPA/AMBNT/LAKE

INITIAL DATE			86/05/26	86/06/08	86/06/14	86/07/07	86/07/22	86/07/25	86/07/25	86/07/25	86/07/25
INITIAL TIME			1500	1400	1500	1400	1330	1030	1030	1030	1030
MEDIUM			WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER
DEPTH-FT(SMK)			0	0	0	0	0	0	3.28	6.56	9.84
00008 LAB	IDENT.	NUMBER						123407			
00010 WATER	TEMP	CENT						25.5	25.4	25.3	25.3
00011 WATER	TEMP	FAHN						77.9$	77.7$	77.5$	77.5$
00029 FIELD	IDENT	NUMBER	201	201	201	201	201	101	101	101	101
00076 TURB	TRBIDMTR	HACH FTU						2.5			
00078 TRANSP	SECCHI	METERS	2.13	1.98	1.68	.91	.91	.80			
00080 COLOR	PT-CO	UNITS						10			
00095 CNDUCTVY	AT 25C	MICROMHO						270			
00098 VSAMPLOC	DEPTH	METERS						.00	1.00	2.00	3.00
00300 DO		MG/L						7.0	7.1	6.7	6.6
00301 DO	SATUR	PERCENT						83.3$	84.5$	79.8$	78.6$
00400 PH		SU						8.80			
00410 T ALK	CACO3	MG/L						110			
00530 RESIDUE	TOT NFLT	MG/L						4			
00625 TOT KJEL	N	MG/L						2.010			
00630 NO2&NO3	N-TOTAL	MG/L						.01K			
00665 PHOS-TOT		MG/L P						.062			
00940 CHLORIDE	TOTAL	MG/L						15			
32211 CHLRPHYL	A UG/L	CORRECTD						48.60			
74041 WQF	SAMPLE	UPDATED	870108	870108	870108	870108	870108	861030	860912	860912	860912
81903 DPTH BOT	AT SITE	FEET						27.0			

INITIAL DATE			86/07/25	86/07/25	86/07/25	86/07/25	86/07/25	86/07/25	86/07/25	86/08/14	86/08/16
INITIAL TIME			1030	1030	1030	1030	1030	1030	1045	1130	1000
MEDIUM			WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER
DEPTH-FT(SMK)			13.12	16.4	19.68	22.96	26.24	29.52	0	0	0
00008 LAB	IDENT.	NUMBER						123408	123409		123548
00010 WATER	TEMP	CENT	25.3	22.4	16.5	14.0	13.1	13.0			23.6
00011 WATER	TEMP	FAHN	77.5$	72.3$	61.7$	57.2$	55.6$	55.4$			74.5$
00029 FIELD	IDENT	NUMBER	101	101	101	101	101	101	102	201	101
00076 TURB	TRBIDMTR	HACH FTU									2.3
00078 TRANSP	SECCHI	METERS							.80	1.07	1.10
00080 COLOR	PT-CO	UNITS									20
00095 CNDUCTVY	AT 25C	MICROMHO									260
00098 VSAMPLOC	DEPTH	METERS	4.00	5.00	6.00	7.00	8.00	9.00	.00		.00

(SAMPLE CONTINUED ON NEXT PAGE)

STORET RETRIEVAL DATE 87/05/26 PGM=ALLPARM PAGE: 12

86-0223
45 18 30.0 094 01 37.0 3
LAKE: INDIAN 2 MI W OF SILVER CREEK
27171 MINNESOTA WRIGHT
AREA: 52.2 HECTARE M 070317
/TYPA/AMBNT/LAKE MEAN DEPTH: - M MAX DEPTH: 7.0 M
21MINNL 860906 07010203
0000 FEET DEPTH

(SAMPLE CONTINUED FROM PREVIOUS PAGE)

	INITIAL DATE			86/07/25	86/07/25	86/07/25	86/07/25	86/07/25	86/07/25	86/07/25	86/08/14	86/08/16
	INITIAL TIME			1030	1030	1030	1030	1030	1030	1045	1130	1000
	MEDIUM			WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER
	DEPTH-FT(SMK)			13.12	16.4	19.68	22.96	26.24	29.52	0	0	0
00300	DO		MG/L	6.5	.2	.2	.2	.2	.2			7.4
00301	DO	SATUR	PERCENT	77.4$	2.3$	2.0$	1.9$	1.9$	1.9$			87.1$
00403	LAB	PH	SU									7.9
00410	T ALK	CACO3	MG/L									160
00530	RESIDUE	TOT NFLT	MG/L									4
00625	TOT KJEL	N	MG/L						3.620	2.220		1.480
00630	NO2&NO3	N-TOTAL	MG/L									.01K
00665	PHOS-TOT		MG/L P						.344	.068		.034
00940	CHLORIDE	TOTAL	MG/L									14
32211	CHLRPHYL	A UG/L	CORRECTD							50.70		33.20
74041	WQF	SAMPLE	UPDATED	860912	860912	860912	860912	860912	861113	861030	870108	861024
81903	DPTH BOT	AT SITE	FEET							17.0		28.0

	INITIAL DATE			86/08/16	86/08/16	86/08/16	86/08/16	86/08/16	86/08/16	86/08/16	86/08/16	86/08/28
	INITIAL TIME			1000	1000	1000	1000	1000	1000	1000	1000	1030
	MEDIUM			WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER	WATER
	DEPTH-FT(SMK)			3.28	6.56	9.84	13.12	16.4	19.68	22.96	26.24	0
00008	LAB	IDENT.	NUMBER							123549		
00010	WATER	TEMP	CENT	23.3	23.0	22.6	21.6	21.5	20.4	15.0	13.5	
00011	WATER	TEMP	FAHN	73.9$	73.4$	72.7$	70.9$	70.7$	68.7$	59.0$	56.3$	
00029	FIELD	IDENT	NUMBER	101	101	101	101	101	101	101	101	201
00078	TRANSP	SECCHI	METERS									1.22
00098	VSAMPLOC	DEPTH	METERS	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	
00300	DO		MG/L	7.3	7.2	6.0	3.2	2.5	.2	.1	.1	
00301	DO	SATUR	PERCENT	83.9$	82.8$	69.0$	36.4$	27.8$	2.2$	1.0$	.9$	
00625	TOT KJEL	N	MG/L							4.290		
00665	PHOS-TOT		MG/L P							.462		
74041	WQF	SAMPLE	UPDATED	860918	860918	860918	860918	860918	860918	861024	860918	870108

	INITIAL DATE			86/09/13	86/10/20
	INITIAL TIME			1400	1430
	MEDIUM			WATER	WATER
	DEPTH-FT(SMK)			0	0
00029	FIELD	IDENT	NUMBER	201	201
00078	TRANSP	SECCHI	METERS	.91	1.07
74041	WQF	SAMPLE	UPDATED	870108	870108

PIC DATA

PHYSICAL CHARACTERISTICS FOR LAKE: INDIAN

Lake Type: Panfish Lake
Dominant Forest/Soil Type: Not Available
Size of Lake: 135 Acres
Shorelength: 2.5 Miles
Maximum Depth: 23.0
Median Depth: 9.0

Secchi Disk Reading (water clarity): 2.4 feet
Lake Contour Map Number: C1179 (available at cost from Documents Division)
(Phone: 612-297-3000)

DEVELOPMENT CHARACTERISTICS FOR LAKE: INDIAN

Shoreland Zoning Classification: RECREATIONAL DEVELOPMENT
Public Accesses in 1983: 1

DNR SECTION OF FISHERIES INFORMATION FOR LAKE INDIAN

WATER CHEMISTRY SURVEY DATE: 8/30/1971

Water Color: Green
Cause of Water Color: Algae
Secchi Disk: 2.4
% Littoral: 63

LAKE DESCRIPTION

Surface Water Area: 129
Management Class: CENTRARCHID
Ecological Type: CENTRARCHID

Accessibility: Public access on bay on West Central shore.

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

NET CATCH DATA

GILL NETS No. of Sets: 1 Gill Net Survey Data: 8/30/1971

Species	# Fish	# Per Set	Total Pounds	Pounds Per Set
Black Bullhead	18	18.0	3.90	3.90
Northern Pike	3	3.0	12.90	12.90
Pumpkinseed Sunfish	2	2.0	0.10	0.10
Black Crappie	150	150.0	21.30	21.30

TRAP NETS No of Sets: 5 Trap Survey Date: 8/30/1971

Species	# Fish	# Per Set	Total Pounds	Pounds Per Set
White Sucker	2	0.4	5.00	1.00
Black Bullhead	61	12.2	13.80	2.76
Brown Bullhead	64	12.8	13.80	0.76
Northern Pike	2	0.4	3.80	0.76
Yellow Perch	1	0.2	0.40	0.08
Walleye	1	0.2	3.40	0.68
Pumpkinseed Sunfish	46	9.2	4.50	0.90
Bluegill Sunfish	93	18.6	18.20	3.64
Black Crappie	91	18.2	13.30	2.66
Hybrid Sunfish	8	1.6	1.20	0.24

FISH STOCKING DATA

Year	Species	Size	# Released
1975	Northern Pike	YEARLING	48
1975	Northern Pike	FINGERLING	1,200
1978	Northern Pike	FINGERLING	7,350

PERMIT DATA FOR LAKE INDIAN

Summary of DNR Permit Applications Issued or Denied as of June 1986 for Lake: INDIAN

Permit Types	Number Issued	Number Denied
Public (Protected) Waters Permits		
Sand Blanket	4	1
General Appropriation Permits	0	0

APPENDIX C

CLIMATOLOGICAL DATA

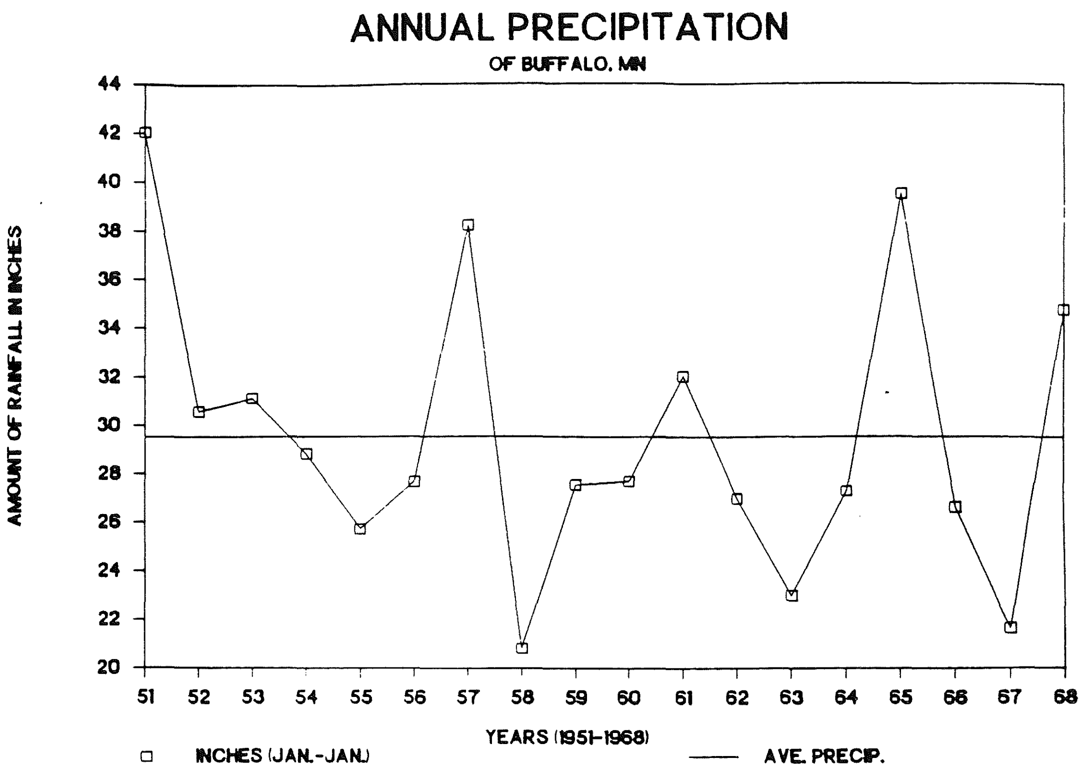
Buffalo, MN Monthly Precipitation

####	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
AMOUNT OF RAINFALL IN INCHES
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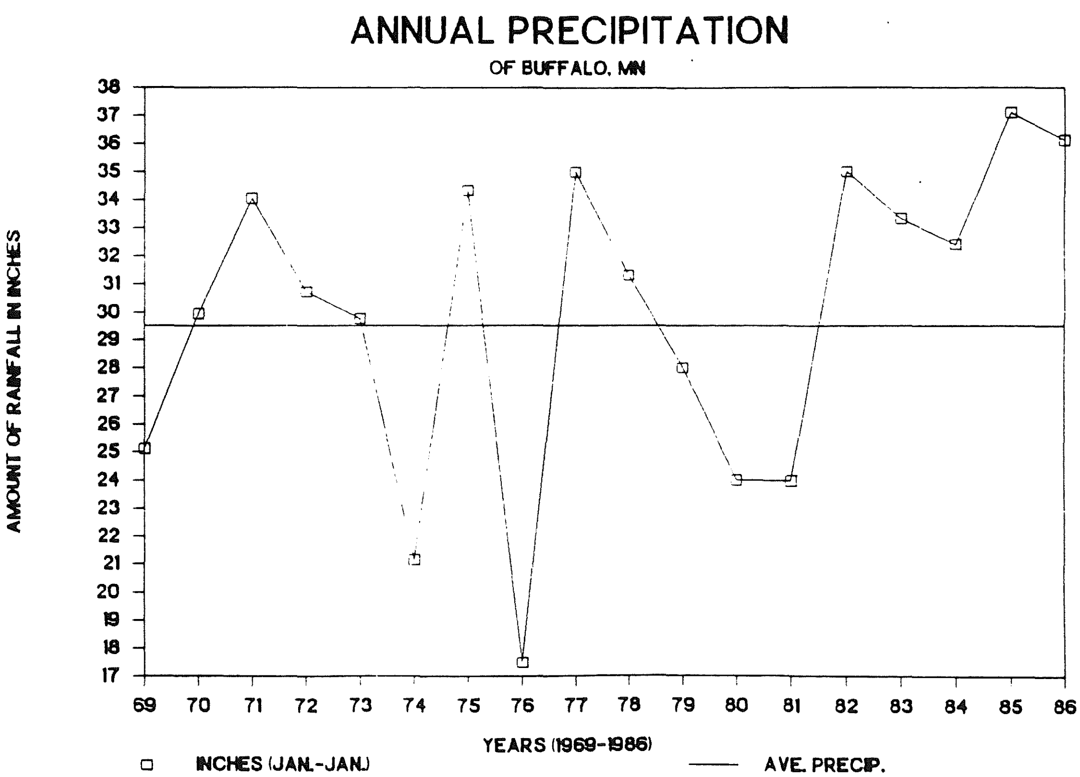
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68
YEARS (1951-1968)
INCHES (JAN.-JAN.)
AVE. PRECIP.



ANNUAL PRECIPITATION
OF BUFFALO, MN
AMOUNT OF RAINFALL IN INCHES
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69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86
YEARS (1969-1986)
INCHES (JAN.-JAN.)
AVE. PRECIP.

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

####	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
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

####	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
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.

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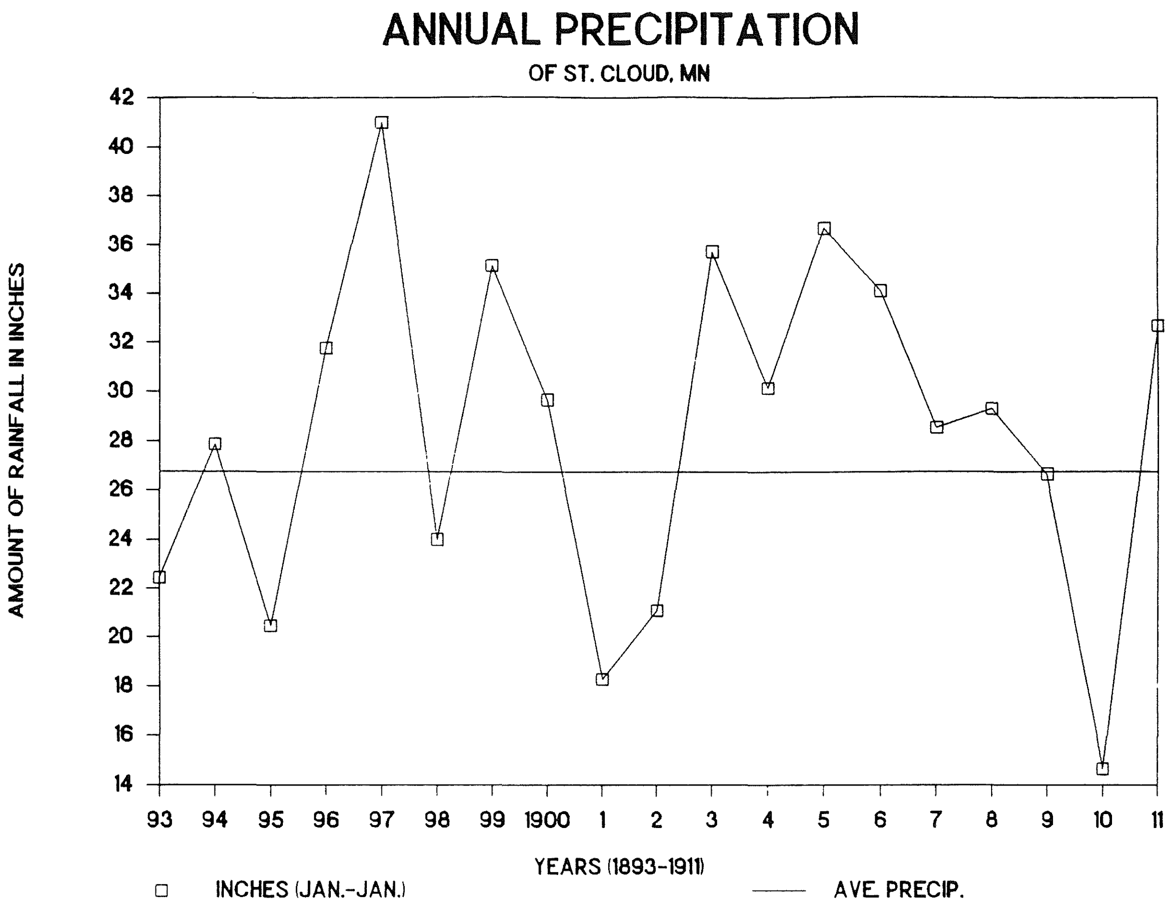
State Climatology Office, Minnesota Department of Natural Resources - Waters, Jim Zandlo, (612) 296-4214.



ANNUAL PRECIPITATION
OF ST. CLOUD, MN
AMOUNT OF RAINFALL IN INCHES
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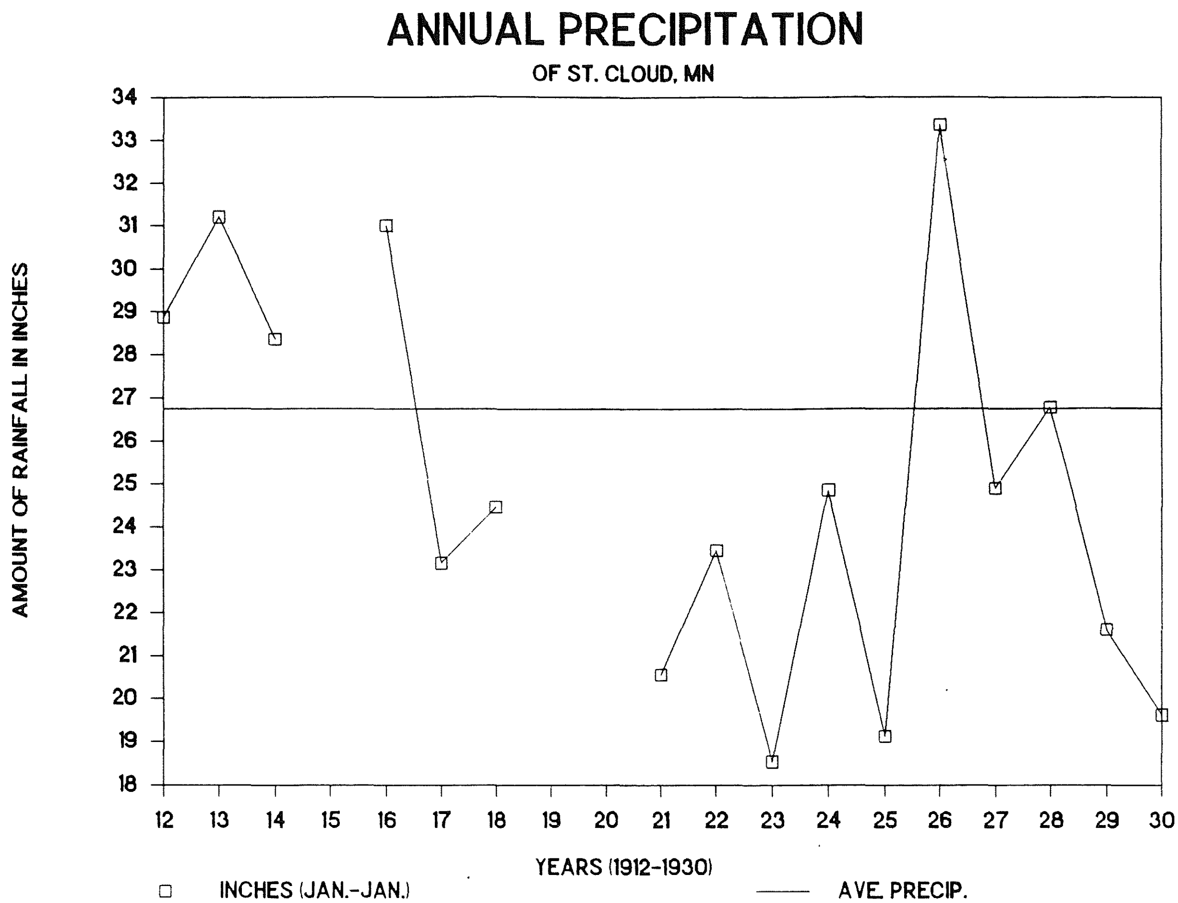
YEARS (1893-1911)
INCHES (JAN.-JAN.)
AVE. PRECIP.


ANNUAL PRECIPITATION
OF ST. CLOUD, MN
AMOUNT OF RAINFALL IN INCHES
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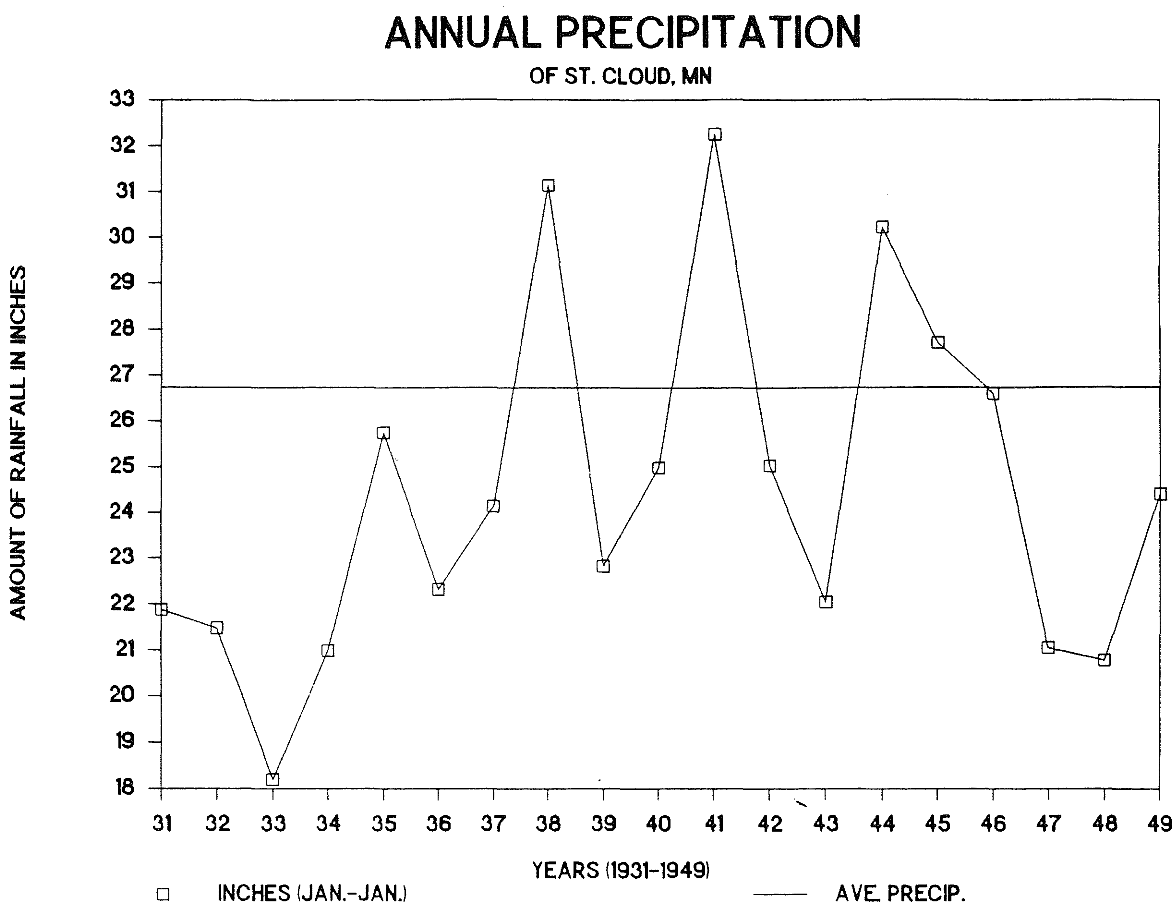
YEARS (1912-1930)
INCHES (JAN.-JAN.)
AVE. PRECIP.



ANNUAL PRECIPITATION
OF ST. CLOUD, MN
AMOUNT OF RAINFALL IN INCHES
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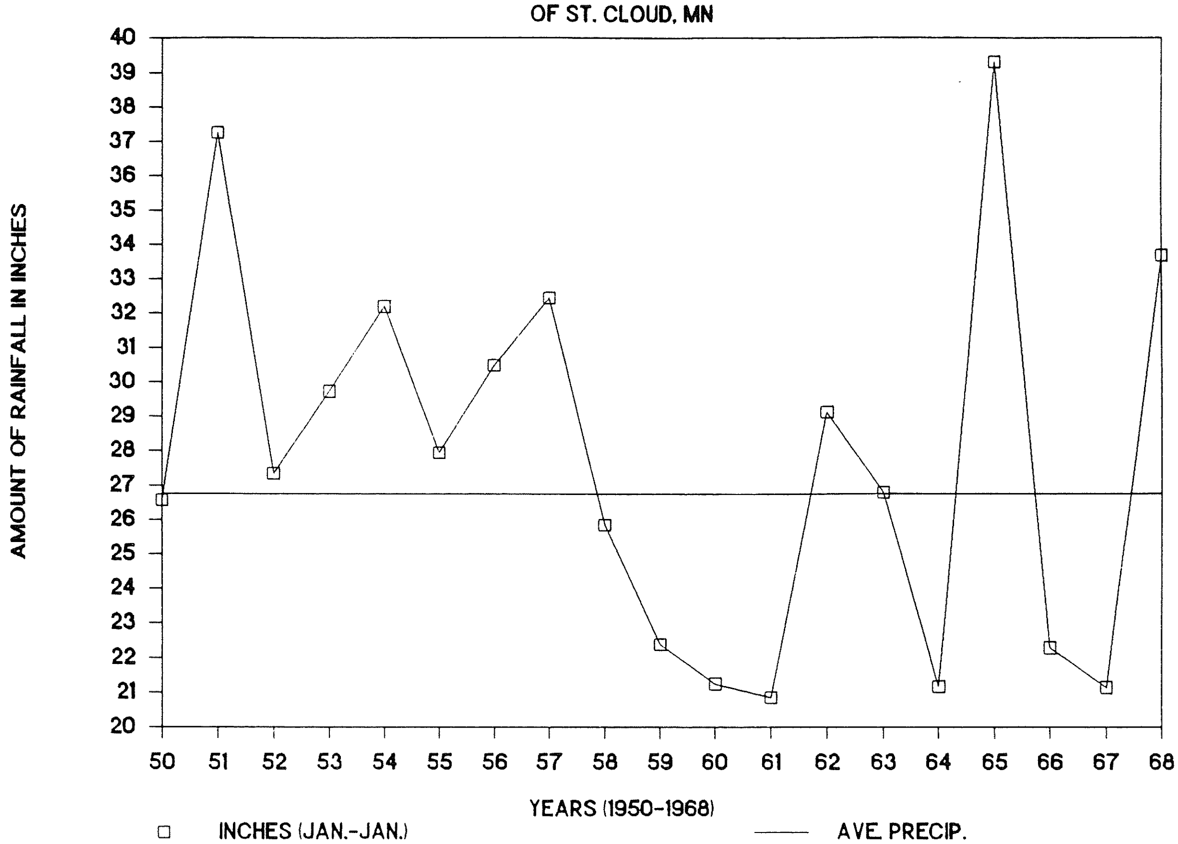
YEARS (1931-1949)
INCHES (JAN.-JAN.)
AVE. PRECIP.

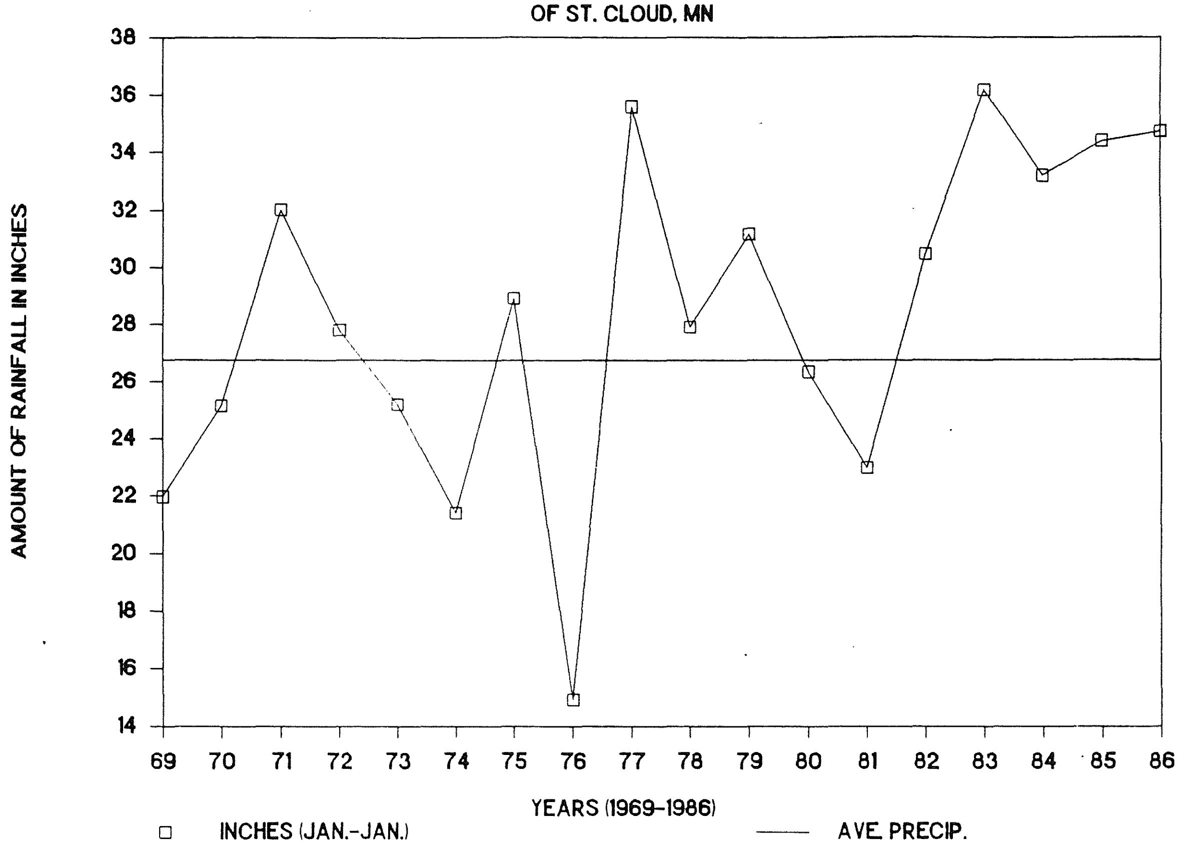
ANNUAL PRECIPITATION

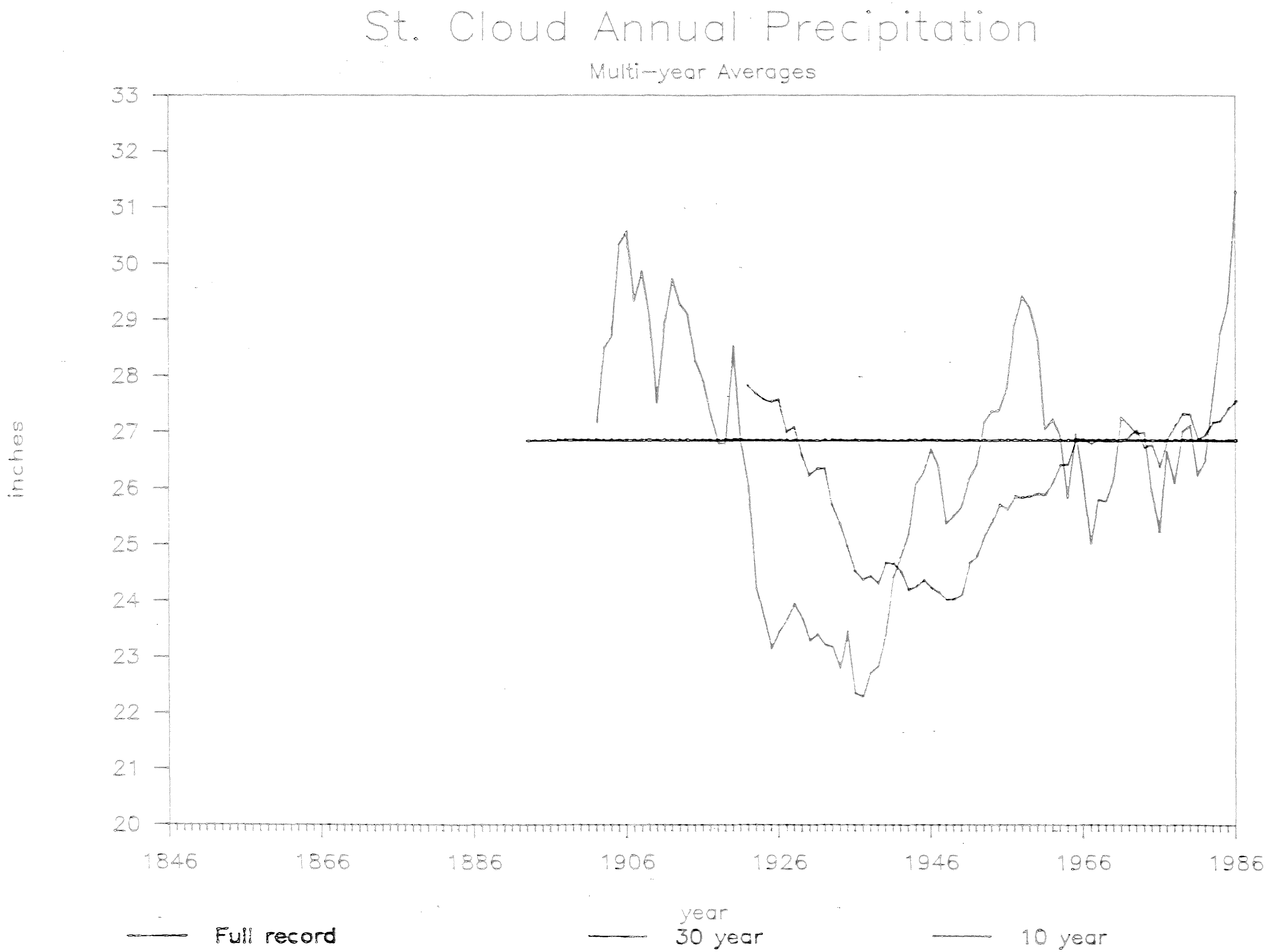
OF ST. CLOUD, MN



ANNUAL PRECIPITATION

OF ST. CLOUD, MN




St. Cloud Annual Precipitation
Multi-year Averages
inches
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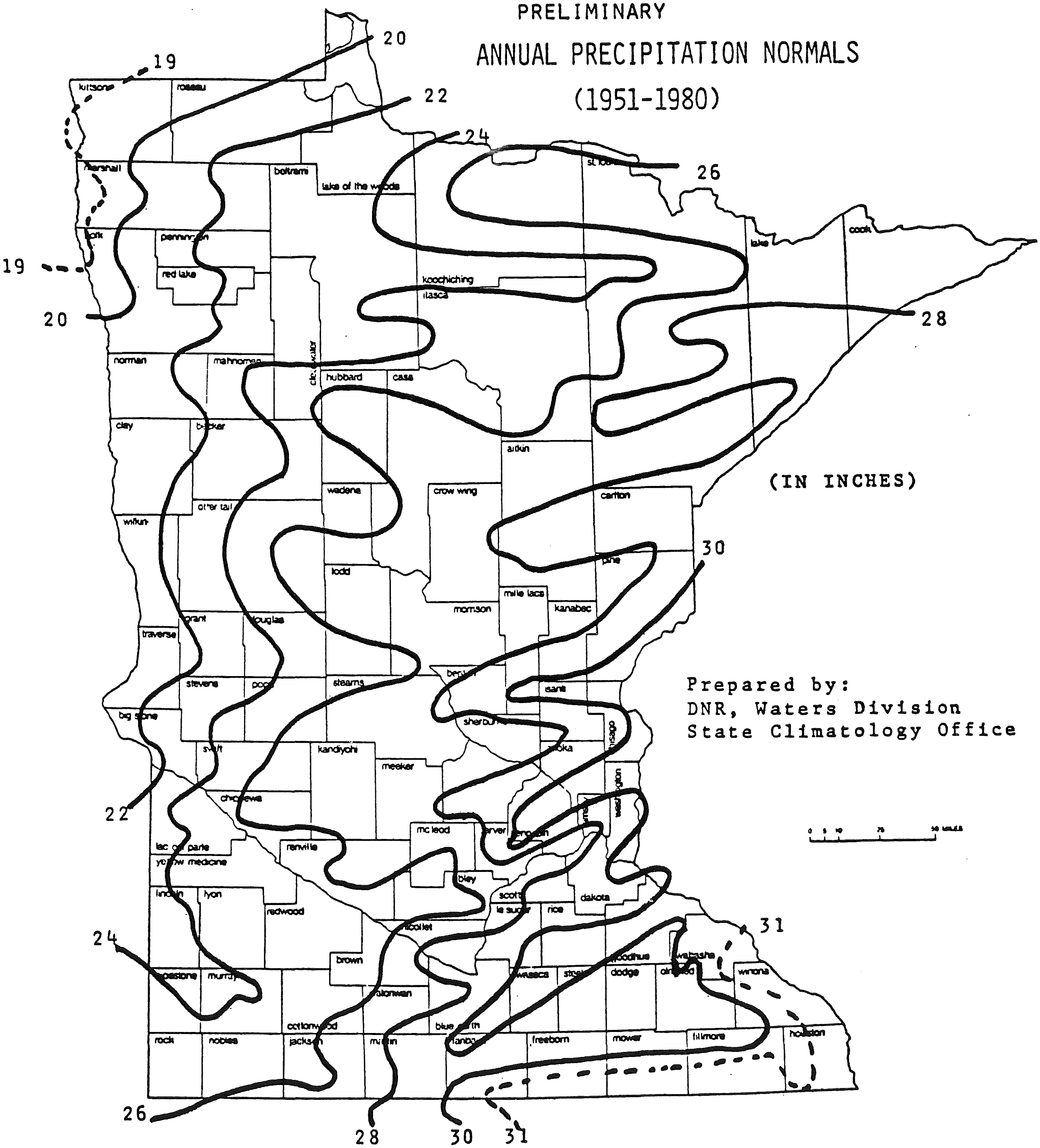
1866
1886
1906
1926
1946
1966
1986
year
Full record
30 year
10 year

PRELIMINARY

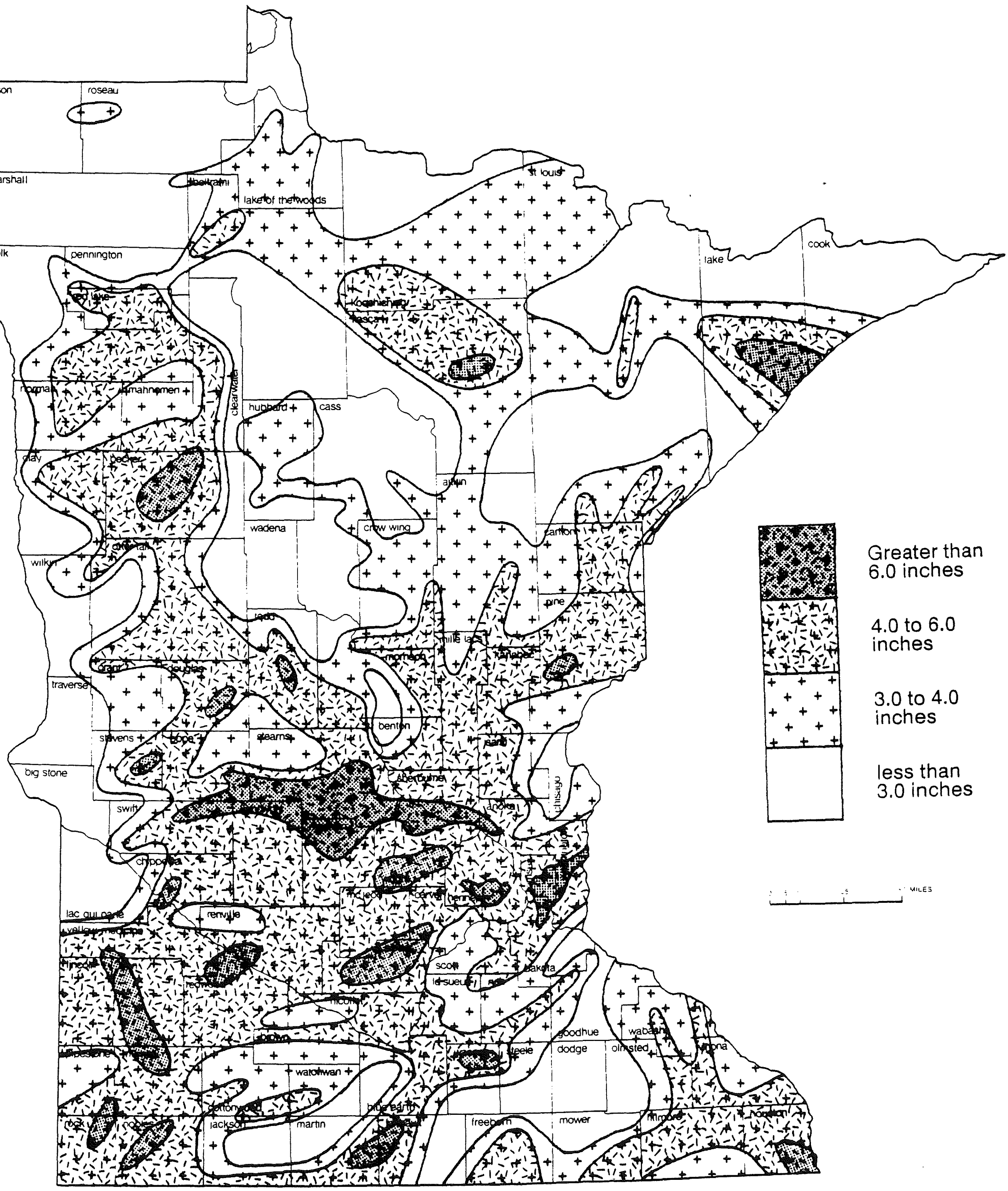
ANNUAL PRECIPITATION NORMALS (1951-1980)

(IN INCHES)



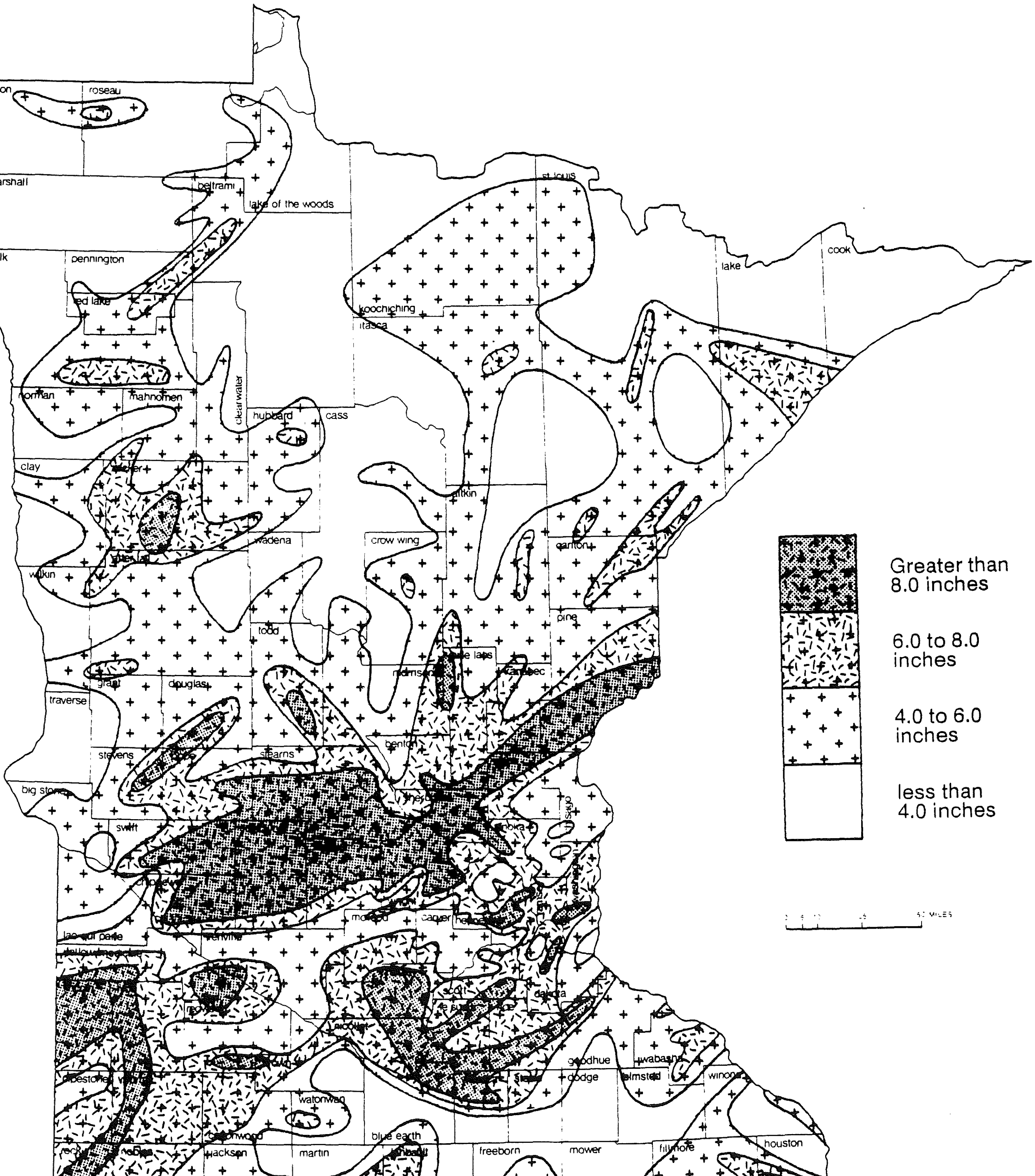
Prepared by:
DNR, Waters Division
State Climatology Office

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



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

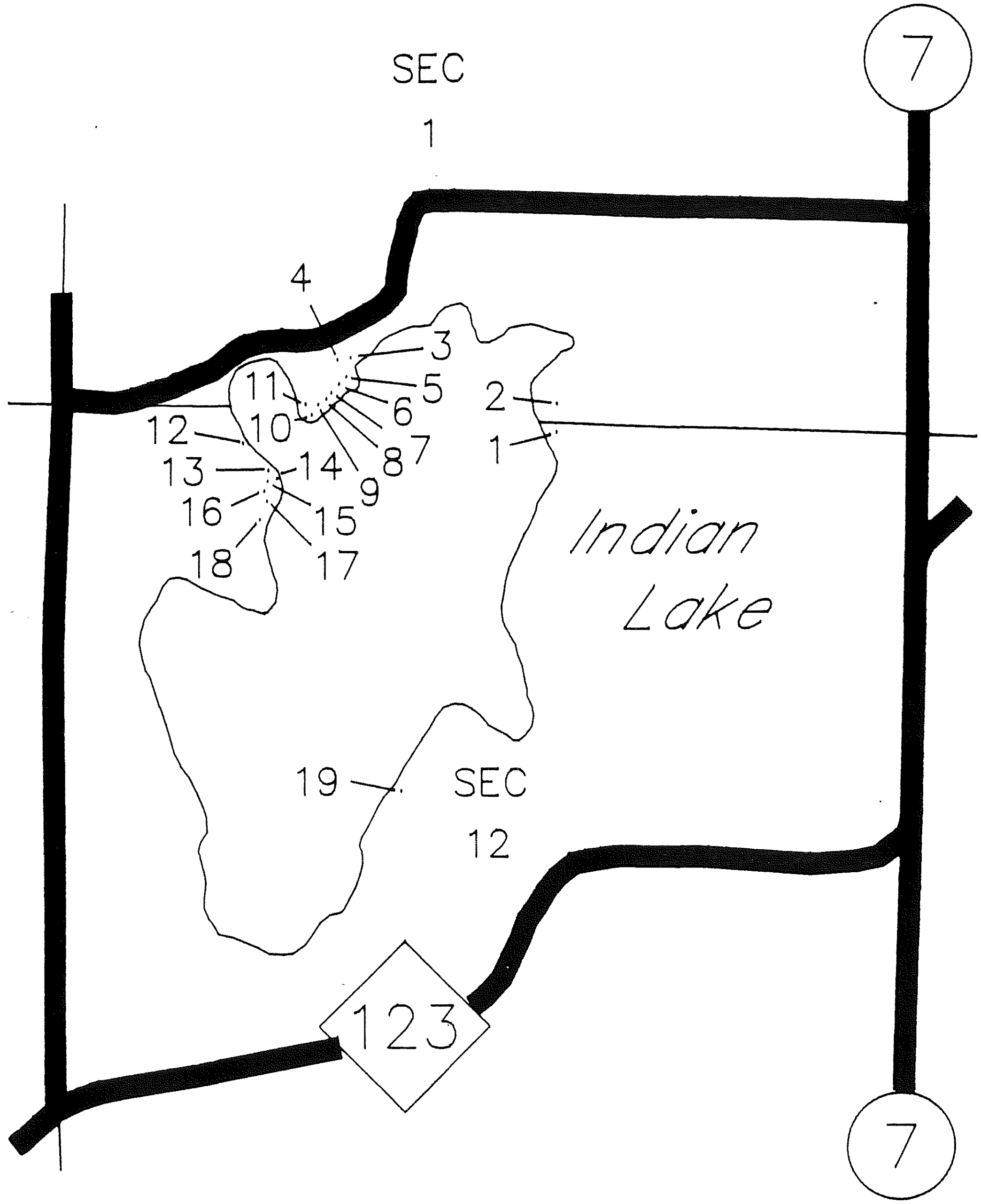
AVERAGE ANNUAL DEPARTURE FROM NORMAL PRECIPITATION FOR 1982 - 1986 (5 YEARS)



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

APPENDIX D

FACT SHEET FOR EACH POTENTIALLY DAMAGED STRUCTURE



DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATERS

N

Not to Scale

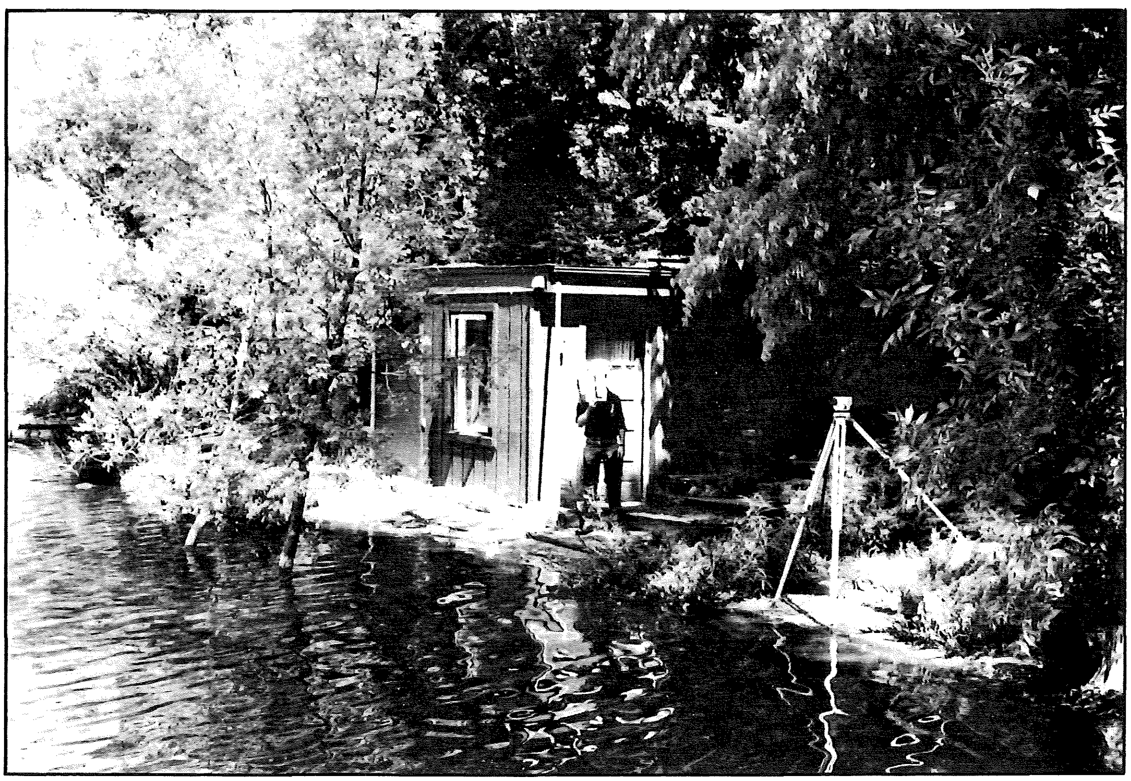
INDIAN LAKE WRIGHT CO.

Structure Number :	1	
Name :	Lindquist, Marion G.	
Address :	1425 Van Buren Avenue St. Paul, MN 55104	
Legal Description :	Sec. 12, Twp. 121, R. 27 Cherokee Acres Lot 4, Block 1, Cherokee Acres.	
Walkout/1stFl Elev. :	1012.08	
Ground Elevation :		
Basement :	NO	
Walkout :	NO	

Market Value

Buildings :	$7,900.00
Land :	$24,200.00
Total :	$32,100.00

Flood Insurance : YES



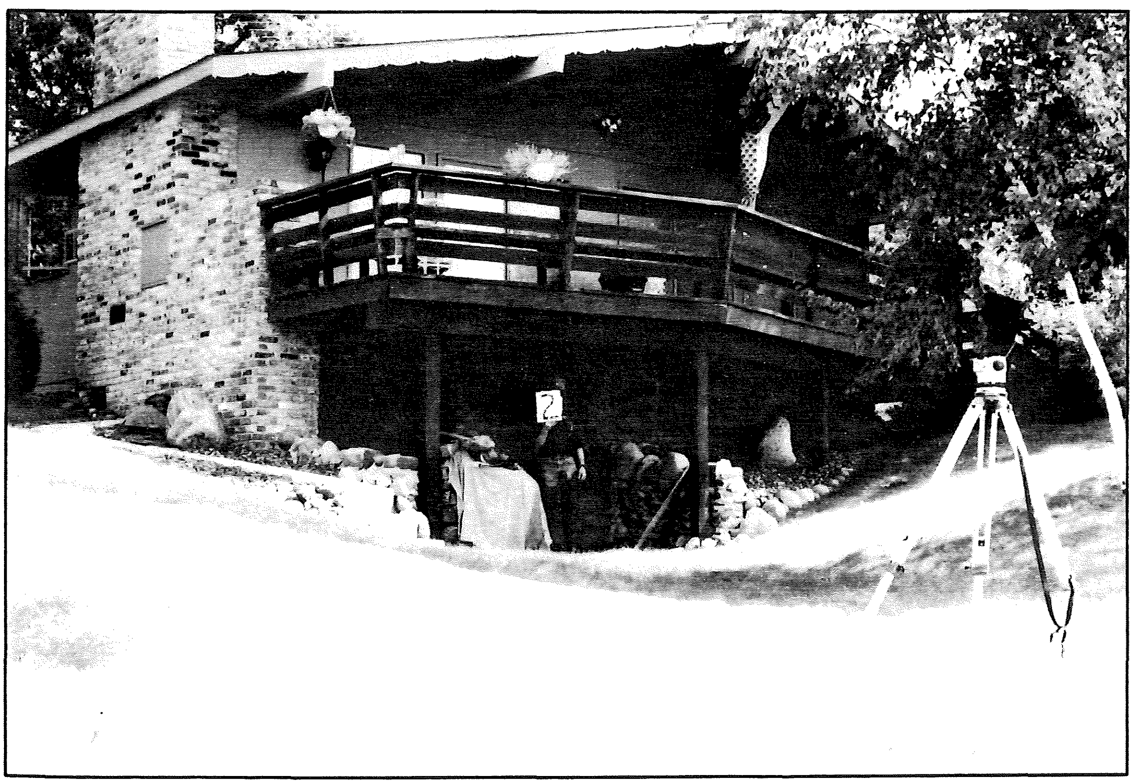
INDIAN LAKE WRIGHT CO.

Structure Number :	2	
Name :	Renneberg, Robert R.	
Address :	Rt. 2, 279 D Maple Lake, MN 55358	
Legal Description :	Sec. 1, Twp. 121, R. 27 Cherokee Acres Lot 3, Block 1, Cherokee Acres.	
Walkout/1stFl Elev. :	1016.79	
Ground Elevation :	1016.7	
Basement :	YES	
Walkout :	YES	

Market Value

Buildings :	$45,600.00
Land :	$24,200.00
Total :	$69,800.00

Flood Insurance : NO



INDIAN LAKE WRIGHT CO.

Structure Number :	3
Name :	Ochs, Richard C.
Address :	Rt. 2, Box 240 M Maple Lake, MN 55358
Legal Description :	Sec. 1, Twp. 121, R. 27, Indian Point, Legal Description on file with the County Assessor's Office. Pin Number: 206-047-00112 876.
Walkout/1stFl Elev. :	1014.67
Ground Elevation :	1012.9
Basement :	NO
Walkout :	NO

Market Value

Buildings :	$11,300.00
Land :	$3,500.00
Total :	$14,800.00

Flood Insurance : NO

INDIAN LAKE WRIGHT CO.

Structure Number :	4
Name :	Breckenridge, Clarence M.
Address :	6309 Concord Avenue Edina, MN 55424
Legal Description :	Sec. 1, Twp. 121, R. 27 Legal Description on file with the County Assessor's Office. Pin Number: 206047-00110 (1986).
Walkout/1stFl Elev. :	1017.30
Ground Elevation :	1014.3
Basement :	NO
Walkout :	NO

Market Value

Buildings :	$14,800.00
Land :	$5,000.00
Total :	$19,800.00

Flood Insurance : NO

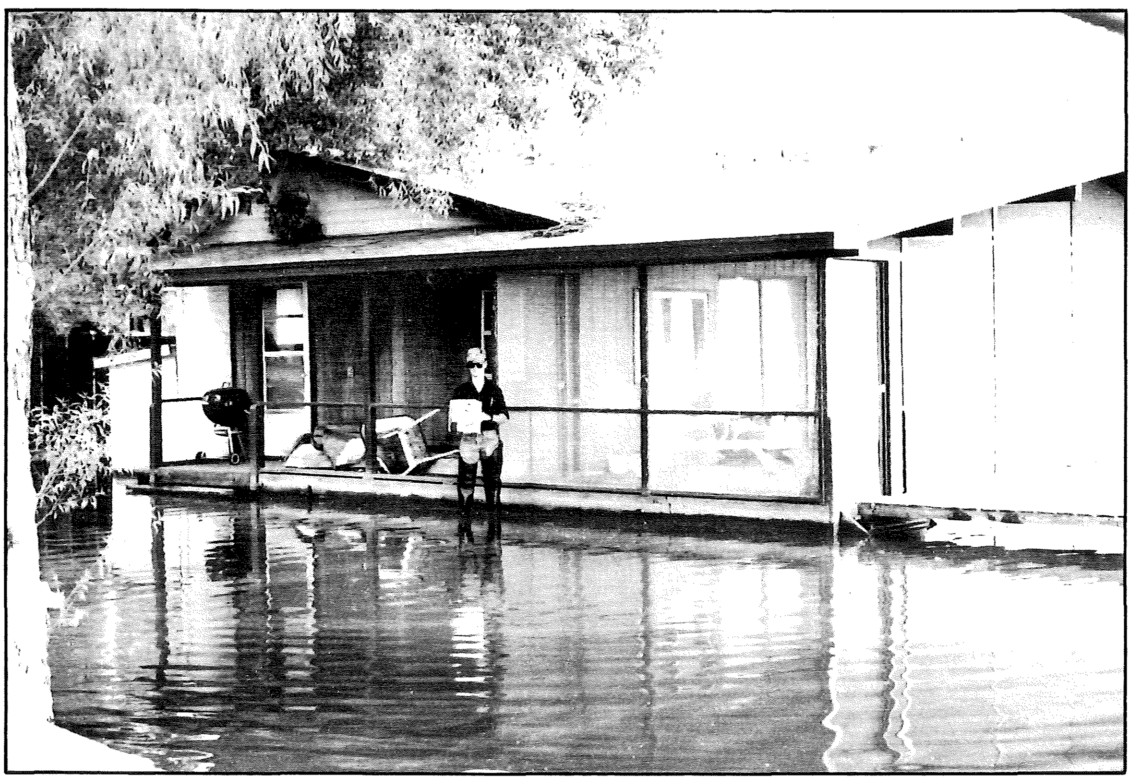
INDIAN LAKE WRIGHT CO.

Structure Number :	5
Name :	Wolff, Lowell and Betty
Address :	6329 Chesire Lane Maple Grove, MN 55369
Legal Description :	Sec. 1, Twp. 121, R. 27 Legal Description on file with County Assessor's Office. Pin Number: 206-047-00111 876.
Walkout/1stFl Elev. :	1012.66
Ground Elevation :	1010.7
Basement :	NO
Walkout :	NO

Market Value

Buildings :	$100.00
Land :	$100.00
Total :	$200.00

Flood Insurance : YES



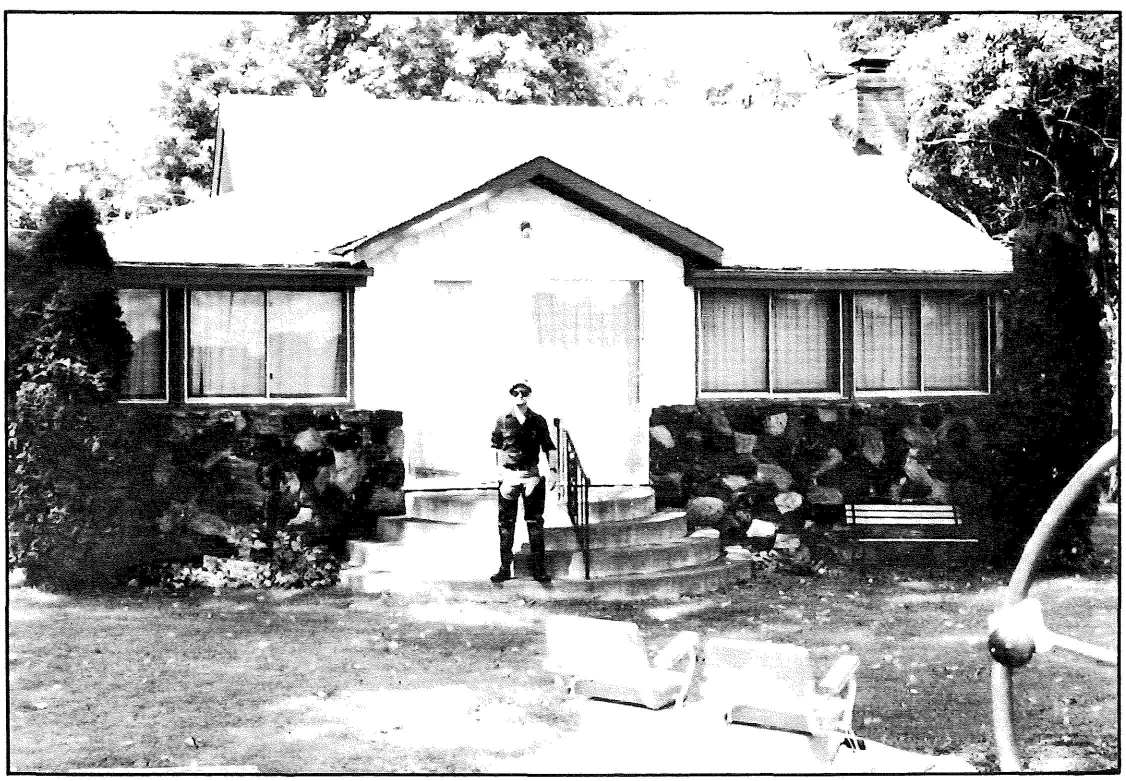
INDIAN LAKE WRIGHT CO.

Structure Number :	6
Name :	Holm, W. and Serota W.R.
Address :	2014 Lowry Avenue Minneapolis, MN 55411
Legal Description :	Sec. 1, Twp. 121, R. 27 Indian Point Lot 10, Block 1, Indian Point.
Walkout/1stFl Elev. :	1015.74
Ground Elevation :	1012.7
Basement :	NO
Walkout :	NO

Market Value

Buildings :	$33,400.00
Land :	$7,100.00
Total :	$40,500.00

Flood Insurance : NO



INDIAN LAKE WRIGHT CO.

Structure Number :	7
Name :	Schwab, Diane F. et al
Address :	5415 France Avenue North Minneapolis, MN 55422
Legal Description :	Sec. 1, Twp. 121, R. 27 Indian Point Lot 9, Block 1, Indian Point.
Walkout/1stFl Elev. :	1015.51
Ground Elevation :	1012.6
Basement :	NO
Walkout :	NO

Market Value

Buildings :	$19,800.00
Land :	$8,000.00
Total :	$27,800.00

Flood Insurance : NO

INDIAN LAKE WRIGHT CO.

Structure Number :	8	
Name :	Serota, Walter and Betty	
Address :	2104 Lowry Avenue North Minneapolis, MN 55411	
Legal Description :	Sec. 1, Twp. 121, R. 27 Indian Point Lot 8, Block 1, Indian Point.	
Walkout/1stFl Elev. :	1016.47	
Ground Elevation :	1013.8	
Basement :	NO	
Walkout :	NO	
Market Value		
Buildings :		$13,400.00
Land :		$8,600.00
Total :		$22,000.00
Flood Insurance :	YES	

INDIAN LAKE WRIGHT CO.

Structure Number :	9
Name :	Matheny, Carol
Address :	5323 A. Penrith Drive Durham, NC 27713
Legal Description :	S. 1/2 Sec. 1, N. 1/2 Sec. 12, Twp. 121, R. 27 Indian Point Lot 7, Block 1, Indian Point.
Walkout/1stFl Elev. :	1016.30
Ground Elevation :	1013.7
Basement :	NO
Walkout :	NO

Market Value

Buildings :	$11,600.00
Land :	$9,500.00
Total :	$21,100.00

Flood Insurance : NO

INDIAN LAKE WRIGHT CO.

Structure Number :	10
Name :	Salzl, Delores E.
Address :	9919 Chisholm Trail Corcoran, MN 55340
Legal Description :	S. 1/2 Sec. 1, N. 1/2 Sec. 12, Twp. 121, R. 27 Indian Point Lot 6, Block 1,Indian Point.
Walkout/1stFl Elev. :	1016.13
Ground Elevation :	1012.3
Basement :	NO
Walkout :	NO

Market Value

Buildings :	$13,100.00
Land :	$9,400.00
Total :	$22,500.00

Flood Insurance :	NO

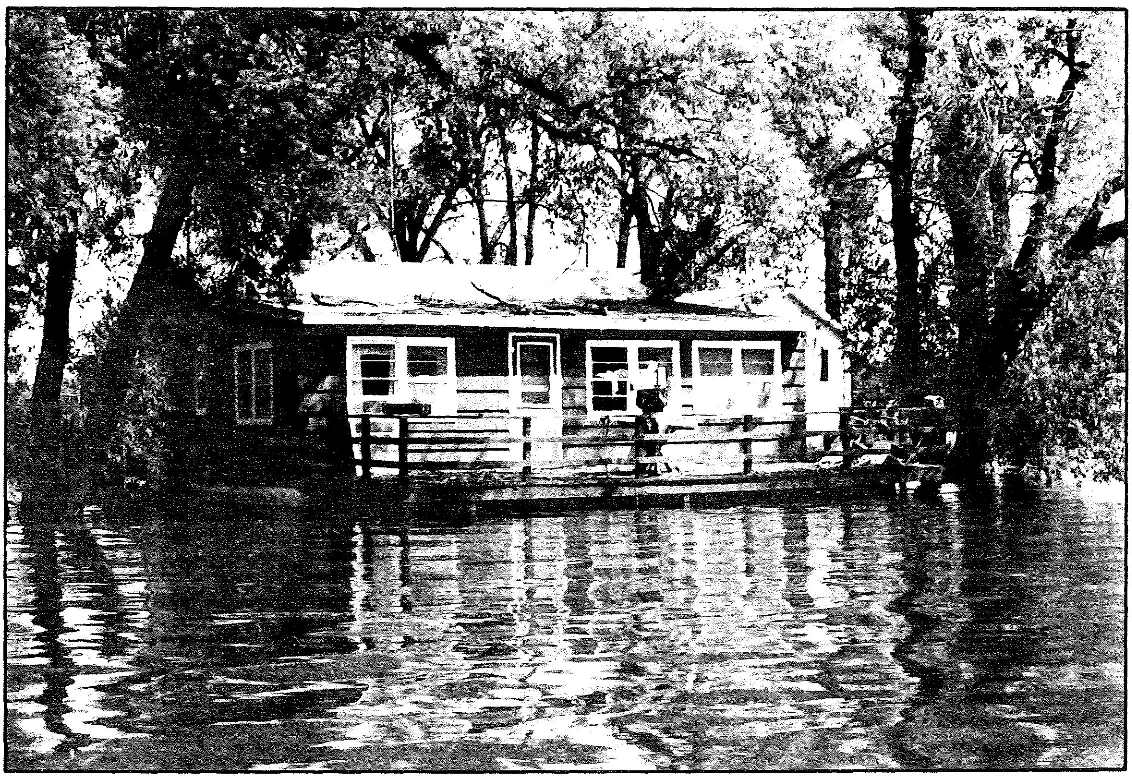
INDIAN LAKE WRIGHT CO.

Structure Number :	11
Name :	Bunnell, L.O. et al
Address :	6914 17th Avenue South Richfield, MN 55423
Legal Description :	S. 1/2 Sec. 1, N. 1/2 Sec. 12, Twp. 21, R. 27 Indian Point Lot 5, Block 1,Indian Point.
Walkout/1stFl Elev. :	1013.17
Ground Elevation :	1010.8
Basement :	NO
Walkout :	NO

Market Value

Buildings :	$100.00
Land :	$100.00
Total :	$200.00

Flood Insurance : NO



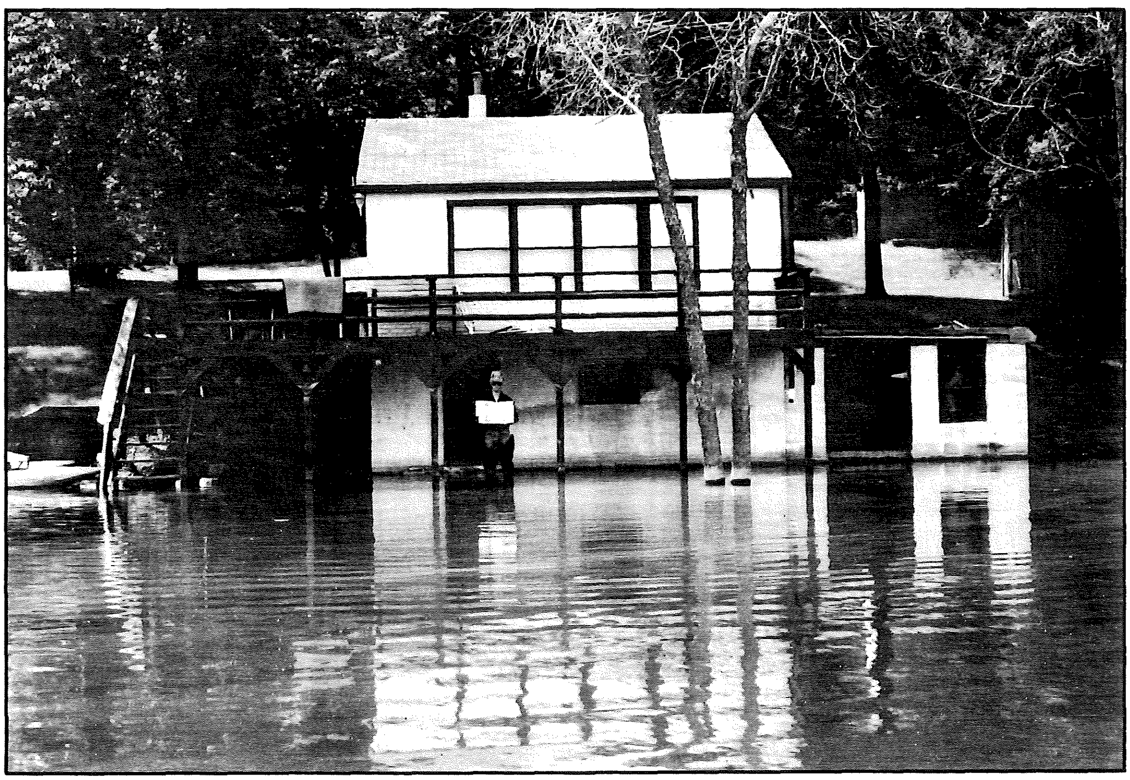
INDIAN LAKE WRIGHT CO.

Structure Number	:	12
Name	:	Fournier, Fred G.
Address	:	4900 Zenith Avenue North Minneapolis, MN 55429
Legal Description	:	Sec. 12, Twp. 121, R. 27 Indian Lake Heights Lots 8 and 9, Indian Lake heights.
Walkout/1stFl Elev.	:	1011.20
Ground Elevation	:	1010.6
Basement	:	YES
Walkout	:	YES

Market Value

Buildings	:	$13,000.00
Land	:	$9,400.00
Total	:	$22,400.00

Flood Insurance : NO



INDIAN LAKE WRIGHT CO.

Structure Number :	13	
Name :	Walton Wesley R.	
Address :	6845 Norwood Lane Maple Grove, MN 55369	
Legal Description :	Sec. 12, Twp. 121, R. 27 Indian Lake Heights Lot 11, Indian Lake Heights.	
Walkout/1stFl Elev. :	1012.85	
Ground Elevation :	1012.0	
Basement :	YES	
Walkout :	YES	
Market Value		
Buildings :		$24,900.00
Land :		$5,100.00
Total :		$30,000.00
Flood Insurance :	NO	

<u>INDIAN LAKE WRIGHT CO.</u>

Structure Number :	14
Name :	Bednarski, Joseph
Address :	101 East 48th Street Minneapolis, MN 55409
Legal Description :	Sec. 12, Twp. 121, R. 27 Indian Lake Heights Lot 12, Indian Lake Heights.
Walkout/1stFl Elev. :	1013.62
Ground Elevation :	
Basement :	YES
Walkout :	YES

Market Value

Buildings :	$4,600.00
Land :	$9,400.00
Total :	$14,000.00

Flood Insurance : NO

INDIAN LAKE WRIGHT CO.

Structure Number :	15
Name :	Harler, James R. et al
Address :	4175 147th lane Anoka, MN 55304
Legal Description :	Sec. 12, Twp. 121, R. 27 Indian Lake Heights Lot 13, Indian Lake Heights.
Walkout/1stFl Elev. :	1018.95
Ground Elevation :	1013.9
Basement :	NO
Walkout :	NO

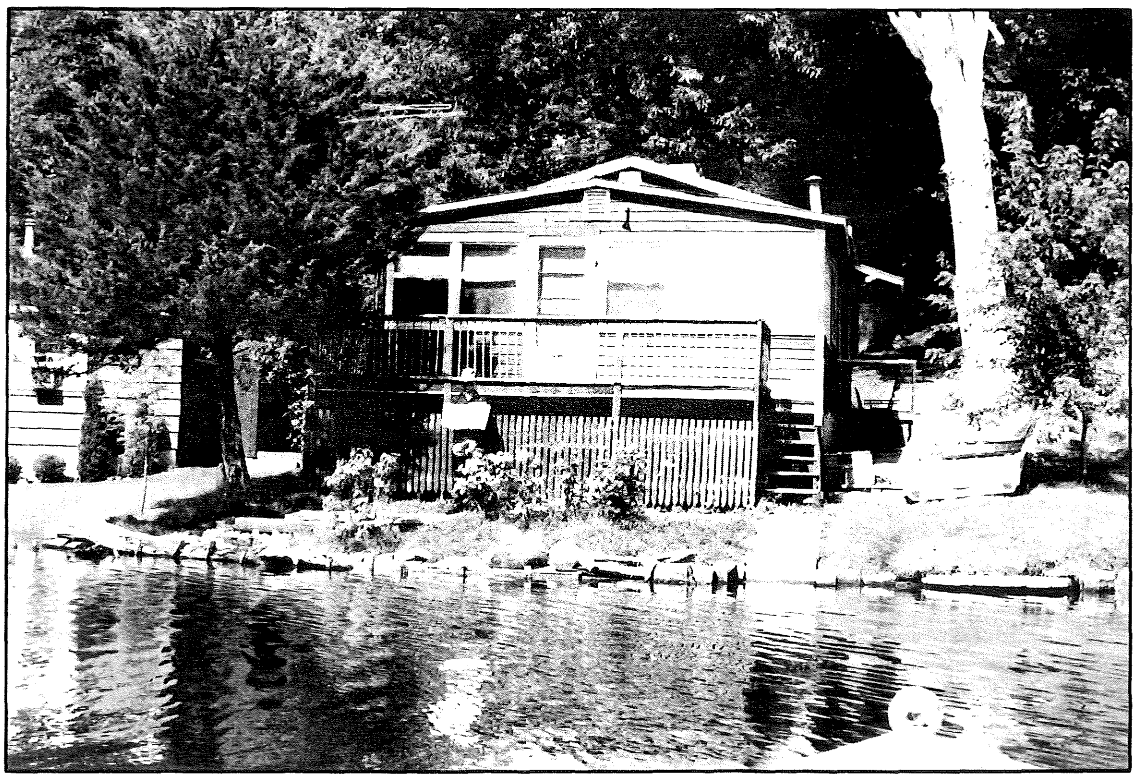
Market Value

Buildings :	$11,000.00
Land :	$10,800.00
Total :	$21,800.00

Flood Insurance : NO

INDIAN LAKE WRIGHT CO.

Structure Number :	16	
Name :	Winger, Oscar et al	
Address :	2308 East 55th Street Minneapolis, MN 55417	
Legal Description :	Sec. 12, Twp. 121, R. 27 Indian Lake Point Lot 13, Indian Lake Point.	
Walkout/1stFl Elev. :	1019.16	
Ground Elevation :	1014.5	
Basement :	NO	
Walkout :	NO	
Market Value		
Buildings :		$15,800.00
Land :		$3,900.00
Total :		$19,700.00
Flood Insurance :	NO	



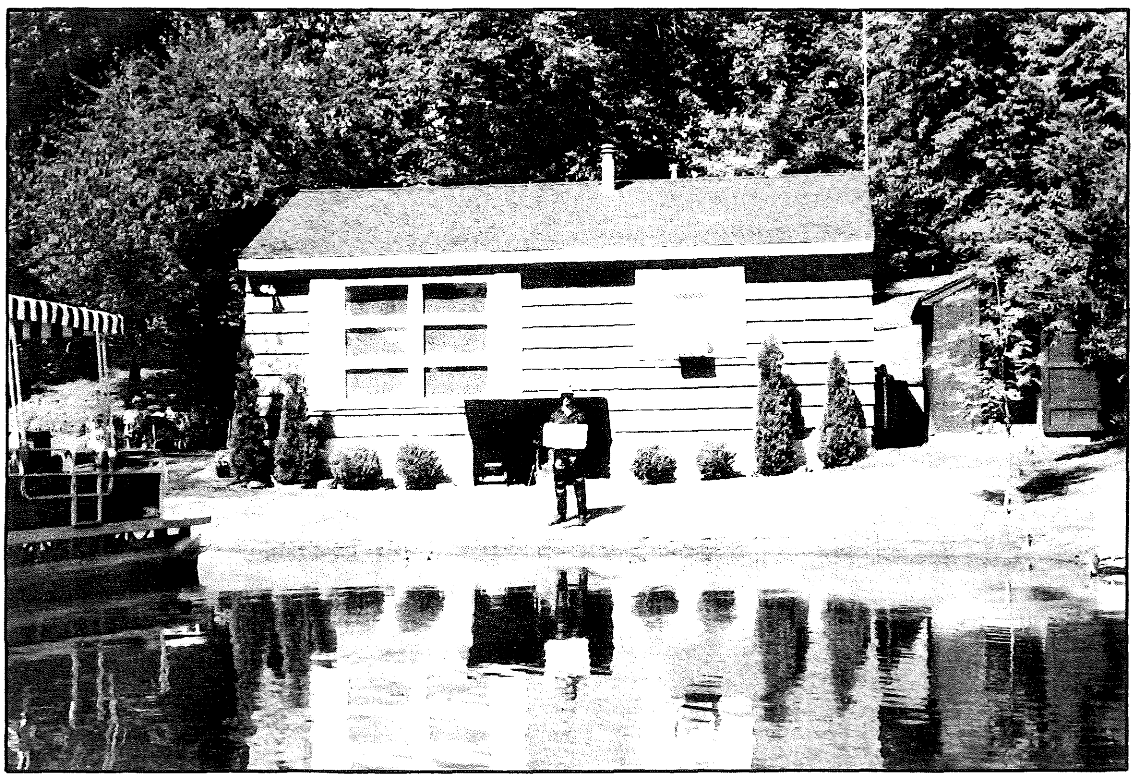
INDIAN LAKE WRIGHT CO.

Structure Number :	17
Name :	Scheeler, Albert F.
Address :	1505 Zealand Avenue North Minneapolis, MN 55427
Legal Description :	Sec. 12, Twp. 121, R. 27 Indian Lake Point Lot 14, Indian Lake Point.
Walkout/1stFl Elev. :	1017.26
Ground Elevation :	1014.3
Basement :	NO
Walkout :	NO

Market Value

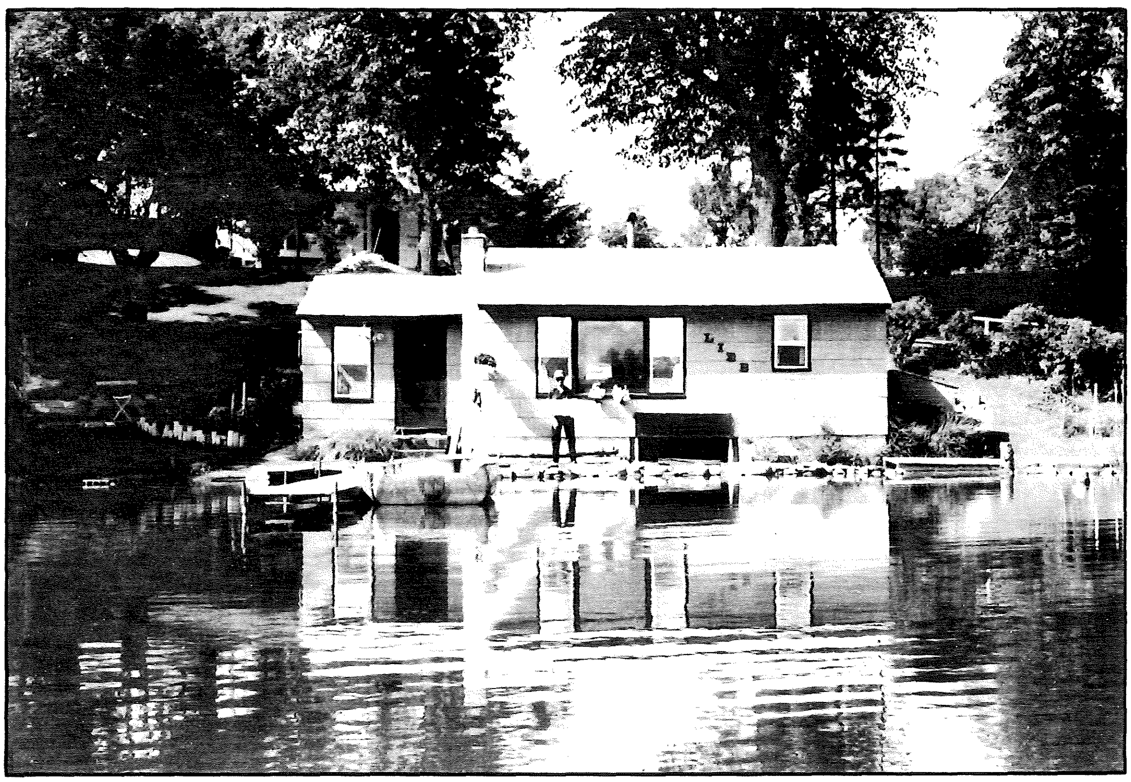
Buildings :	$12,900.00
Land :	$3,900.00
Total :	$16,800.00

Flood Insurance : NO



INDIAN LAKE WRIGHT CO.

Structure Number :	18	
Name :	Lieb, William H.	
Address :	4921 Park Avenue South Minneapolis, MN 55417	
Legal Description :	Sec. 12, Twp. 121, R. 27 Indian Lake Point Lot 16, Indian Lake Point.	
Walkout/1stFl Elev. :	1014.43	
Ground Elevation :	1011.9	
Basement :	NO	
Walkout :	NO	
Market Value		
Buildings :		$13,300.00
Land :		$5,100.00
Total :		$18,400.00
Flood Insurance :	NO	



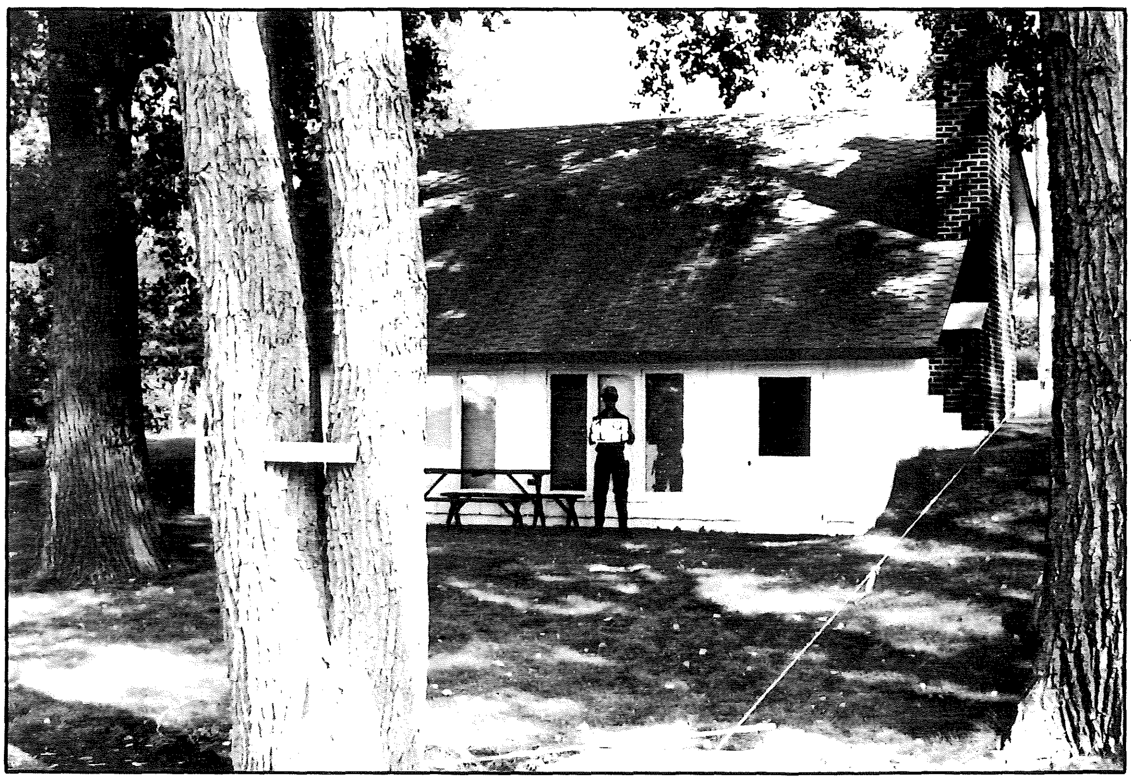
INDIAN LAKE WRIGHT CO.

Structure Number :	19
Name :	Reichard, David A.
Address :	11511 3rd Avenue North Plymouth, MN 55441
Legal Description :	Sec. 12, Twp. 121, R. 27 Nylin Shores Lot 10, Nylin Shores.
Walkout/1stFl Elev. :	1014.73
Ground Elevation :	
Basement :	YES
Walkout :	YES

Market Value

Buildings :	$39,700.00
Land :	$13,300.00
Total :	$53,000.00

Flood Insurance : NO



APPENDIX E

INDIAN LAKE WATER LEVEL HISTORY

INDIAN LAKE (86-223) LAKE LEVEL READINGS

DATE	GAUGE READING	ELEVATION	DATE	GAUGE READING	ELEVATION
05/15/84	Prior to gauge	1010.58	06/13/86	4.32	1011.86
06/12/84	Prior to gauge	1011.24	06/19/86	4.26	1011.80
08/30/85	4.70	1010.54	06/21/86	4.46	1012.00
09/02/85	4.68	1010.52	06/29/86	4.31	1011.85
09/03/85	4.80	1010.64	07/03/86	4.28	1011.82
09/04/85	4.81	1010.65	07/05/86	4.34	1011.88
09/07/85	4.78	1010.62	07/10/86	4.28	1011.82
09/08/85	5.08	1010.92	07/12/86	4.31	1011.85
09/09/85	5.32	1011.16	07/13/86	4.32	1011.86
09/10/85	5.36	1011.20	07/19/86	4.40	1011.94
09/11/85	5.37	1011.21	07/22/86	4.32	1011.86
09/15/85	5.34	1011.18	07/24/86	4.36	1011.90
09/17/85	5.35	1011.19	07/29/86	4.32	1011.86
09/20/85	5.32	1011.16	08/04/86	4.18	1011.72
09/22/85	5.32	1011.16	08/07/86	4.26	1011.80
09/24/85	5.38	1011.22	08/11/86	4.24	1011.78
09/29/85	5.36	1011.20	08/14/86	4.18	1011.72
09/30/85	5.39	1011.23	08/16/86	4.14	1011.68
10/03/85	5.38	1011.22	08/19/86	4.12	1011.66
10/04/85	5.41	1011.25	08/22/86	4.18	1011.72
10/08/85	5.43	1011.27	08/25/86	4.18	1011.72
10/12/85	5.48	1011.32	08/27/86	4.16	1011.70
10/14/85	5.49	1011.33	08/28/86	DNR	1011.65
10/15/85	5.50	1011.34	08/31/86	4.06	1011.60
10/25/85	5.48	1011.32	09/03/86	4.10	1011.64
10/29/85	5.42	1011.26	09/07/86	4.06	1011.60
10/31/85	5.38	1011.22	09/10/86	4.14	1011.68
10/04/85	5.36	1011.20	09/15/86	4.19	1011.73
11/09/85	5.35	1011.19	09/17/86	4.40	1011.94
11/11/85	5.32	1011.16	09/18/86	4.44	1011.98
11/13/85	5.28	1011.12	09/19/86	4.50	1012.04
04/01/86	6.02	1011.52	09/21/86	4.66	1012.20
04/03/86	6.06	1011.56	09/22/86	4.74	1012.88
04/05/86	6.14	1011.64	09/25/86	4.82	1012.36
04/14/86	6.24	1011.74	09/27/86	4.83	1012.37
04/16/86	6.28	1011.78	09/29/86	4.80	1012.34
04/18/86	6.29	1011.79	10/11/86	4.68	1012.22
04/20/86	6.38	1011.88	10/13/86	4.69	1012.23
04/24/86	6.38	1011.88	10/23/86	4.59	1012.13
04/26/86	6.42	1011.92	10/29/86	4.54	1012.08
04/28/86	6.60	1012.10	11/03/86	4.48 removed	1012.02
04/29/86	6.62	1012.12	11/25/86	DNR	1011.90
05/02/86	6.64	1012.14	05/02/87	4.66	1010.99
05/13/86	"0" new	1012.24	05/08/87	4.55	1010.88
05/17/86	4.66	1012.20	05/12/87	4.48	1010.81
05/26/86	4.62	1012.16	05/16/87	4.38	1010.71
05/28/86	4.60	1012.14	05/23/87	4.36	1010.69
05/30/86	4.56	1012.10	05/31/87	4.28	1010.61
06/04/86	4.38	1011.92	06/06/87	4.18	1010.51
06/08/86	4.34	1011.88	06/10/87	4.12	1010.45

DATE	GAUGE READING	ELEVATION
06/17/87	4.00	1010.33
06/23/87	3.94	1010.27
06/29/87	3.78	1010.11
07/06/87	3.68	1010.01
07/24/87	3.58	1009.91
07/30/87	3.56	1009.89
08/03/87	3.58	1009.91
08/10/87	3.48	1009.81
08/12/87	3.56	1009.89
08/16/87	3.60	1009.93
08/22/87	3.48	1009.81
08/29/87	3.40	1009.73
08/31/87	3.40	1009.73
09/07/87	4.20	1009.63
09/11/87	4.16	1009.59
09/14/87	4.16	1009.59
09/18/87	4.20	1009.63
09/30/87	4.08	1009.51

APPENDIX F

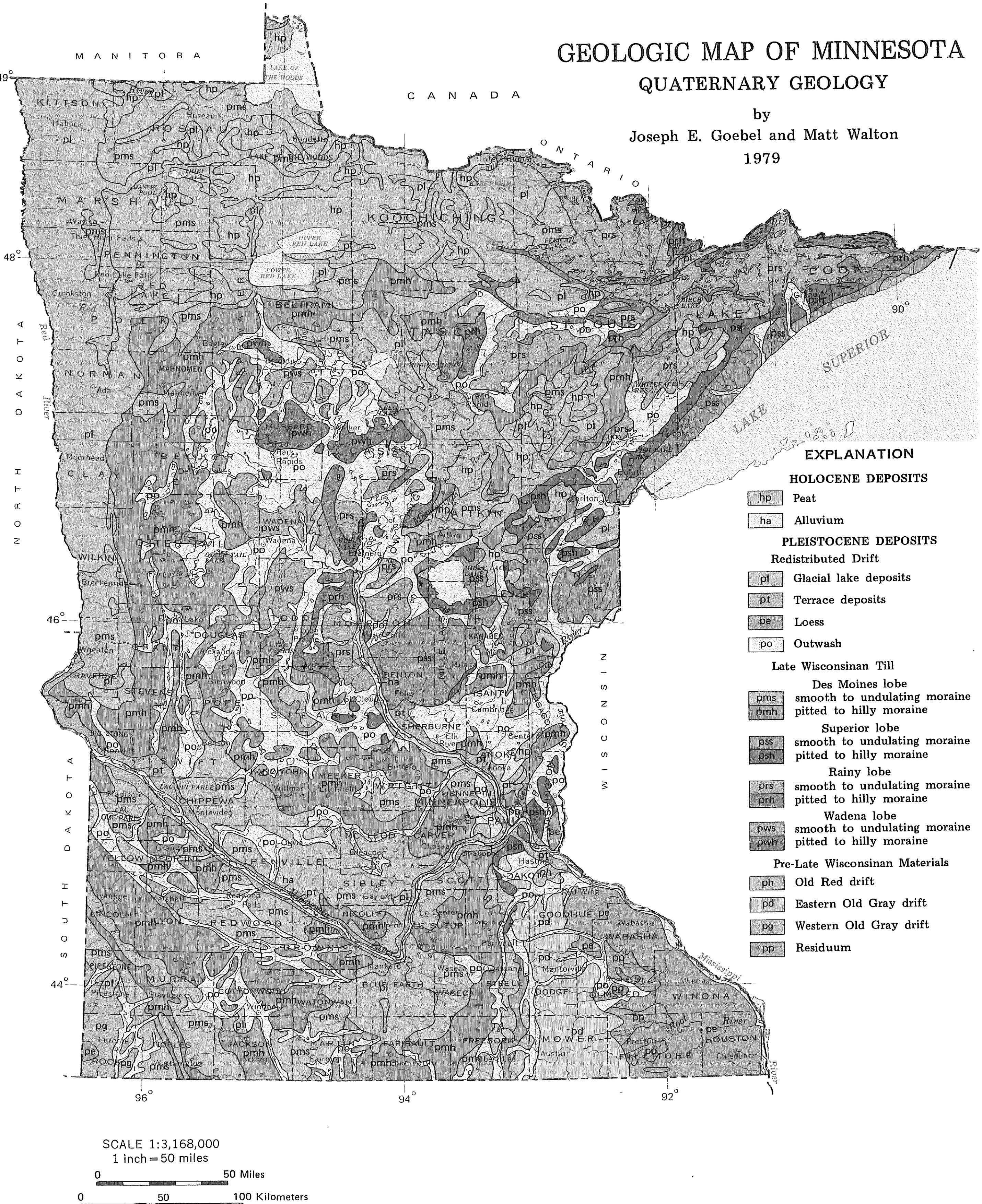
GEOLOGIC MAP OF MINNESOTA

Minnesota Geological Survey
University of Minnesota
Matt Walton, Director

GEOLOGIC MAP OF MINNESOTA

QUATERNARY GEOLOGY

by
Joseph E. Goebel and Matt Walton
1979



Published with the support of the Legislative Commission on Minnesota Resources

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, Illinoisan 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.

pss, psh — SUPERIOR LOBE TILL—Smooth to undulating moraine (pss) 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 northwest-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 Illinoisan 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.

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

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