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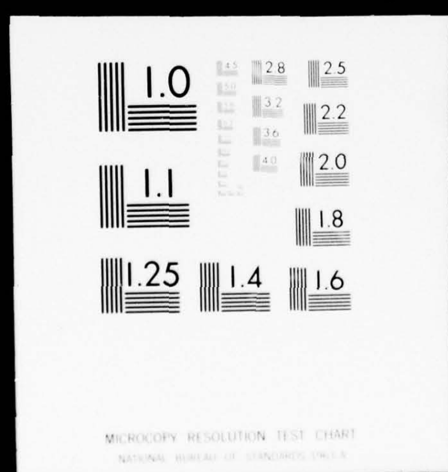

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Book 14
Surface Water Data

Seafarer Site Survey
Upper Michigan Region

for
U.S. Navy
Naval Electronic Systems Command
Washington, D.C.

by
EDAW inc.
under contract to
GTE Sylvania
Communication Systems Division

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The region under study is drained by many streams and rivers flowing out of the area. Primary drainage is towards Lake Superior in the north and west and towards Lake Michigan in the south and east. In most of the area, however, drainage is poorly developed and these regions are characterized by numerous ponds, lakes and swampy areas.

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20. Water quality in streams is generally good with total dissolved solids content low -- no more than about 200 ppm even under low flow conditions,with hardness less than 120 pmm.

Surface water resources are not extensively developed at the present time with main uses being for recreation, fishing, hydroelectric power production,and industry.

BOOK 14

SURFACE WATER DATA
of the
UPPER MICHIGAN REGION
PROJECT SEAFARER

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for
U. S. Navy. Naval Electronic Systems Command

by
EDAW, Inc., 50 Green Street, San Francisco 94111

Under Contract to
GTE Sylvania, Communication Systems Division

April, 1976

CONTENTS

SUMMARY

The Study Area is drained by many streams that converge into large streams and rivers flowing out of the area. These major drainages flow in two general directions. Large streams draining the northern and western portions of the Study Area generally flow north to Lake Superior. Streams draining the central and southeastern portions of the area drain southeastward into Lake Michigan, or into the Menominee River (which, in turn, drains into Lake Michigan).

In parts of the Study Area, especially where Precambrian bedrock is at or near the surface, the drainage net is highly developed, and there is efficient drainage. This results in "flashy" stream behavior, where the streams rise quickly following a period of rainfall, have high peak flows, and then subside rapidly. In most of the area, however, drainage is poorly developed. These areas are characterized by numerous ponds, lakes, and swampy areas. There are often thick and extensive deposits of permeable glacial overburden, and during rainy periods, much of the rain infiltrates the ground instead of running off. The presence of significant numbers of surface water bodies allows temporary storage of surface runoff. These factors combine to produce a streamflow behavior characterized by relatively gradual rises in streams, moderate peak flows, and then gradual declines in streamflow. In such areas, the base flow of streams during rainless periods is sustained by ground water that has infiltrated into the glacial overburden and then emerges as springs and seeps which feed the streams. Thus, these areas having poorly developed drainage do not usually exhibit "flashy" stream behavior, but instead tend to have a relatively uniform flow. Many USGS stream gaging stations are located in the Study Area, and numerous streamflow records are available.

The quality of water in the streams is generally good. The Precambrian bedrock in the central part of the Study Area yields very little soluble material to the streams. The overlying glacial deposits in this area yields only small amounts of soluble materials, so the total dissolved solids content of most streams is low--probably no more than about 200 ppm even under low flow conditions. During periods of high flow, the concentrations of various ions in streams tend to decrease due to dilution. The Paleozoic rocks around the periphery of the Study Area contribute more dissolved materials to the streams. Limestones in particular can cause the surface waters to be somewhat hard, since they contribute calcium and magnesium to streams flowing over them. Hardness during low flow conditions in most of the Study Area is

less than 120 ppm. Excessive iron is not a problem in most streams. There is some evidence of bacterial contamination of streams and lakes in highly populated parts of the area, but this is not a widespread problem. Lakes having surface outlets generally have water quality similar to that of streams but sometimes of lower hardness and lower TDS. In lakes without surface outlets, the water is often very soft (less than 20 ppm), and the TDS concentration is generally low.

Silt loads in streams within the area are generally low, although stream turbidities can be high in local areas downstream of mining operations. This turbidity is reduced by dilution downstream of the source, however, and does not appear to have any seriously adverse effect on fish life. In some areas, the presence of extensive fine grained lakebed deposits can cause high silt loads in streams draining these areas.

There is some potential for scour problems in areas where there are appreciable thicknesses of unconsolidated glacial deposit materials which can be picked up and transported by streams during periods of high flow.

The surface water resources of the Study Area are not extensively developed at the present time. Some of the main uses of streams, lakes and reservoirs are for recreation, fishing, dilution of waste waters, hydroelectric power production (see Utilities Report) and industry, particularly ore processing.

EVOLUTION

Processes Leading to Existing Conditions

Surface water is one component of the overall hydrologic system of the Upper Peninsula of Michigan. The source of the water is precipitation, which runs off the surface forming streams and lakes, percolates downward to join the ground water storage, or is returned to the atmosphere by evapotranspiration. The runoff waters erode the surface and form stream channels and valleys. Water that percolates into the ground may move through the shallow aquifers and eventually enter the surface flow at a lower elevation. Between rains, this ground water seepage maintains stream flow. Surface water, on the other hand, may provide recharge to ground water supplies when the surface water level is higher than the adjacent ground water table. This situation is most likely to occur during the spring melt when water levels are high, and flooding of low lands adjacent to stream channels allows a large volume of water to infiltrate into the ground water reserves.

Besides streams and rivers, surface water also occurs in lakes, swamps, and bogs. Most of the lake basins within the Study Area have been formed as a result of glacial processes. Some are impounded by man-made structures and used for power generation and recreation.

The degree of development of the stream drainage is influenced by factors such as topography and the character of the underlying geologic materials. In areas of low relief, the drainage is poorly developed and characterized by a small number of streams with few tributaries, interconnecting swamps, bogs, and lakes. This is due in part to the low relief, but also is a result of the relatively young topographic surface that has developed since the retreat of the last glacier from the area approximately 10,000 years ago. Over an extremely long period of time, a more efficient drainage net will probably develop, but within the foreseeable future, the present drainage can be considered stable.

Man has modified surface water flow conditions within the Study Area by building dams and reservoirs that hold back runoff; by construction projects, culverts, and other stream channel modifications that alter flow patterns and change natural erosion; and by urbanizing specific areas, with construction of road networks and other paved areas, erection of structures, planting lawns and gardens, etc., all of which result in changes in infiltration and drainage. In some local areas, the natural surface water quality has been changed somewhat by disposal of waste materials, and by fertilization resulting from agricultural procedures. However, surface water in the area is relatively unmodified because of the relatively low population and lack of urbanization.

Anticipated Future Conditions

It is unlikely that significant changes will occur in the surface water regime of the Study Area in the foreseeable future, except in the vicinity of existing or future recreational lake developments. In these potentially rapidly developing areas, it is possible that the quality of the surface water could change due to disposal of wastes, and that erosion and siltation could be accelerated by grading operations. It is likely that any construction activity near stream crossings would accelerate erosion and siltation, but these effects could be minimized by strict control of the procedures employed, as required by the Michigan Department of Natural Resources (see Appendix D). Also quality of the surface water could be affected by significant disposal of waste water, and treatment may be necessary.

DISTINCTIVE UNITS AND CHARACTERISTICS

Occurrence of Surface Water

General Occurrence and Use

Surface water is the water flowing or impounded on the surface of the land. This includes rivers, streams, lakes, ponds, and reservoirs. The source of surface water is precipitation that falls within the area and either enters the system directly as runoff, or infiltrates into the ground and indirectly becomes surface flow when it subsequently emerges as springs and seeps. Both perennial and intermittent streams exist within the Study Area. These two types of streams and the relative sizes of the streams (as shown by stream order) are indicated on the Surface Water Data Map. The surface waters of the Study Area have important industrial, minicipal, and domestic uses. These include power generation, mining, recreation, and use as minicipal water sources.

Principal Rivers

The principal drainage in the Study Area is either north to Lake Superior or southeast toward Lake Michigan (see Surface Water Data Map). Important rivers flowing into Lake Superior are the Yellow Dog, Huron, Silver, and Sturgeon. The Paint and Michigamme Rivers flow south or southeast into the Menominee River bordering the south-central edge of the Study Area. The Menominee River empties into Lake Michigan at Menominee. The Escanaba River flows generally southeast, and empties into Lake Michigan at Escanaba.

Lakes

Lake Superior borders part of the Study Area to the north. Inland water bodies are found throughout the Study Area and represent about 2% of the total surface area. Most of these are natural lakes and ponds, and the majority are less than 20 acres in size. The largest natural lakes are more than 500 acres in size. The large number of natural water bodies found in the Study Area is the result of the recent glaciation. In many places, natural basins now exist where the ice gouged out bedrock or deposited glacial debris so that closed depressions were formed. Lakes and ponds are also found in depressions on topographically low, deposit-covered areas where the drainage is young and inefficient. Only those lakes that were indicated on the original 1:250,000 scale base maps were delineated on the Surface Water Data Map; however, many smaller lakes that are not shown exist in the Study Area.

Seafarer Site Survey Upper Michigan Region

by
EDAW inc.
San Francisco, California

under contract to
GTE Sylvania
Communication Systems Division
Needham Heights, Massachusetts

for
U.S. Navy
Naval Electronic Systems Command
Washington, D.C.

6 Mile Square

Scale 0 1 2 4 6 miles

North

SURFACE WATER

STREAM ORDER (See Text)

- 3
- 3 Intermittent
- 4
- 4 Intermittent
- 5
- 6
- 6+

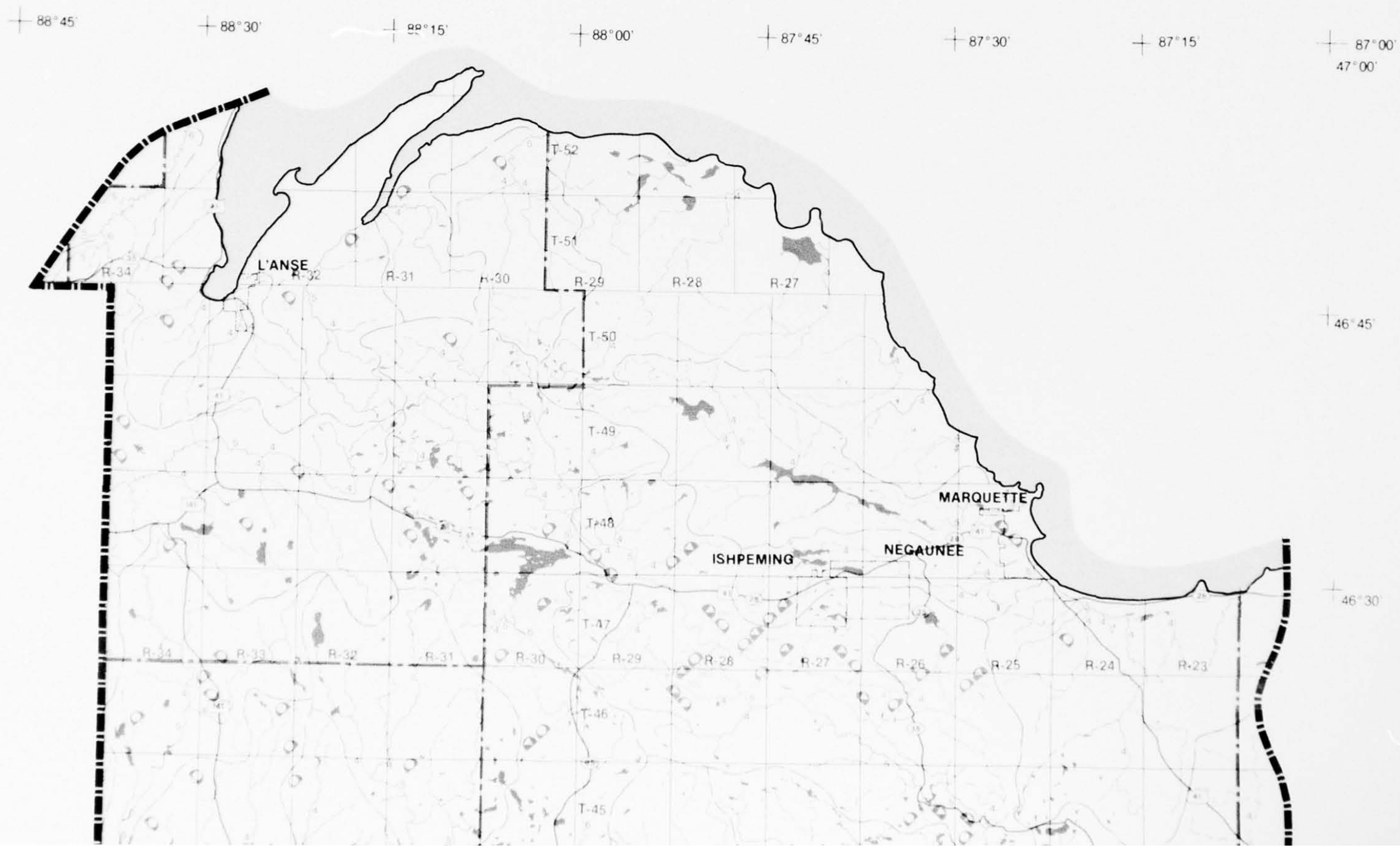
Primary Watersheds

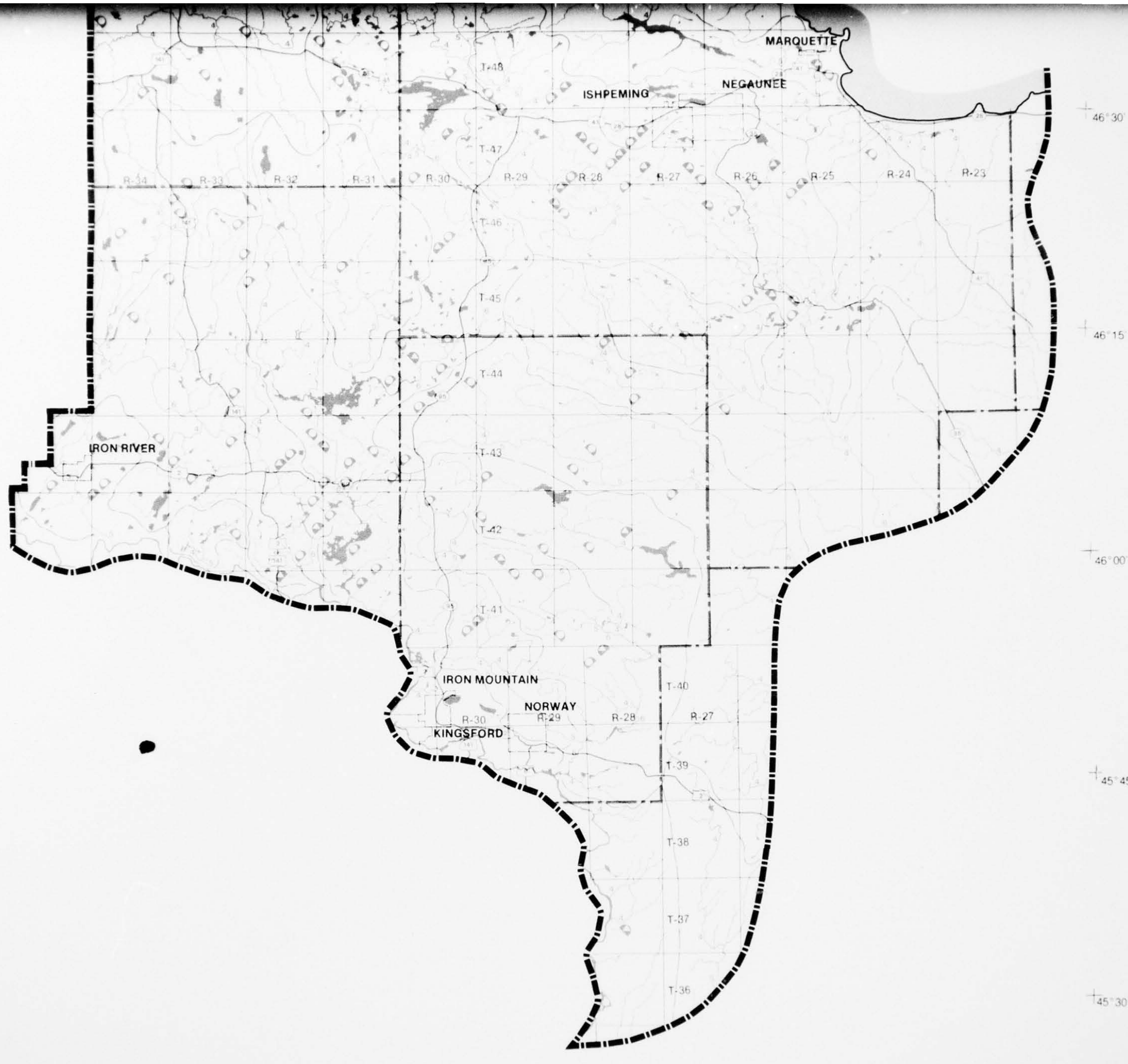
Secondary Watersheds (Greater than 4th Order Streams)

Lakes and Reservoirs

Stream Gaging Stations

Temperature, Silt Load and Water Quality Sampling Points (See Text)




MARQUETTE
NEGAUNEE
ISHPEMING
IRON RIVER
IRON MOUNTAIN
NORWAY
KINGSFORD
T-48
T-47
T-46
T-45
T-44
T-43
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R-23
46°30'
46°15'
46°00'
45°45'
45°30'

The predominant use of man-made reservoirs in the Study Area is for agriculture, municipal water supplies, and hydroelectric power generation. Some of the larger reservoirs include Lake Michigamme (4,212 acres) and Dead River Storage Basin (2,704 acres) in Marquette County, and Peavy Pond (2,673 acres) in Iron County. All of these are used for hydroelectric power generation.

A new reservoir in the Study Area is the Greenwood Reservoir (about 1,400 acres) located near Greenwood (see Figure 1). This reservoir, completed in September of 1973, was constructed by Cleveland Clifs Iron Company to provide water for iron ore processing. It has a usable capacity of 23,300 acre-feet. Two outlets in the afterbay regulate the release and diversion flow. The diverted water flows into Schweitzer Reservoir via Green Creek. Water is then diverted from Schweitzer Reservoir for iron ore processing and returned to the Middle Branch Escanaba River via another Green Creek. The release flow from Greenwood Reservoir is maintained no lower than 24 cfs.

Information on most of the lakes, ponds, and reservoirs in the Study Area is presented in the Michigan Lake Inventory Bulletins. The inventories are by county, and include area, location, origin, maximum depth, shore type (% organic and mineral), fish type, and whether threr is public access to each of the listed water bodies. These publications are available from the Michigan Department of Resources Development, Michigan State University, East Lansing, Michigan.

Springs

Springs are not of great importance in the Study Area. Available spring records indicate that flows are generally less than 5 gallons per minute for springs issuing from glacial deposits. Large springs are also rare in the crystalline Precambrian bedrock because of its low ground water storage capabilities. It is possible, however, that large spring flows occur in areas underlain by Paleozoic sedimentary rocks, and where the crystalline bedrock is well fractured and can be recharged from secondary storage, such as lakes, streams, or overlying glacial deposits.

Drainage Areas

The bedrock underlying most of the Study Area consists primarily of Precambrian rock with smaller areas of Paleozoic sedimentary rocks. Over most of the Study Area the bedrock is covered by up to 300' of unconsolidated glacial deposits. The most extensive areas where glacial deposits are thin or absent are in east-central Baraga and Marquette Counties.

The character of the surficial material has a great effect on the development and behavior of the streams draining that area. In the Study Area, the streams with a drainage basin developed primarily in the areas of crystalline bedrock with little or no glacial mantle tend to be somewhat "flashy" due to the low permeability of the rock and consequent lack of infiltration. These streams are characterized by quick, high peak flows following rains and low flow during dry periods. An example of this type of stream is the Peshekee River in Marquette County.

In general, most major streams with drainage basins on thick glacial deposits are not "flashy", since the permeability of these materials is much greater than that of the crystalline rocks. The higher permeability permits more infiltration of snowmelt and rainfall, and thus reduces the runoff and peak flow of the basin, resulting in a poorly developed drainage net.

Water infiltrating the surface material recharges ground water aquifers, and some water eventually seeps into streams at a lower elevation. This seepage maintains stream flow between rains and during the winter. Thus, in general, the streams on relatively permeable glacial deposits tend to be less "flashy" with lower peak flows and have higher, more uniform base flows derived from ground water seepage. There are some exceptions to this. Drainage basins on impermeable till, with a well developed drainage pattern may also show a "flashy" behavior.

The degree of development and integration of the drainage net is also an important factor in controlling the character of the stream flow. Many of the streams on glacial deposits in the Study Area have a poorly developed drainage pattern. These streams have few tributaries that interconnect swamps, lakes, and bogs. This reduces rapid runoff and provides surface storage, thus reducing peak flows. The poorly drained portions of the Study Area are a consequence of both low relief and the relatively young geologic age of the drainage basins. The last glacier retreated from the Upper Peninsula of Michigan approximately 10,000 years ago, and the drainage pattern has not had sufficient time to fully develop on some of the relatively low-lying glacial deposits.

Surface waters are derived ultimately from precipitation. The distribution of normal precipitation within the Upper Peninsula of Michigan during the period 1931-1960 is shown in Figure 3 of the Climatic Data narrative. The normal precipitation is relatively uniform in the Study Area and ranges from 30 to 32 inches per year.

Stream Sampling/Gaging Stations

The various types of sampling/gaging stations and sources of data are as follows:

U.S. Geological Survey Stream Gaging Stations

These are stations of the U. S. Geological Survey that record daily discharge on major streams. The stations are permanent, although occasionally a site may be added or deleted. The records are published annually by the USGS in Water Resources Data for Michigan, Part 1, Surface Water Records. Summary flow data for these stations are included in Appendix A.

U.S. Geological Survey Crest Stage Partial-Record Stations

These recording stations are mechanical devices that record peak stream stages between readings. They are monitored by the USGS, and the data are published in Water Resources Data for Michigan, Part 1, Surface Water Records.

U.S. Geological Survey Water Quality Stations

These are more or less permanent stations at which one or more of various water quality parameters are measured. These data include measurements of chemical quality, bacterial quality, water temperature, and sediment content. The data are published annually by the USGS in Water Resources for Michigan, Part 2, Water Quality Records. Summary records for these stations are included in Appendix C.

U.S. Geological Survey Miscellaneous Sampling Sites

These consist of water quality data obtained at sites other than established water quality stations. Included with these data in the Appendix are four sampling locations and data from USGS Water Supply Paper 1841.

U.S. Geological Survey Water Quality Data from Circular 634

These consist of chemical quality data published in Circular 634, Chemical Quality of Michigan Streams. The data were collected at times of high and low flow on streams in 1967. Some of the sampling locations overlap with USGS water quality stations.

Michigan Department of Conservation - U.S. Geological Survey Water Quality Data

These data consist of stream and lake water quality measurements collected for county ground water reports within the Study Area.

Miscellaneous Streamflow Measurements in Michigan Through September 1970

These measurements consist of about 160 miscellaneous gaging points in the Study Area at which discharge measurements have been made between the early 1940s and September 1970 by the U. S. Geological Survey through cooperative programs with other federal, state, and local agencies. These data consist of discharge measurements published in the USGS annual series of reports, unpublished data from USGS files, and also published discharge measurements made by the Michigan Bureau of Water Management. These miscellaneous gaging points are not shown on the Surface Water Data Map; however, a list of the streams on which there are data for one or more gaging locations is included in Appendix A.

STORET Retrieval Information

This includes a large amount of data from miscellaneous water quality stations in Baraga, Delta, Dickinson, Houghton, Iron, Marquette, and Menominee Counties. The data consists of one or more chemical analyses, the use of the water, and sometimes the flow rate. This information is not included in the Appendices, but is available in computer printout form from Michigan Department of Natural Resources, Bureau of Water Management and Water Resources Commission, Comprehensive Studies Section, Stevens T. Mason Building, Lansing, Michigan 84926. (A copy of this information is also held in the ESA files.)

Discussion of Data

Chemical Quality

Streams and Rivers. The surface water within the Study Area is generally of good chemical quality. Glacial deposits, which cover most of the area, contribute only a small amount of dissolved ions to surface runoff. Most of the bedrock at the surface is hard Precambrian rock, which contributes only a small amount of dissolved material. The Paleozoic rocks of the Study Area generally contribute the most dissolved material to surface and ground water. In particular, limestone and dolomite contribute calcium and magnesium, and increase the hardness. Where present, these rock types have a local effect on surface water quality. During low flow, the chemical composition of the streams approaches that of the ground water because at low flow the stream is maintained principally by ground water seepage. Ground water tends to have a higher dissolved ion content because of longer contact time with mineral grains. Although sometimes high in iron content, the ground water of the area is also of good quality, and even at low flow the streams usually have a total dissolved solids (TDS) content of less than 200 ppm. The hardness of the stream water is usually in the range of 50 to 100 ppm (soft to moderately hard), although a few streams have values outside this range. Detailed water quality information on specific streams or areas shown on the Surface Water Data Map is contained in the Appendix and the STORET retrieval information.

Lakes. The quality of lake water in the Study Area is generally good. Lakes with outlets have about the same range of chemical constituents as streams, although the hardness and total dissolved solids in the lakes may be lower. The limited data available indicate that lakes without outlets have very soft waters (less than 20 ppm) and low TDS concentrations. This seems to indicate that these lakes are fed principally by precipitation and surface runoff. If the waters were mostly spring-derived, the TDS and hardness would probably be greated and more nearly that of the ground water. These lakes must also have outflow leakage to prevent concentration of ions by evaporation.

Water Temperature

The temperature of a stream is controlled largely by air temperature, and reflects seasonal changes. The volume of ground water seepage into a stream also has an effect on the temperature. Streams with high base flows tend to be cooler in the summer and warmer in the fall than streams fed principally by surface runoff. This is because the temperature of the ground water is relatively constant throughout the year; thus, streams that receive a large volume of ground water seepage are less responsive to seasonal temperature variations. The water temperature of a stream has a great effect on its chemical, bacterial, and physical processes, and thus, suitability for various uses. Trout, for example, thrive best in waters that seldom exceed 20°C. (68°F.) stream temperature. Records in the Study Area indicate that the stream water temperature is usually less than 20°C., although there may be short periods during the summer when daily water temperatures exceed this value. The municipal and industrial wastes that currently flow into the streams in the area have a small effect on stream temperature.

Industrial, Municipal, and Domestic Pollution

Industrial, municipal, and domestic pollution of the streams, lakes, and rivers of the Study Area is not a great problem at this time. The population density is low for the area as a whole, and stream flow relatively high. With increases in population and further economic development, more efficient waste-treatment methods may be required at some locations to avoid degradation of the surface water.

At present effluent from domestic septic tanks causes local contamination in some streams. Shallow shoreward lake water may contain small amounts of coliform bacteria adjacent to cottages and resorts. It can be expected that greater development and recreational use of lakes and smaller streams will increase this problem.

Records of municipal waste water treatment are maintained by the Water Resources Division of the Michigan Department of Natural Resources. The Department of Natural Resources also periodically monitors the receiving water downstream from effluent discharge points.

The two principal industrial uses of water in the Study Area are for power generation and in the iron industry. Except for possible changes to the temperature, use of surface water for hydroelectric power generation has essentially no effect on its quality. The iron industry uses vast amounts of water in the mining and processing of ore. Most of the water used in the iron industry comes from the Michigamme, Carp, and Middle Branch Escanaba Rivers and

Schweitzer Creek. After most of the suspended sediment is removed in settling ponds, the water is eventually put back into the stream. Water used in beneficiation processes and returned to streams has an increase of hardness, total dissolved solids, sulphate, nitrate, silica, turbidity, and sediment concentration. The chemical quality of this discharge, however, is still good and does not greatly affect the receiving stream (Wiitala, et al., 1967, p. 121).

Flow Characteristics

Peak Flows and Flooding. Peak flow is the maximum discharge of a stream during a given time period. A statistical peak flow such as "20 year peak flow" is the discharge that on the average would occur once every 20 years. This is simply a long-term mathematical average. It does not imply that each 20 year peak flow will be 20 years apart. Under given climatic conditions, the peak flow of a stream depends on various geologic and hydrologic characteristics such as the infiltration capacity of the surficial material, drainage basin area, development of the drainage net, stream gradient, topography, and the number and size of lakes. In an area of reasonably similar geologic materials and uniform climatic conditions, the yearly mean peak flow will generally increase with increasing basin size.

In the Michigan Study Area, the relationship between increasing drainage area and increasing peak flow is not universally valid. As discussed previously, the variable character of the underlying rock and soil materials has a great effect on the peak flows of the streams in the Study Area. A river that is developed principally on crystalline Precambrian rock or on relatively impermeable glacial deposits will tend to have higher peak discharges than an equivalent sized drainage basin developed on more permeable materials.

Calculated Peak Flows. Statistical peak flows were predicted for unregulated stream gaging points by the use of the method of Wiitala (1965). Values were determined for the 5, 10, 20, and 30 year peak flows at 12 gaging station locations. These data are included in Table 1. This prediction method is limited by the shortness of recorded stream flow data. Benson (1960) studied the accuracy of different recording periods based on a theoretical 1,000 year record. He concluded that a 31 year record was necessary to predict flows within 25% accuracy for the 25 year flood, and 105 years to predict the 25 year flood to within 10%.

The predicted peak flows were compared to existing records at the six stations with recording periods greater than 20 years (Table 1). In these comparisons, the size of the predicted flow seems to be at least in the range of the recorded flows. A correction factor can be included in the predicted data to account for surface storage in lakes and swamps. This would reduce the predicted peak flows. This factor was ignored in this study, and the predicted flows are thus on the high side.

It should also be noted that the predicted peak flows are derived using generalized curves for areas with similar flood behavior. When studying smaller basins within these areas, however, consideration should be given to local geologic and hydrologic conditions. For example, a stream draining an area underlain by relatively impermeable till, or exposed bedrock, may have higher peak flow than would be suggested by this prediction method.

In summary, when tempered with additional geologic and hydrologic data, this method can be used to give a reasonable indication of expected peak flood flow in unregulated streams in the Study Area. Actual stream gage records are more desirable, but when they are of short period of record, or nonexistent, this method is valuable.

High flows in Michigan's Upper Peninsula are usually the result of spring snowmelt of a combination of rain and snowmelt. High intensity rainfall may also cause infrequent summer flooding. On July 29, 1949, for example, 5" of precipitation was measured in about two hours at Ishpeming. It is estimated that the resulting flood caused several hundred thousand dollars of damage to roads and open fields.

The record floods of the spring of 1960 were the result of both rain and snowmelt. The property loss from this flood was low, primarily due to a lack of damage potential on the floodplains (Wiitala, et al., 1967, p. 34).

On a smaller areal extent, ice damming is another potential flood hazard. During the spring breakup, ice blocks may wedge and block the stream channel, causing local flooding.

These are six HUD flood studies currently in progress in the Upper Peninsula of Michigan. These studies will provide data on expected discharges for floods of various recurrence intervals and will also determine flood zones. The areas under study are the unincorporated areas of Delta and Menominee Counties and the towns of Escanaba, Gladstone,

Table 1. PREDICTED MAGNITUDE AND FREQUENCY OF FLOODS AT SELECTED LOCATIONS

Station Number	Station Name	Drainage Area (sq. mi.)	Flow (cfs) Recurrence Interval (yrs) 5	10	20	30
405	Sturgeon River near Sidnaw, Mich.	171	1940	3570	4410	4620
578	Middle Branch Escanaba R. at Humboldt	46.0	1540	1870	2310	2420
580	Middle Branch Escanaba R. nr. Ishpeming	128	1680	2040	2520	2640
584	Goose Lake Outlet nr. Sands Stn. Mich.	37.5	630	765	945	990
605	Iron River at Caspian, Mich.	92.1	770	935	1155	1210
610	Brule River near Florence, Wisc.	389	2380	2890	3570	3740
622	Peshekee River nr. Champion, Mich.	133	3500	4250	5250	5500
622.3	Michigamme R. nr. Michigamme, Mich.	194	2520	3060	3780	3960
623	Michigamme R. at Republic, Mich.	240	2940	3570	4410	4620
624	Michigamme R. nr. Witch Lake, Mich.	316	3640	4420	5460	5720
653	West Branch Sturgeon R. nr. Randville	56.1	532	646	798	836
655	Sturgeon River nr. Foster City, Mich.	237	1680	2040	2520	2640

Table 2. PREDICTED AND OBSERVED PEAK FLOWS

Station	Location	Predicted 5 yr	10 yr	20 yr	30 yr	Observed (cfs)/year	Number of Years Recorded
605	Iron River at Caspian	770	935	1155	1210	1930/1953	23
405	Sturgeon River near Sidnow	2940	3570	4410	4620	4630/1960	31
610	Brule River nr. Florence, Wisc.	2380	2890	3570	3740	4700/1953	28

Menominee, and Ironwood. These studies are being done by the Escanaba office of the U. S. Geological Survey, and by Johnson and Anderson, a consulting firm in Pontiac, Michigan. The expected completion date of these studies is some time during 1976. Although the area considered in these flood studies include only a small part of the Study Area, the methods and results will have some application to the entire area.

Stream Ordering. Various methods have been proposed for the study of streams and drainage basins. Drainage density, for example, is the total length of streams in a basin divided by the area of the basin. Another parameter sometimes measured is stream frequency--the number of streams divided by the drainage area.

During this study, streams have been ordered by a system proposed by Strahler (1957). By this method, the smallest streams of the drainage net mapped on the particular topographic base map used are designated as first order. Moving downstream, the stream becomes second order at the joining of two first-order streams, third order at the joining of two second-order streams, and so on. Two streams of the same order must meet to raise the stream to the next higher order. A stream of a given order, however, may have any number of lower order tributaries.

The streams in the Study Area were ordered on a 1:250,000 scale topographic base. Consequently, the lowest order streams were designated third order to compensate approximately for the orders that would have been obtained had the ordering been done on a 1:24,000 topographic base to conform with other study areas. The results of the stream ordering and the outlines of the drainage basins are shown on the Surface Water Data Map.

Stream order can be qualitatively related to peak flow. In general, the order of the largest stream in a drainage basin increases with increasing drainage area. Drainage area is one of the most important factors affecting peak flows in different basins, and the expected peak flow should increase with increasing stream order. This relationship, however, is not universally true in the Study Area, primarily because of the variation of geologic materials.

Sediment Yield

Factors that affect the sediment yield from a basin are the amount and form of precipitation, character of the soil, plant cover, drainage density, topography, and land use. Although data are somewhat limited, the quantity of suspended sediment in the surface water is generally low in the Study Area. Low sediment yield can be generally expected from the areas of glacial outwash deposits and exposed crystalline Precambrian rock. Areas of outwash deposits produce low sediment yield due to the coarseness of material. Further, the rapid infiltration of precipitation in these materials results in a lower runoff.

On the other hand, glacial lake deposits have relatively high sediment yield due to the fine grain size and low cohesion of the particles. This explains the siltation problems that occur in northern Ontonagon County (west of the Study Area) where extensive lake deposits exist. The sediment yield from till deposits is generally lower than that from areas of glacial lake deposits. These deposits are clay-rich, cohesive, and not as erodible as the less cohesive lake deposits.

Other factors can also have a large influence on local sediment yield. Denuding land for agricultural uses, for example, exposes a vast amount of material to erosion that in its natural state was protected by dense vegetation. Poor farming practices can greatly increase this problem.

Local Problems Related to Surface Flow

The Michigan Department of State Highways and Transportation has furnished general information pertaining to flow problems at highway crossings in the western portion of the Michigan Upper Peninsula.

Common Highway maintenance problems within the Study Area include minor road washouts due to high streamflow, wave erosion along Lake Superior beaches, and breakage of beaver dams. The breakage of beaver dams can result in extremely high, localized flows in remote areas. Companies maintaining natural gas transmission lines in the northern United States and Canada employ pilots who regularly fly the pipeline right-of-way and check for potential problems such as beaver dam buildups that could result in damage to the buried pipe (Wall Street Journal, December 29, 1975, page 1).

Siltation is a problem outside of the Study Area in northern Ontonagon County due to the predominance of fine grained, easily eroded glacial lake deposits. The problem is greatest at highway crossings along Highway M-64, and on most of the streams in Ontonagon County that flow into Lake Superior. Dredging is often required to remove silts that accumulate at the mouth of the Ontonagon River. Similar fine grained glacial lake-bed deposits are found in northern Baraga County (see Surficial Geologic Data Map), and streams draining these areas may have local siltation problems where stream flow is restricted.

Ice damming could be a problem within the Study Area, particularly where a river enters a lake. During the spring breakup, blocks of ice and debris may jam up and restrict streamflow. This can cause flooding and excessive scour due to high flow velocities beneath the jam. The problem can be controlled by dynamiting to break up ice jams as they develop. This problem is intensified by the high streamflows that occur during the spring melt.

Another streamflow problem in the Study Area includes minor bank erosion at the U. S. 41 crossing on the Chocolay River in Marquette County. This problem is minor and is usually corrected with rockfill or riprap replacement.

RELATIONSHIP TO OTHER DATA

The flow characteristics of a stream are controlled by both climatic and geologic factors. Ultimately, the total volume of water available for the surface water/ground water system is the volume of precipitation minus the water lost by evaporation and evapotranspiration (water released to the atmosphere by evaporation and plant transpiration). The proportion of available water that becomes surface runoff is controlled by climatic factors (intensity of rainfall, temperature) geologic factors (permeability of geologic materials, topography) and other related factors including vegetation. Water that does not run off and is not removed by evapotranspiration will, after exceeding the moisture-holding capacity of the soil, recharge the ground water supplies.

Ground and surface waters are intricately related, and water often moves between surface flows and ground water aquifers. When the stream level is higher than the adjacent ground water table, the stream is influent, and water flows from the stream into the shallow aquifer. A stream is effluent when the stream water level is lower than the ground water table and ground water seeps into the stream channel. A stream may be effluent or influent along different sections of its channel, or it may change, over the course of the year. For example, a stream may be influent during flood flow when the level is above the ground water table and become effluent during dry periods.

The discharge of the stream and permeability of the geologic materials will determine how much exchange of water there is between the ground water and a surface channel. Streams flowing through permeable glacial outwash, or alluvial deposits, may lose or gain a relatively large volume of water. Good producing wells can often be located in permeable units near streams where the aquifer is being continually recharged.

The base flow of a stream is the flow maintained by ground water seepage during fair weather. Areas of more permeable geologic material generally have a lower runoff, but provide more ground water recharge than less permeable areas. In the more permeable areas, the peak flows are reduced and more water is available for base flow. This results in a more uniform yearly flow than may be present in less permeable areas. Examples of this type of stream are the West Branch, Flopper and Bear Creeks, and the Chocolay River. These are located south and southeast of Ishpeming.

The distribution of surface water has an influence on population distribution and land use. Towns and cities are commonly founded along streams and rivers for readily accessible water and waste removal. Surface water is also important for agricultural and industrial use. Surface water is an important aspect of the sporting, recreation, and tourist industries. Besides esthetic qualities, the surface water provides for boating, water skiing, fishing, and other aquatic activities.

VALIDITY

Data Sources

The U. S. Geological Survey, Michigan Geological Survey, and Michigan Department of Natural Resources were the principal sources of data. The delineation of the stream courses was determined from U. S. Geological Survey 1:250,000 scale topographic maps.

Types of Data Available

General information on surface water was obtained from county ground water reports. These reports were available for all of the counties in the Study Area except Marquette. Information on the water resources of the Marquette Iron Range was obtained from a USGS Water Supply Paper by Wiitala, et al. (1967). The report is primarily concerned with the Marquette Range mining area, but much of the discussion is applicable to the entire Michigan Upper Peninsula.

Surface water quality data were available from several sources. Data from the regularly monitored USGS Water Quality Stations were obtained from "Water Resources Data for Michigan, Part 2, Water Quality Records", 1970 through 1974. Low and high flow chemical analyses were found in USGS Circular 634, "Chemical Quality of Michigan Streams". The report by Wiitala, et al. (1967) provided chemical analyses and sediment load measurements within the Marquette mining area. Miscellaneous stream and lake water analyses were found in county ground water reports by the Michigan Geological Survey, and in the unpublished data of C. J. Doonan. Finally, chemical analyses from miscellaneous sites in the Study Area are available from the STORET Retrieval System.

Important streamflow data were obtained from the records of the USGS stream gaging stations. These include regular measurements of flow, low and high flow peaks for the year and over the recording period, mean flow, drainage area, and remarks concerning any upstream flow regulations. Other peak flow data were obtained from Crest Stage Partial Record Stations of the USGS. Stream discharge measurements at miscellaneous sites are available from the publication "Compilation of Miscellaneous Streamflow Measurements in Michigan through September 1970", prepared by the U. S. Geological Survey and Michigan Geological Survey. Also, some stream discharge measurements at miscellaneous sites are available from the STORET Retrieval System.

Data Reliability/Limitations

This discharge at a gaging station is determined by measuring the cross section and velocity distribution of the stream. The calculated discharge is plotted against the gage height at different flows to give a stage-discharge relation curve. From this curve, the discharge at any gage height is determined. These values are not strictly accurate due to the complicated variables such as changing channel cross section, erosion, siltation, velocity distribution, etc. Also, approximations must be made for gage heights greater than those for which velocity measurements exist. During the winter, ice formation may require that the discharge be calculated in another manner. Further information on gaging methods can be found in Corbett, et al., 1943.

The degree of accuracy of the discharge at a given gaging station is indicated under "Remarks" in the record for that station. An "excellent" record means that about 95% of the daily discharge values are within 5%. A "good" record means within 10%, a "fair" within 15%, and a "poor" everything less than "fair". Within the Study Area, almost all of the stations have at least "good" accuracy, although a little over half of these have only "fair" accuracy during the winter. For purposes of planning, water management, construction, etc., these values of discharge are considered well within required limits of accuracy.

The water quality data are condidered accurate. Laboratory analyses, however, are more reliable than those done in the field. Regularly monitored quality stations are more valuable than miscellaneous sampling sites because they show seasonal variations related to flow, or other factors.

The various reports on the ground and surface waters of the Study Area were done by established and qualified agencies. The conclusions are consistent between reports and in agreement with the data.

Procedures Used in Processing Data

The Surface Water Data Map produced in this study shows the stream courses, major drainage basins, stream order, and locations of sampling points corresponding to the data in the Appendices. It also shows whether the streams are perennial or intermittent. This map is a summary of some basic hydrologic data of the Study Area.

All available surface water information on the Study Area was studied, and the general character and behavior of the streams were determined. Streamflow and water quality locations were plotted on the Surface Water Data Map and keyed to the Appendix. The miscellaneous flow and sampling sites found in the STORET Retrieval System, and in the publication "Compilation of Miscellaneous Streamflow Measurements in Michigan through September 1970", by the U. S. Geological Survey and Michigan Geological Survey was not included because of space limitations.

Basic hydrologic data are included in the Appendices. Apendix A contains records of maximum and minimum stream flows recorded at USGS stream gaging stations. These data are keyed to the sampling locations on the Surface Water Data Map with the USGS station numbers. Appendix B contains water quality and some temperature data collected by the Michigan Department of Natural Resources. These records are keyed to the sampling locations by the Township and Range System of the Bureau of Land Management. Appendix C contains water quality, silt load, and temperature data recorded at USGS Water Quality Stations. Like Appendix A, these sampling points are located on the Surface Water Data Map with the USGS stations numbers. In many cases, the USGS Water Quality Stations are also stream gaging stations and have the same station numbers. Symbols on the Surface Water Data Map indicate the type of data (stream flow, water quality, silt load, temperature) available for each sampling point.

To avoid confusion with outside data, it should be noted that the USGS Stations numbers have been abbreviated in this report to simplify coding on the Surface Water Data Map. The actual stations numbers have eight digits; however, since the first three digits are the same for all stations in the Study Area, they have been dropped. In most cases, the last two digits are zeros, which are deleted, leaving the fourth, fifth, and sixth digits as the abbreviated stations number. If, however, one or both of the last digits is not zero, then it is added, preceded by a decimal point. Thus, for example, the USGS Station No. 04057820 is shortened to 578.2 in this report.

Water quality data in Appendix B, collected by the Michigan Department of Natural Resources, are keyed to the map by the Township-Range system. A typical sampling location is, for example, T47N R33W 5-1 NE SE. The first two parts, T43N R33W are the coordinates of a six mile square township, as shown in Figure 1 . Each township is subdivided into 36 one mile square section, as also shown on Figure 1 . The numbers 5-1 in the above sampling location refers to Section 5, sampling location No. 1. In addition, NE SE indicates that the well is located in the northeast quarter of the southeast quarter of Section 5. Only the identification No. 5-1 appears on the map, however, as the coordinates of the township can be readily determined.

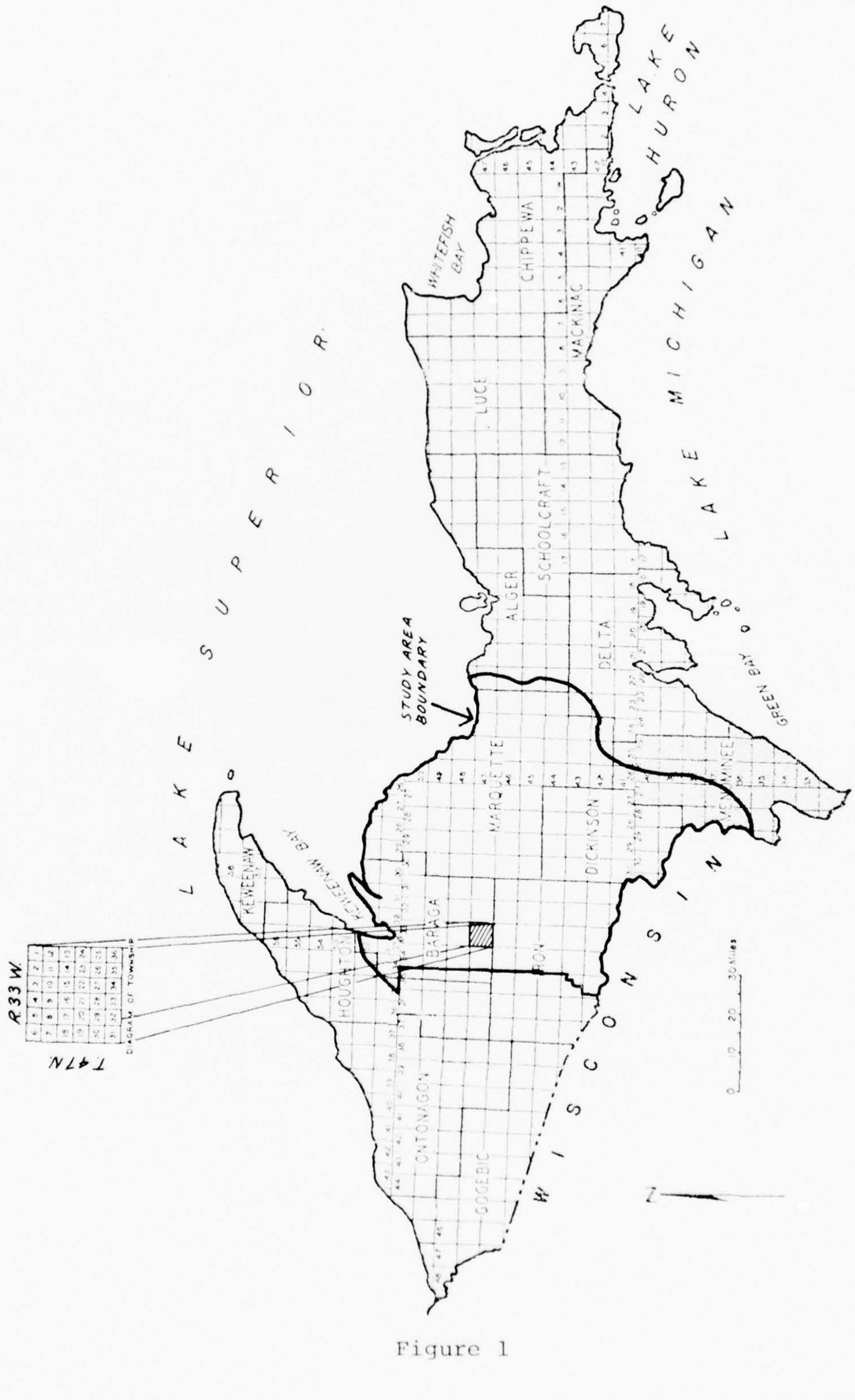

Figure 1. Coordinates of Townships in the Study Area.

Figure 1

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APPENDIX A

STREAM FLOW DATA (USGS)

U.S. GEOLOGICAL SURVEY STREAM GAGING STATIONS

Station Number	Station Name	Drainage Area (sq. mi.)	Period of Record	Average Discharge for period** (cfs) +	Extremes for Period of Record Max. discharge (cfs)	Min. discharge (cfs)	Remarks
405	Sturgeon River near Sidnaw	171	1912-1915 & 1943-1975	212	4630	4.6	
444	Carp River near Negaunee	51.4	1961-1975	59.3	351	3.7	
578	Middle Branch Escanaba River at Humboldt	46	1959-1975	61.0	1640	4.5	
57811	Greenwood Reservoir near Greenwood	67.4	1973-1974*	-	24,420	18,300	Gage measures contents of reservoir.
57813	Greenwood Diversion near Greenwood	-	1973-1974*	-	28	0	
57814	Greenwood Release near Greenwood	67.4	1973-1974*	-	63	10	Maximum discharge listed is for period after regulation began.
5782	Middle Branch Escanaba River near Greenwood	73.2	1973-1974*	-	1060	12	
580	Middle Branch Escanaba River near Ishpeming	128	1954-1975	141	2680	12	
581	Middle Branch Escanaba River near Princeton	219	1961-1975	221	2580	2.2	

+ cubic feet per second
* 1975 data not included
** Average does not include 1975 water year

U.S. GEOLOGICAL SURVEY STREAM GAGING STATIONS (continued)

Station Number	Station Name	Drainage Area (sq. mi.)	Period of Record	Average Discharge for period ** (cfs) +	Extremes for Period of Record Max. discharge (cfs)	Min. discharge (cfs)	Remarks
5819	Schweitzer Reservoir near Palmer	23.1	1963-1975	-	5900 acre-feet	2920 acre-feet	Gage measures storage in Schweitzer Reservoir.
582	Schweitzer Creek near Palmer	23.6	1069-1975	-	860	0.4	
584	Goose Lake Outlet near Sands Station	37.5	1965-1975	33.2	458	6.1	
585	East Branch Escanaba River at Gwinn	124	1954-1975	112	2390	19	
605	Iron River at Caspian	92.1	1948-1975	92.1	1430	25	
610	Brule River near Florence	389	1914-1916 & 1944-1975	361	4700	118	
615	Paint River at Crystal Falls	597	1944-1975	594	19,900	7.7	
620	Paint River near Alpha	631	1952-1975	172	8050	62	
622	Peshekee River near Champion	133	1961-1975	213	3610	3.2	
6223	Michigamme River near Michigamme	194	1968-1975	295	2590	36	
623	Michigamme River at Republic	240	1961-1975	321	3950	7	
624	Michigamme River near Witch Lake	316	1964-1975	444	4360	44	

U.S. GEOLOGICAL SURVEY STREAM GAGING STATIONS (continued)

Station Number	Station Name	Drainage Area (sq. mi.)	Period of Record	Average Discharge for period ** (cfs) +	Extremes for Period of Record Max. discharge (cfs)	Min. discharge (cfs)	Remarks
625	Michigamme River near Crystal Falls	656	1944-1975	704	7260	71	
630	Menominee River near Florence	1780	1914-1975	1801	19,500	38	
653	West Branch Sturgeon River near Randville	56.1	1958-1975	43.3	570	1.5	
653.93	East Branch Sturgeon River below Skunk Creek near Felch	61.8	1973-1974*	-	476	9	
655	Sturgeon River near Foster City	237	1954-1975	183	2570	15	
656	Pine Creek near Iron Mountain	16.8	1972-1974	-	200	1.8	
660	Menominee River near Pembine	3240	1949-1975	3008	26,900	694	

U.S.G.S. PARTIAL RECORD (PEAK FLOW) STREAM GAGING STATIONS

Station Number	Station Name	Period of Record	Drainage Area (sq. mi.)	Water Year	Date	Maximum Annual Discharge (cfs)
442	Carp Creek at Ishpeming	1970-1974	16.5	1970	May 31, 1970	246
578.2	Middle Branch Escanaba River near Greenwood	1970-1972	73.3	1971	April 20, 1971	861
579	Black River near Republic	1961-1968 & 1970-1974	34.4	1970	May 31, 1970	557
583	Warner Creek near Palmer	1961-1968 & 1970-1972	14.2	1970	May 31, 1970	600

STREAMS IN STUDY AREA ON WHICH MISCELLANEOUS DISCHARGE MEASUREMENTS ARE AVAILABLE*

Streams Tributary to Lake Superior

Sturgeon River:
- Lateral Creek near Three Lakes
- Tioga River near Covington
- Pelkie Creek near Alberta

Sturgeon River near Alberta:
- Plumbago Creek at Alberta
- Rock River near Covington
- Rock River near Alberta

Kelsey Creek near Keweenaw Bay
Hazel Creek near Baraga
Six Mile Creek near Baraga
Silver Creek near L'Anse
Huron River near Skanee
Salmon Trout River near Big Bay
Iron River:
- Yellow Dog River near Big Bay

Iron River near Bay Bay
Dead River:
- Little Dead River near Ishpeming

Carp River:
- Carp Creek near Greenwood
- Carp Creek near Ishpeming
- Carp Creek in diversion channel near Ishpeming
- Carp Creek at Ishpeming
- Carp Creek upstream from Partridge Creek at Ishpeming
  - Partridge Creek at Ishpeming
- Gold Mine Creek near Ishpeming

Carp River at Deer Lake near Ishpeming
Carp River near Negaunee:
- Teal Lake outlet at Negaunee
- Carp River tributary near Negaunee
- Morgan Creek near Negaunee
- Morgan Creek near Marquette

Chocolay River:
- West Branch Chocolay River:
  - Silver Lead Creek above treatment planet at K. I. Sawyer Air Base
  - Silver Lead Creek below treatment plant at K. I. Sawyer Air Base

Note: Discharge measurement sites are listed in downstream with tributaries (indented) preceding the next main stem discharge site. Streams followed by colons do not have measurement sites above the tributaries listed below it.

*Data available in: Knutilla, 1974

Streams Tributary to Lake Superior (continued)

West Branch Chocolay River near Sands
West Branch Chocolay River near Skandia
Chocolay River near Harvey
Big Creek near Sands
Peterson Creek at Sands
Peterson Creek near Sands
Big Creek near Harvey
Cedar Creek near Sands
Cedar Creek near Harvey
Cherry Creek near Harvey
Chocolay River near Harvey
Silver Creek near Harvey
Silver Creek at Harvey
Silver Creek at Lake Superior and Ishpeming Railroad near Harvey

Streams Tributary to Lake Michigan

Escanaba River:
Middle Branch Escanaba River near Champion
Second River near Humboldt
Halfway Creek at U. S. Highway 41 near Humboldt
Halfway Creek near Humboldt
Middle Branch Escanaba River at Humboldt
Middle Branch Escanaba River near Humboldt
Boston Lake outlet at Diorite
Boston Lake outlet at Clarksburg
Middle Branch Escanaba River near Clarksburg
Black River near Humboldt
Middle Branch Escanaba River near Greenwood
Black River:
Lake Lory outlet near Humboldt
McKinnon Lake outlet near Humboldt
Lake Lory outlet at Highway 601 near Humboldt
Black River near Republic
Bruce Creek near Republic
Black River near Greenwood
Middle Branch Escanaba River tributary near National Mine
West Branch Creek near Republic
West Branch Creek at Highway 581 near National Mine
West Branch Creek tributary near National Mine
Rocky Creek near National Mine
Rocky Creek at mouth near National Mine
West Branch Creek near National Mine
Wes. Branch Creek near mouth near National Mine

<u>Streams Tributary to Lake Michigan</u> (continued)

- Middle Branch Escanaba River near National Mine
- Middle Branch Escanaba River near Suomi
  - Middle Branch Escanaba River tributary No. 2 near Suomi
  - Middle Branch Escanaba River tributary No. 3 near Suomi
  - Flopper Creek near Princeton
    - Flopper Creek tributary near Princeton
  - Flopper Creek at Highway 565 near Princeton
  - Bear Creek near Princeton
    - Bear Creek tributary near Princeton
    - Bear Creek tributary No. 2 near Princeton
    - Bear Creek tributary near Bear Creek
  - Bear Creek near mouth near Princeton
  - Green Creek near Palmer
  - Green Creek at County Road 565 near Palmer
  - Green Creek near Princeton
  - Green Creek at M-35 near Princeton
- East Branch Escanaba River:
  - Ely Creek near National Mine
  - Schweitzer Creek:
    - Green Creek near National Mine
      - Unnamed tributary near National Mine
  - Schweitzer Creek near National Mine
  - Schweitzer Creek near Palmer
  - Schweitzer Creek at Highway 565 near Palmer
  - Warner Creek near Palmer
- East Branch Escanaba River near Palmer
  - Fifteen Creek near Palmer
  - Goose Lake outlet:
    - Partridge Creek at Negaunee
    - Partridge Creek near Negaunee
  - Goose Lake inlet at Goose Lake near Palmer
  - Goose Lake outlet near Palmer
  - Goose Lake outlet near Sands Station
  - East Branch Escanaba River near Sands Station
    - Uncle Tom Creek near Sands Station
    - O'Neal Creek near Sands Station
  - East Branch Escanaba River at O'Neal Creek near Sands Station
  - East Branch Escanaba River near Gwinn
    - East Branch Escanaba River tributary near Gwinn
    - Halfway Creek at Gwinn
  - East Branch Escanaba River at Gwinn
  - Big West Branch Escanaba River near Arnold
  - Sandmill Creek:
    - Little Lake outlet near Forsyth

Streams Tributary to Lake Michigan (continued)

- Ford River at Ralph
  - North Branch Ford River at Alfred
  - South Branch Ford River near Helps
  - Ten Mile Creek at Faunus
  - Ten Mile Creek at mouth near LaBranche
- Big Cedar River near Spaulding
  - West Branch Big Cedar River near Hermansville
- Big Cedar River at US-2 near Spaulding
- Menominee River:
  - Brule River near Caspian
      - Iron Lake Creek near Iron River
      - Sunset Creek near Iron River
      - Stanley Creek near Iron River
      - Stanley Creek US-2 near Iron River
    - Iron River at Iron River
    - Iron River at US-2 at Iron River
    - Iron River near Caspian
      - Holmes Creek at Caspian
    - Iron River at Caspian
      - Iron River tributary at Caspian
    - Armstrong Creek:
      - Mastodon Creek:
        - Alpha Creek near Alpha
          - Spring near Alpha
      - Net River:
        - North Branch Net River near Amasa
        - East Branch Net River near Amasa
      - Hemlock River near Amasa
      - Chicagon Creek near Iron River
    - Paint River near Crystal Falls
      - Briar Hill Creek near Crystal Falls
  - Michigamme River:
    - Peshekee River:
      - Dishno Creek near Champion
    - Peshekee River near Champion
    - Magers Creek near Champion
    - Spurr River at Michigamme
  - Michigamme River near Champion
    - Spruce River:
      - Mill Creek near Republic
    - Spruce River near Champion
    - Trout Falls Creek near Republic
    - Fence River near Witch Lake
    - Deer River near Balsam
- Menominee River near Florence, Wisconsin
  - White Creek near Norway
  - Sturgeon River:
    - West Branch Sturgeon River near Randville

Streams Tributary to Lake Michigan (continued)

West Branch Sturgeon River near Felch
West Branch Sturgeon River near Foster City
East Branch Sturgeon River near Felch
East Branch Sturgeon River near Hardwood
East Branch Sturgeon River at Foster City
East Branch Sturgeon River near Foster City
Sturgeon River near Waucedah
Pine Creek:
Pine Creek tributary near Randville
Sturgeon River at Loretto
Hamilton Creek near Loretto
Little Cedar River at Hermansville

APPENDIX B

WATER QUALITY

Michigan Department of Natural Resources

Geological Survey

ANALYSES OF SURFACE WATER

SECTION & NUMBER	Source	Date	TOWNSHIP AND RANGE	Specific Conductance (Micromhos at 25°C)	Hardness ($CaCO_3$)	Dissolved Oxygen	pH	Temperature (°F)
	Streams:							
10-1	Swartz Creek below dam	9/18/64	44N 28W-1	230	140	8.4	7.3	53
24-1	West Br. Escanaba River	9/17/64	44N 28W-2	---	150	10.0	8.0	46
25-1	West Br. Escanaba River	9/17/64	44N 27W-1	---	150	10.0	7.5	--
17-1	Ford River at M95 bridge	9/17/64	43N 30W-1	300	190	10.0	7.3	52
1-1	North Br. Ford River	9/17/64	43N 28W-1	---	190	9.5	8.0	46
22-1	Ford River at Ralph	9/17/64	43N 28W-2	287	190	9.6	7.5	47
25-1	Ford River at Alfred	9/16/64	43N 27W-1	---	200	10.8	8.0	49
*	N. Br. of W. Br. Sturgeon River	10/ 8/64	42N 30W-1	300	200	----	7.5	45
*	West Br. Sturgeon River	10/16/64	42N 30W-3	285	200	----	7.5	47
23-1	Six Mile Creek	10/ 7/64	42N 29W-2	275	150	----	7.5	46
*30-1	West Br. Sturgeon River	10/16/64	42N 29W-3	300	210	----	7.5	48
20-1	West Br. Sturgeon River	10/14/64	42N 28W-1	285	170	----	8.0	54
12-1	West Br. Sturgeon River	11/ 6/64	41N 29W-2	250	150	----	7.5	--
	Lakes with outlets:							
33-1	Pickerel Lake	10/23/64	43N 28W-3	320	190	----	8.0	--
20-1	Solberg Lake	10/16/64	42N 29W-1	320	220	----	8.0	--
24-1	Lyons Lake	11/ 6/64	41N 29W-2	250	150	----	7.5	--
	Lakes with no outlets:							
5-1	Coy Lake	10/21/64	44N 30W-1	70	50	----	7.0	--
14-1	Silver Lake	10/19/64	44N 30W-2	<50	20	----	6.5	--
21-1	Edey Lake	10/19/64	44N 30W-3	<50	20	----	6.0	--
28-1	Sawyer Lake	10/19/64	44N 30W-4	<50	20	----	6.5	--
18-1	Brush Lake	10/15/64	42N 30W-2	<50	20	----	6.0	54

* Not on Surface Water Map

< = Less than

Field analysis of chemical constituents of water from streams

Weather: BrS - Bright Sun
C - Cloudy
PC - Partly cloudy

Section and No.	Stream	Location	Date sampled	Hour	Weather	Air Temp °F	Water Temp °F	Specific conductance (micromhos at 25°C)	pH	Hardness in ppm	Dissolved oxygen in ppm	Remarks
*	Brule River	NE¼ SW¼ sec 9 T41N R32W	5- 4-65	3:40	---	--	52	140	7.4	90	----	
7-1	Fence River	SE¼ SE¼ sec 7 T45N R31W	8-25-65	11:15	C	65	--	160	7.5	85	8.0	
10-1	West Branch Hemlock River	SW¼ NE¼ sec 10 T45N R33W	5- 5-65	9:45	---	56	44	50	---	---	----	
17-1	Little Hemlock River	SE¼ SW¼ sec 17 T45N R33W	5- 5-65	9:20	---	55	44	60	---	---	----	
31-1	Michigamme River	SE¼ NE¼ sec 31 T43N R31W	7-16-65	12:15	C	72	69	90	7.2	51	9.0	Slight yellow tint
32-1	Michigamme River (Peavy Pond)	NW¼ SE¼ sec 32 T42N R31W	5-12-65	-----	---	--	59	60	7.0	34	----	Slight yellow tint
21-1	Net River	NW¼ SW¼ sec 21 T45N R34W	8-19-65	10:00	PC	64	67	120	7.3	68	8.0	Sampled wide pool below small rapids
8-1	East Branch Net River	NW¼ NW¼ sec 8 T46N R33W	8-19-65	3:30	BrS	67	68	105	7.3	69	9.0	Sampled deep pool below small rapids
20-1	East Branch Net River	NW¼ SW¼ sec 20 T46N R33W	5- 5-65	11:00	---	53	48	50	---	---	----	
13-1	West Branch Net River	SE¼ NW¼ sec 13 T46N R34W	5- 5-65	11:40	---	55	47	50	---	---	----	
7-1	Paint River	NW¼ NW¼ sec 7 T43N R32W	5- 4-65	5:00	---	57	52	50	---	60	----	
*	Paint River	NE¼ SW¼ sec 24 T42N R32W	5-12-65	-----	---	70	58	60	6.5	34	----	Sampled above dam

Field analysis of chemical constituents of water from lakes

Section and No.	Lake	Location	Date sampled	Hour	Weather	Air Temp °F	Water Temp °F	Specific conductance (micromhos at 25°C)	pH	Hardness in ppm	Dissolved oxygen in ppm	Remarks
	Lakes having outlets											
29-1	Cable Lake	SW¼ NE¼ sec 29 T46N R34W	5- 5-65	12:30	-------------	64	48	70	---	---	----	
33-1	Dawson Lake	NE¼ SE¼ sec 33 T43N R31W	7-16-65	1:30	Partly cloudy	76	75	240	8.0	137	10.0	Heavy weed cover on lake bottom
5-1	Deer Lake	NE¼ SE¼ sec 5 T45N R32W	8-13-65	11:00	Bright sun	77	74	130	7.7	69	9.0	Sand bottom, sparse vegetation
24-1	Lake Emily	SW¼ NE¼ sec 24 T43N R34W	8-11-65	3:20	Bright sun	82	73	250	8.0	120	9.0	Sand & gravel bottom, sparse vegetation
5-1	Lake Mary	NE¼ SW¼ sec 5 T42N R31W	5-12-65	-----	-------------	70	64	100	7.5	51	----	Water clear
7-1	Shank Lake	SE¼ sec 7 T46N [illegible]	8-18-65	-----	-------------	--	70	95	7.7	51	9.6	Some vegetation, sediment in sample
5-1	Stanley Lake	SE¼ SE¼ sec 5 T42N R35W	7-21-65	2:10	Cloudy	69	71	200	8.0	120	10.0	Bottom very stony
35-1	Swan Lake (near shore)	SW¼ NE¼ sec 35 T44N R33W	8-18-65	7:PM	Sunny	59	73	165	8.7	165	10.0	Heavy bottom growth. Sun nearly set
35-1	Swan Lake (at surface)	SW¼ NE¼ sec 35 T44N R33W	8-24-65	8:45 PM	Dark	64	71	170	8.0	85	10.6	Day had been bright sun
35-1	Swan Lake (at 33' depth)	SW¼ NE¼ sec 35 T44N R33W	8-24-65	8:45 PM	Dark	64	71	165	8.0	85	3.2	
	Lakes not having outlets											
26-1	Lake Ellen	NE¼ SE¼ sec 26 T44N R31W	8-12-65	11:30	Bright sun	76	72	70	7.7	51	9.0	Sand bottom, no vegetation near site
6-1	Glidden Lake	NW¼ NW¼ sec 6 T42N R31W	8-12-65	9:20	Cloudy	72	69	<50	6.2	17	9.0	Yellow tint, sparse vegetation, muddy bottom
36-1	Golden Lake (at surface)	About ¼ mi. N of park	8-24-65	4:00	Bright sun	71	69	<50	7.5	12	7.0	
36-1	Golden Lake (at 40-50' depth)	About ¼ mi. N of park	8-24-65	4:00	Bright sun	71	58	<50	6.0	12	0	Lake quite rough
24-1	Haines Lake	NW¼ SE¼ sec 24 T43N R31W	8-10-65	12:00	Bright sun	68	72	<50	6.7	17	8.0	Muddy bottom, water cloudy

(*) Not plotted on Surface Water Data Map.

-Chemical constituents of water from spring-fed ponds

Weather: S - Bright sun; C - Cloudy; R - Rain.
Altitude estimated from U. S. G. S. topographic maps.

Section & Number	Number	Location in sec. ¼ ¼	Owner	Date sampled	Weather	Air Temp. °F	Water Temp. °F	Specific conductance (micromhos@25°C)	Hardness (ppm)	Iron (ppm)	Dissolved oxygen (ppm)	pH	Altitude	Remarks
24-1	42N 33W 24-1	SE SW	Louis Kurtz	9/ 9/65	S	74	64	120	51	0.2	15	> 10	1480	Spring uncovered in one end of pond, bedrock exposed at opposite end. Water has green tint.
20-1	43N 33W 20-1	NE NW	Bernard Pringle	9/ 9/65	C,R	65	60	240	136	0	9.4	7.9	1420	2 bubbling springs near West end. Est. discharge at pond overflow 10 gpm, water clear, does not freeze.
27-1	43N 33W 27-1	SW NW	Earnest Reiman	9/ 9/65	C,R	65	62	400	238	0	8.0	7.9	1400	2 bubbling springs, water level in pond very stable, pond does not freeze in vicinity of springs.

SURFACE WATER QUALITY - BARAGA COUNTY

Lakes without "outlet"

Section & Number	Lake	Township	Range	Section	Location in Section	Date Samples	Iron (Fe)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Total Dissolved Solids	Hardness ($CaCO_3$)	Specific Conductance	pH	Temperature	Estimated Yield, gpm
28-1	Big Lake	49N	34W	28	NW-SW	9/19/69	.10	2	17	0.0	0.2	-	3	50	5.9	2.0	-
18-1	Laws Lake	50N	32W	18	NW-NW	9/22/69	.20	67	8.0	0.0	0.4	58	48	90	7.0	18.5	-
33-1	Petticoat Lake	48N	31W	33	SW-SE	8/21/69	-	17	1.0	0.1	0.1	-	14	50	6.8	24.0	-

SURFACE WATER QUALITY - BARAGA COUNTY

Lakes with outlets

Section & Number	Lake	Township	Range	Section	Location in Section	Date Samples	Iron (Fe)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Total Dissolved Solids	Hardness ($CaCO_3$)	Specific Conductance	pH	Temperature	Estimated Yield, gpm
28-1	CRAIG LAKE	49N	31 W	28	SW-NE	9-22-69	0.50	6	11	1.0	0.1	<32	8	<50	6.7	18.0	–
27-1	KING LAKE	48N	33W	27	SE-NE	9-20-69	0.50	9	8.0	0.8	3.8	–	14	<50	6.9	13.0	–
24-1	WORM (VERMILAC) LAKE	48N	34W	24	NW-SE	9-20-69	0.30	10	6.0	1.0	1.4	–	15	<50	6.8	14.0	–
18-1	RUTH LAKE	48N	31W	18	SE-NE	8 12-69	.30	17	0.0	1.5	0.0	29	18	<50	6.9	20.5	–

SURFACE WATER QUALITY - BARAGA COUNTY

Section & Number	Stream	Township	Range	Section	Location in Section	Date Samples	Iron (Fe)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (CL)	Nitrate (NO_3)	Total Dissolved Solids	Hardness ($CaCO_3$)	Specific Conductance	pH	Temperature	Estimated Yield, gpm
1-1	Hazel Creek	50N	34W	1	NE-SW	8/26/69	0.1	119	3.0	1.2	0.3	127	93	195	7.6	12	-
35-1	Huron River	52N	30W	35	NW-NW	8/19/69	0.1	66	3.0	1.0	0.1	65	50	100	7.8	10	-
26-1	Peshekee River	50N	31W	26	SW-NW	9/18/69	0.5	29	7.0	0	1.0	39	29	60	7.8	13	-
18-1	Silver River	51N	31W	18	SW-NW	8/14/69	0.4	-	-	-	-	-	65	115	8.5	19	-
12-1	Six Mile Creek	50N	34W	12	NW-NW	8/28/69	-	105	1.5	0.8	0.1	107	80	160	7.5	14	-
8*	Slate River	51N	31W	8	SE-NE	8/19/69	.10	68	3.0	1.0	0.2	75	54	115	7.5	18.5	-
8-1	Tioga River	48N	32W	8	SW-NW	8/20/69	0.50	51	0.0	0.5	0.1	54	42	83	7.1	150	-

*Source 8 does not appear on the Surface Water Data Map.

APPENDIX C

WATER QUALITY, TEMPERATURE, AND SEDIMENT CONCENTRATION

U.S. Geological Survey Water Quality Stations

U.S.G.S. WATER QUALITY STATION 653

WEST BRANCH OF STURGEON RIVER NEAR RANDVILLE

Values for water year October 1969 to September 1970.

	Specific Conductance (micromhos at 25°C)	Temperature (°C)
Minimum	315	0
Maximum	340	22.0
Average	332	8.4

U.S.G.S. WATER TEMPERATURE STATIONS

Station Number	Station Name	Period of Record*	Maximum Temperature for Period (°C)	Minimum Temperature for Period (°C)
578	Middle Branch Escanaga River at Humboldt	1973-1974	22.5	freezing
578.12	Greenwood Afterbay near Greenwood	1973-1974	24.5	1.0
578.13	Greenwood Diversion near Greenwood	1974	22.5	2.0
578.14	Greenwood Release near Greenwood	1974	23.5	1.0
5782	Middle Branch Escanaba River near Greenwood	1974	26.0	freezing
580	Middle Branch Escanaba River near Ishpeming	1961-1974	25.5	freezing
582	Schweitzer Creek near Palmer	1961-1971	25.0	freezing
622	Peshekee River near Champion	1961-1974	28.5	freezing
655	Sturgeon River near Foster City	1956-1974	30.0	freezing
656	Pine Creek near Iron Mountain	1972-1974	24.0	freezing

*1975 data unpublished and not included in this tabulation.

SEDIMENT CONCENTRATION DATA

Station Number	Station Name	Period of Record	Number of Samples	Minimum Concentration (ppm)	Maximum Concentration (ppm)
442	Carp Creek at Ishpeming	4-62 to 4-63	3	2	24
444	Carp River near Negaunee	8/1961 to 4/1963	4	2	12
578	Middle Branch Escanaba River at Humboldt	7/1961 to 6/1963	26	1	16
580	Middle Branch Escanaba River near Ishpeming	7/1961 to 9/1963	27	1	11
582	Schweitzer Creek near Palmer	11/1961 to 11/1963	29	1	96
585	East Branch Escanaba River at Gwinn	7/1961 to	daily	1	58
622	Peshekee River near Champion	11/1961 to	25	1	10

TEMPERATURE AND SEDIMENT DATA

			Temperature (°C)		Sediment Concentration (mg/I)	
Station Number	**Station Name**	Period of Record	Min. for Period	Max. for Period	Min. for Period	Max. for Period
579	Black River near Republic	1962-1965 (sed) 1961-1968 (temp)	freezing	27	1	27
624	Michigamme River near Witch Lake	1964-1969 (sed) 1964-1970 (temp)	freezing	23	0	80

Chemical analyses of samples collected from Michigan streams under low- and high-flow conditions, 1967

[Chemical analyses of field-measured samples, in milligrams per liter]

Station No.	Station Name	Location	Drainage area (sq mi)	Date sampled	Time	Discharge (cfs)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Hardness as $CaCO_3$: Ca, Mg.	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25°C)	pH	Water temperature F°	Water temperature C°
STREAMS TRIBUTARY TO LAKE SUPERIOR																
245	Middle Branch Ontonagon River near Trout Creek.	SW¼sec. 8, T. 47 N., R.38 W.	203	Sept. 7	2015	110	88	0	8.0	2.0	71	2	150	7.3	61	16.0
						43.5	76	0	7.0	2.0	63	1	125	7.3	60	15.5
425	Otter River near Elo.	NE¼sec. 8, T. 50 N., R.34 W.	162	Apr. 4	1000	499	39	0	5.0	2.0	30	4	85	7.4	34	1.0
				Aug. 21	1600	84.2	112	0	6.0	4.0	88	0	180	7.8	57	14.0
444	Carp River near Negaunee.	SE¼sec. 20, T. 48 N., R.26 W.	51.4	Aug. 16	1025	35.7	98	0	13	9.0	92	12	190	7.4	73	23.0
445.83	Cherry Creek near Harvey.	SE¼sec. 13, T. 47 N., R.25 W.	4.53	Aug. 16	1900	18.2	107	0	6.0	4.0	92	4	180	7.7	49	9.5
STREAMS TRIBUTARY TO LAKE MICHIGAN																
578	Middle Branch Escanaba River at Humboldt.	SW¼sec. 1, T. 47 N., R.29 W.	46	Apr. 2	1430	346	20	0	5.0	1.0	15	0	<50	7.4	34	1.0
				Aug. 18	1030	14.8	41	0	8.0	4.0	40	0	85	7.2	58	14.5
579	Black River near Republic.	NE¼sec. 2, T. 46 N., R.29 W.	34.4	Apr. 4	1000	150	15	0	6.0	4.0	20	8	65	7.1	34	1.0
				Aug. 17	1310	8.18	51	0	16	6.0	58	16	130	7.0	69	20.5
580	Middle Branch Escanaba River near Ishpeming.	SW¼sec. 12, T. 46 N., R.28 W.	128	Apr. 4	1430	824	12	0	11	3.0	17	7	50	7.6	34	1.0
				Aug. 16	1305	41.2	42	0	7.0	4.0	40	6	80	7.3	67	19.5
581	Middle Branch Escanaba River near Princeton.	NW¼sec. 12, T. 45 N., R.26 W	210	Apr. 4	1500	930	23	0	8.0	2.0	18	0	50	7.6	33	0.5
				Aug. 14	1750	370	42	0	1.0	4.0	40	6	85	7.1	68	20.0
582	Schweitser Creek near Palmer.	SW¼sec. 1, T. 46 N., R.27 W	23.6	Apr. 3	1615	133	61	0	7.0	3.0	60	10	135	7.6	34	1.0
				Aug. 16	0915	5.71	53	0	4.0	.0	470	2	140	7.4	64	12.0
583	Warner Creek near Palmer.	NW¼sec. 10, T. 46 N., R.26 W.	14.2	Apr. 3	1105	119	29	0	15	6.0	32	8	60	7.5	31	1.0
				Aug. 15	1815	4.48	112	0	13	12	102	10	230	7.4	67	19.5
584	Goose Lake Outlet near Sands Station.	SE¼sec. 12, T. 46 N., R.26 W.	37.6	Apr. 11	1555	203	65	0	75	9.6	131	81	310	7.4	38	3.5
				Aug. 15	1435	10.5	73	0	42	7.0	98	38	220	8.0	60	15.5
585	East Branch Escanaba River at Gwinn.	NE¼sec. 21, T. 45 N., R.25 W.	124	Apr. 3	1120	722	37	0	33	5.0	55	25	110	7.0	31	1.0
				Aug. 14	1420	42.0	71	0	17	0.0	72	14	160	7.5	63	17.0
605	Iron River at Caspian.	SW¼sec. 1, T. 42 N., R.35 W.	92.1	Apr. 1*	1300	552	13	0	69	5.0	78	68	195	6.6	37	3.0
				Sept. 8	1515	61.6	137	0	210	15	316	201	580	7.9	60	15.5
610	Brule River near Florence, Wis.	SE¼sec. 11, T. 41 N., R.32 W.	380	Apr. 2	1510	1620	48	0	22	1.0	60	21	110	7.4	33	0.5
				Aug. 30	1315	327	120	0	42	4.0	158	40	255	7.5	60	15.5
615	Paint River at Crystal Falls.	SE¼sec. 20, T. 43 N., R.32 W.	597	Apr. 11	1200	4270	26	0	5.0	1.0	22	1	55	7.5	36	2.0
				Aug. 31	1510	447	73	0	8.0	5.0	66	6	120	7.4	61	16.0
620	Paint River near Alpha.	NW¼sec. 25, T. 42 N., R.32 W.	631	Apr. 11*	1315	1770	20	0	21	2.0	23	6	51	7.4	36	2.0
				Aug. 30	1510	82.4	80	0	8.5	4.0	72	6	115	7.4	65	18.5
621	Peshekee River near Michigamme.	SE¼ sec. 1, T. 48 N., R.30 W.	60.5	Apr. 10	1515	761	0	0	4.0	2.0	11	4	<50	7.4	33	0.5
				Aug. 17	1635	22.0	29	0	4.0	2.0	26	2	<50	6.9	70	21.0
622	Peshekee River near Champion.	NW¼sec. 13, T. 48 N., R.30 W.	133	Apr. 10	1530	1330	10	0	4.0	1.0	10	2	<50	7.2	34	1.0
				Aug. 18	1150	41.0	22	0	1.5	3.0	22	4	<50	7.3	65	18.5
622.7	Michigamme River near Champion.	NW¼sec. 27, T. 47 N., R.30 W.	231	Apr. 18	1115	2690	16	0	11	1.0	17	4	<50	7.4	37	3.0
				Aug. 18	1655	135	17	0	8.0	4.0	20	0	<50	6.8	66	19.0
623	Michigamme River at Republic.	SE¼sec. 18, T. 46 N., R.29 W.	240	Aug. 18	1730	140	17	0	7.0	3.0	23	9	50	7.0	68	20.0
624	Michigamme River near Witch Lake.	NW¼sec. 1, T. 44 N., R.30 W.	316	Apr. 18	1300	2950	20	0	12	2.0	20	4	50	7.7	40	4.5
				Aug. 18	1800	180	49	0	8.0	4.0	46	0	95	7.5	66	19.0
625	Michigamme River near Crystal Falls.	NW¼sec. 20, T. 43 N., R.31 W.	656	Apr. 19	1050	4310	32	0	5.0	2.0	30	4	70	7.5	......	......
				Aug. 31	1820	616	51	0	8.0	2.0	49	7	100	7.2	65	18.5
630	Menominee River near Florence, Wis.	NE¼sec. 16, T. 41 N., R.31 W.	1780	Apr. 18	1400	11200	26	0	10	2.0	33	17	85	7.5	43	6.0
				Aug. 31	0820	515	117	0	56	6.0	128	32	250	8.2	61	16.0
653	West Branch Sturgeon River near Randville.	NE¼sec. 30, T. 42 N., R.29 W.	56.1	Apr. 2	1400	291	70	0	18	3.0	68	11	140	7.8	34	1.0
				Aug. 25	1350	13.4	217	0	8.5	4.0	186	8	325	8.0	61	16.0
655	Sturgeon River near Foster City.	NW¼sec. 36 T. 41 N., R.28 W.	237	Apr. 2*	1015	1180	88	0	20	1.0	58	20	175	7.5	33	0.5
				Aug. 25	1900	46.5	229	0	8.5	3.0	191	6	340	7.8	70	21.0

APPENDIX D

RULES AND REGULATIONS CONCERNING INLAND LAKES AND STREAMS ACT

DEPARTMENT OF NATURAL RESOURCES

HYDROLOGICAL SURVEY DIVISION

Rules and Regulations

Concerning

INLAND LAKES AND STREAMS ACT

Filed with the Secretary of State, April 25, 1974.

These rules take effect 15 days after filing with the Secretary of State.

(By authority conferred on the Department of Natural Resources by section 11 of Act. No. 346 of the Public Acts of 1972, being section 281.961 of the Michigan Compiled Laws.)

R 281.811. Definitions.

Rule 1. (1) The definitions in the act are applicable to these rules.

(2) "Act" means Act 346 of the Public Acts of 1972, being sections 281.951 to 281.965 of the Michigan Compiled Laws of 1948.

(3) "Applicant" means a person applying for a permit pursuant to the provisions of the act.

(4) "Bottomland dredging" means dredging of channels and canals, and the removal of any rock, stone or soil from bottomlands.

(5) "Bottomland filling" means placement of rock, stone, soil or other materi on bottomlands.

(6) "Minor drainage structures and facilities" means all of the following:

(a) Cross road culverts which serve only to equalize the existing water surfaces at the ends of the culvert.

(b) Cross road culverts constructed to continue the existence of drainage courses other than inland lakes or streams.

(c) Roadside ditches which serve to convey storm water runoff from the highway right of way without materially changing the drainage pattern which existed prior to the construction of the ditches.

(d) Standard appurtenances for storm water runoff facilities, such as manholes, catch basins and headwalls.

(e) Cross road culverts which are constructed for continuation of a drainage course where the drainage area above the culvert is less than 2 square miles.

(7) "Mainstream portions of natural watercourses" includes but is not limited to:

(a) Grand river drain (Jackson county)

Point of beginning: The intersection of Liberty and Milwaukee streets in the city of Jackson.

Point of ending: The west line of Rives township, Jackson county, 1,165 feet south of the northwest corner of section 7, [illegible]

(b) Rogue river drain (Newaygo and Kent counties)

Point of beginning: At its intersection with the south line of section 2, T10N, R12W, Tyrone township, Kent county.

Point of ending: At Ransom lake in section 12, T11N, R12W, Grant township, Newaygo county.

(c) Shiawassee river trunk drain (Saginaw county)

Point of beginning: At the junction of the Shiawassee river and the Flint river in section 9, T11N, R4E, James township, Saginaw county.

Point of ending: At a point in mid-channel of said river in section 34, T10N, R3E, St. Charles township, Saginaw county, approximately 0.2 mile from the south line of said section.

(d) (i) Clinton river drain (Macomb county)

Point of beginning: The Market street bridge in the city of Mount Clemens.

Point of ending: The Red Run drain outlet.

(ii) Clinton river drain (Oakland county)

Point of beginning: At the intersection with Orchard Lake road on the north line of section 32, T3N, R10E, city of Pontiac.

Point of ending: At the intersection with Auburn road on the east line of section 27, T3N, R10E, city of Pontiac.

(e) Black river drain (Sanilac county)

Point of beginning: At the south line of section 6, T10N, R16E, Lexington township, Sanilac county.

Point of ending: At the north line of section 1, T12N, R14E, Custer township, Sanilac county.

(f) Maple river drain (Gratiot and Shiawassee counties)

Point of beginning: At Highway US-27, section 28, T9N, R2W, Washington township, Gratiot county.

Point of ending: At its upper terminus in section 3, T6N, R3E, Shiawassee township, Shiawassee county.

(g) Little Thornapple river drain (Barry and Ionia counties)

Point of beginning: At the south line (M-43) of section 13, T4N, R8W, Carlton township, Barry county.

Point of ending: At the outlet from Tupper lake where the outlet enters Jordan lake in section 34, T5N, R7W, Odessa township, Ionia county.

(h) Kawkawlin river drain (Bay county)

Point of beginning: Mouth of river on Saginaw bay, in section 33, T15N, R5E, Bangor township, Bay county.

Point of ending: At the intersection with Euclid avenue on the west side of section 5, T14N, R5E, Bangor township, Bay county.

(i) St. Joseph river drain (Hillsdale county)

Point of beginning: At intersection of the line between sections 8 and 9, T8S, R4W, Camden township, Hillsdale county.

Point of ending: At a point 715 feet southeast of the line between sections 25 and 26, T8S, R4W, Camden township, Hillsdale county.

(j) East Branch of St. Joseph river drain (Hillsdale county)

Point of beginning: At intersection of the line between sections [illegible] and 34, T7S, R1W, Pittsford township, Hillsdale county.

Point of ending: At intersection with the state line.

(k) Pigeon river drain (Huron county)

Point of beginning: At the mouth of the Pigeon river on Saginaw bay in the village of Caseville, including the mouth of the Pigeon river cut-off drain.

Point of ending: To a point three-fourths of a mile south of [illegible] road in section 1, T17N, R10E, Caseville township, Huron county.

(8) "Reasonable sanding of beaches to the existing water's edge by a riparian owner" means placing a layer of sand, free of organic or other pollutant matter, which does not shift the location of the existing ordinary high water mark or shoreline contour.

R 281.812. Permit applications.

Rule 2. (1) Permit application forms shall be obtained from the [illegible] survey division of the department or from any field office of the department. In addition to the completed application form, the applicant shall submit the following:

(a) An application fee made payable to the state of Michigan.

(b) A map or diagram in black ink, on 8½" x 13" sheet of white paper, [illegible] the proposed project and indicating the location of the ordinary high water mark if known; the existing water's edge; the adjacent shoreline property and structures if known; and contour information depicting the topography of the site.

(c) The name and address of an officer of any appropriate property owners' association, as recorded with the county clerk of the county in which the proposed project will be located and the names and addresses of adjacent or opposite riparians

(2) In the case of upland channeling, cross-section profiles of the channel and the adjacent upland and soil information may be required by the department in addition to a permit application.

(3) In case of pipeline crossing for the transportation of hydrocarbons, evidence of having on file an approved contingency failure plan with the water resources commission shall be submitted to the department.

(4) Proposed marina plans shall show fills, pilings and other structures including moorage areas, boat storage areas, turning basins and traffic lanes existing or proposed. The plan shall include the extent of the riparian lands and bottomlands proposed to be used.

(5) The applicant shall submit a statement that there is or is not litigation involving the property.

(6) The department may require the submission of other information that may be necessary to complete an assessment of the proposed project.

R 281.813. Permit conditions.

Rule 3. (1) A permit shall provide that the work specified therein shall be completed within a specified term, normally not more than 1 year from the date of issuance, or as otherwise determined by the department. An extension of time may be granted by the department. An administrative fee shall not be required for an application for an extension of time.

(2) When a proposed project requires the crossing of numerous streams, the applicant shall submit a preliminary site plan showing the proposed work and all lakes or streams. After completing a timely field investigation, the department shall advise the applicant of those crossings which require a permit under the act.

(3) All proposed projects which involve a lake or stream crossing shall be subject to the specifications and standards prescribed in rules.

(4) A permit does not obviate the necessity of receiving approval from the state department of public health or a local unit of government where applicable, including a local unit of government responsible for administering Act No. 245 of the Public Acts of 1970, being sections 281.631 to 281.645 of the Michigan Compiled Laws, Act No. 347 of the Public Acts of 1972, being sections 282.101 to 282.117 of the Michigan Compiled Laws, and the United States army corps of engineers, where applicable.

(5) The department shall issue a conditional permit when emergency conditions warrant a project to protect property or the public health and welfare.

(6) The department may issue a permit where extension of work performed under an earlier permit will result in less or no damage to natural resources.

(7) The department shall not issue a permit, except a conditional permit, until 30 days after the mailing of the list to each eligible subscriber, as provided for in subsection (1) of section 6 of the act.

(8) Upon request, the department shall immediately provide [illegible] of a permit application and supporting documents, at cost of reproduction, if the documents are reproducible. If not reproducible, these documents [illegible] at the department's office.

R 281.814. Environmental assessment.

Rule 4. In each application for a permit, all existing and potential adverse environmental effects shall be determined and a permit shall not be issued unless the department determines all of the following:

(a) That the adverse effects to the environment and the public trust are minimal and will be mitigated to the extent possible.

(b) That the resource affected is not a rare resource.

(c) That the public interest in the proposed development is greater than the public interest in the unavoidable degradation of the resource.

(d) That no feasible and prudent alternative location is available.

BRIDGE CONSTRUCTION

R 281.821. Bridge application procedures.

Rule 11. (1) Plans and specifications describing the proposed project should accompany the permit application form and be submitted to the hydrological survey division, department of natural resources, as soon as approved by the owner and at least 60 days prior to taking bids or initiating any work. Five copies of the plans and specifications should accompany the application form. Upon completion of a departmental review, the department shall issue the necessary permits under the act and Act No. 245 of the Public Acts of 1929, as amended, being sections 323.1 to 323.13 of the Michigan Compiled Laws.

(2) The following construction items require submission of plans and specifications:

(a) Programmed culvert replacements.

(b) Culverts replacing bridges.

(c) Bridges.

(d) Road improvement projects involving public waters.

(e) Structures affecting navigation.

Rule 281.822. Emergencies.

Rule 12. Culvert and bridge repairs or replacement may be made in an emergency situation upon contacting the department for verbal approval. A written report including details of emergency bridge and culvert repairs shall be forwarded to the department at the earliest practical date.

R 281.823. **Bridge construction procedures.**

Rule 13. (1) Each construction project should be completed so as to prevent erosion and subsequent damaging siltation of streams or lakes. The area of erodible land exposed to the elements by the grading operations at any one time shall be controlled by the owner's engineer and the duration of such exposure prior to final trimming, finishing or maintenance of the area should be as short as practical.

(2) Gravel or stone, consisting of durable particles of rock and containing only negligible quantities of fines, shall be used for construction pads, haul roads and temporary roads in or across streams.

(3) When required by the department, a sedimentation basin shall be constructed downstream from the work site to trap silt and sediment resulting from construction operations. A detailed sketch of a sedimentation basin is available on request from the department. The collected silt and sediment shall be removed as directed by the owner's engineer and the sedimentation basin removed on completion of the project. As found necessary, the department will assist the owner in the design of a sedimentation basin.

(4) The disturbance of lands and waters that are outside the limits of construction as staked shall be avoided.

(5) The owner shall give written notice 5 days prior to the start of work.

R 281.824. *Specifications.*

Rule 14. (1) The department of state highways standard specifications (1970 or later editions) listed below are necessary for the protection of the natural resources. These specifications are intended to cover all construction and other related work as it affects natural resources found in and adjacent to the work areas.

(2) General coverage in proposal or specifications:

(a)	Protection and restoration of property,	Sec. 1.07.07 Std. Specs.
(b)	Forest protection,	Sec. 1.07.13 Specs.
(c)	Control of water pollution and siltation,	Sec. 1.07.14 Specs.
(d)	Borrow areas,	Sec. 2.08.01 Std. Specs.
(e)	Borrow area restoration,	Supp. Specs.
(f)	Channel excavation,	Sec. 2.09.05 Std. Specs.

(3) Additional department of state highways standard specifications covering measures for prevention of *erosion and siltation:*

(a)	Topsoil surface,	Sec. 6.53 Std. Specs.
(b)	Mulching,	Sec. 6.54 Std. Specs.
(c)	Seeding,	Sec. 6.52 Std. Specs.
(d)	Fertilizing,	Sec. 6.52 Std. Specs.
(e)	Riprap (plain-heavy),	Sec. 6.01 Std. Specs.
(f)	Cobble gutter (plain-grouted),	Sec. 6.03 Std. Specs.
(g)	Slope planting,	Sec. 6.55 Std. Specs.
(h)	Dune grass planting,	Sec. 6.55 Std. Specs.
(i)	Sodding,	Sec. 6.[illegible] Std. Specs.
(j)	Slope protection,	Sec. 6.01 Std. Specs.
(k)	Crushed limestone surface,	Supp. Specs.
(l)	Paved ditches,	Supp. Specs.
(m)	Rye seeding,	Sec. 6.52 & Supp. Specs.

(4) The state highway design office has information for the design engineer on control of erosion through sodding; water control by catch basins, downspouts, concrete shoulders and spillways; borrow restoration, particularly adjacent to highway limits; seeding, mulching and plantings. Standard plans are available as follows:

(a)	Special outlet headwalls, etc.,	E-4-A-9F
(b)	Sodding, etc.,	E-4-A-10D
(c)	Paved ditches, etc.,	E-4-A-110C
(d)	Shoulder gutter and spillway,	E-4-A-128

PIPELINE AND OTHER UTILITY WATER CROSSING

R 281.831. *Application procedures.*

Rule 21. Plans for all underground utility projects where construction is contemplated to cross or be within 50 feet of a stream, lake or reservoir shall be furnished by the owner to the hydrological survey division of the bureau of water management of the department.

R 281.832. General requirements; all size pipelines and conduits.

Rule 22. (1) The owner or his agent shall submit general construction plans, including a route map and stream crossing specifications. These general plans and related documents shall be submitted not later than 3 months prior to the solicitation of bids and preferably the route plans should be reviewed with the department prior to acquisition of rights of way. Five copies of construction plans and specifications *shall be submitted with the application.*

(2) A pre-construction meeting shall be held if deemed necessary by either the department or the owner in order to thoroughly acquaint all concerned parties with the measures which must be taken to minimize erosion and siltation and properly protect the natural resources in the project area.

(3) Ten days written notice shall be given to the department by the owner before the beginning of work.

(4) The owner shall take all necessary steps to prevent damage to fish and game habitat and to preserve the natural resources of the state. Excavation shall be carried out so as to minimize discharge of damaging material into any stream, lake or reservoir.

(5) The work of clearing, scalping, grading, slope erosion protection, ditching backfilling and final clean-up within 50 feet of streams, lakes and reservoirs shall be completed within as short a period as reasonably possible in order to minimize erosion occurring from wind and precipitation.

(6) Trench excavation on any one spread shall be stopped when 10,000 feet remain open, except as authorized in the permit issued by the department.

(7) Replacing of bank plugs and grading of stream banks within 50 feet shall be accomplished immediately following pipe laying.

R 281.833. Special requirements.

Rule 23. Certain information and special protective measures may be required by the department at specified stream crossings. The following items, if required shall be outlined by the department to the owner either prior to or in the permit issued covering the job.

(a) Three days oral notice of crossing, ditching or blasting within 50 feet of certain stream crossings.

(b) Construction work across certain stream crossings may be prohibited within 3 days just preceding, or during, Memorial day, Independence day or Labor day holiday periods.

(c) Installation of approved warning signs may be required at certain stream crossings, to be located as directed by the department, to provide notice of pipeline crossing construction or excavation and shall be maintained by the owner until removal is authorized by the department or until the water crossing bed has been restored to normal.

(d) Soil data on certain water crossings may be requested to determine the nature of soil to be encountered and to delineate possible trouble areas with regard to trench excavation limits. A plan and profile sheet of the water crossing may be requested by the department where soil data indicates a need therefor.

(e) Temporary sedimentation basins or cofferdams may be required for certain water crossings. In such case, the provisions for sedimentation basins hereinafter set forth shall apply.

R 281.834. Sedimentation basins and cofferdams.

Rule 24. (1) Sedimentation basins or cofferdams, where required, shall be constructed prior to any other work at the site crossing. A detail sketch of a sediment basin is available on request from the department.

(2) Temporary weirs or cofferdams are to be removed, including any materials trapped by them in the control of siltation, within 2 weeks of final clean-up. Intermittent removal of silt or sand during construction may be required for proper operation of sedimentation basins. In any event, the sedimentation basins shall be cleaned before removal.

(3) Weirs shall be constructed of continuous interlocking steel sheeting except where other substitute materials are authorized by the department. When specified by the department, a detail sheet of the weir installation will be furnished by the owner.

(4) The owner is responsible for securing the necessary approval of private land owners where temporary additional right of way or easement is necessary to construct and operate a settling basin. An easement is not required in locations where the crossing is made on state owned lands.

R 281.835. Haul roads.

Rule 25. (1) Temporary haul roads crossing streams shall be constructed of coarse aggregate with culverts or logs or both laid parallel to the stream. Only coarse aggregate or metal or wood mats may be used as a running surface on log construction. The side slopes shall be protected with permanent riprap, as specified in Rule 26, up to a level 2 rows above the normal water level and over the ends of the culverts.

(2) Permanent haul roads crossing streams (roads that are to be left in place at the request of the property owner) will require a permit under Act No. 245 of the Public Acts of 1929, as amended. Plans and specifications for such crossing shall be prepared by a registered professional engineer and submitted by the property owner along with his application for a permit to construct the facilities.

(3) Both temporary and permanent haul roads shall have adequate top width to permit passage of all construction equipment without sloughing of side slopes.

(4) Culverts of adequate size and length, approved by the department, are required in both temporary and permanent haul roads.

(5) Fording of streams is permitted only where it will not cause either erosion or siltation.

R 281.836. Trench excavation.

Rule 26. (1) All pipe trenches shall be excavated to a depth which will provide a minimum cover of 30 inches from the bed of the stream to the top of the pipe. This minimum cover shall control except where special conditions at certain water crossings may warrant a lesser or greater depth of cover.

(2) Appropriate trench excavation methods shall be employed to minimize material from the pipe trench flowing into the stream, giving due consideration to the soil, terrain, cover, side slopes and weather conditions involved.

(3) The pipe trench excavation shall stop some distance from the stream to leave a protective plug of 10 to 20 feet of unexcavated material at each bank. The plugs shall be left in place until the pipe laying operation across the stream has begun. Bypassing of water in the trench to the side by diversion ditches or by pumping may be required at certain water crossings.

(4) The trench in the stream bed may be backfilled if the material used does not cause excessive siltation. Stone, coarse aggregate or washed gravel shall be used where backfill is required and where use of existing material will cause excessive siltation.

(5) Pumping or draining from trench excavations shall be made on either side of the pipeline and not into the waters of the state. The owner shall secure the necessary approval of private land owners before discharging water from the trench excavation onto private lands.

281.817. Stream bank protection.

Rule 27. (1) Following the installation of the pipeline or cable, all work was along or across streams or lakes shall be restored immediately and the exposed ds and banks shall not remain unprotected over 7 days, except where subsequent rmission is provided for a pumping and testing operation.

(2) All disturbed stream banks shall have a finished slope no steeper than on 2 (1 vertical and 2 horizontal) to prevent sloughing until stabilized by getative cover or riprap. The 1 on 2 slope shall be graded up and back to the gh water line. If the top of the natural bank is more than 3 feet above the high ter line, a minimum 10-foot berm shall be constructed at this level and the re-ining slope constructed upward parallel with or on a flatter slope than the origi-l natural bank.

(3) All raw soil exposed above the permanent riprap protection line shall be ther sodded, riprapped or seeded, fertilized and mulched. Temporary riprap and bags) may be used.

(4) Mulch is to consist of 3 inches of straw or other approved material. Mulch slopes greater than 10% shall be held in place by a spray of asphalt type SS-1S ulsion mixed with an equal amount of water.

(5) Seeding and fertilizing rates shall be as follows:

(a) Fertilizer per acre, 200 pounds of 6-24-24.

(b) Seed per acre, 10 pounds Kentucky 31 fescue, 3 pounds Birdsfoot trefoil nd 3 pounds white clover.

(6) Permanent riprap shall be placed from the bed of the channel to 3 feet bove normal high water line or to the top of the bank. Permanent riprap shall be to 1 mix of sand to cement in burlap or canvas bags, sackrete, broken concrete, an-size rock or other material approved by the department. Sackrete where used hall be transferred to burlap or canvas bags.

(7) Deflection dikes, reinforced by 1 row of sandbags, shall be used to di-ert runoff and minimize slope erosion from steep slopes adjacent to water crossings, here the contributing runoff could be great enough to cause slope erosion. Water hall be diverted to undisturbed areas adjacent to the right of way.

(8) Deflection dikes shall be placed along the top of all stream banks where he entire slope is not protected with riprap. They shall also be placed at the op of and at 100 foot intervals or less on slopes greater than 20%.

281.838. Final clean-up.

Rule 28. Final clean-up shall consist of removing the temporary haul road cross the stream; reshaping the stream as nearly as possible to its original con-iguration, width, depth and bottom material; protection of the stream banks as pecified in Rule 27; and removing all construction material and debris from the rossing site, including any material and debris downstream from the site as a esult of the pipeline construction.

R 281.839. Use of water for cleaning and testing pipeline.

Rule 29. (1) The cleaning and testing procedure shall be conducted in a manner that will minimize potential problems which might affect fish and game habitat or other natural resources of the state.

(2) Water used for filling the pipeline may be taken from a lake, stream or reservoir, if a written request is made to the department and the requisites listed below are met. In addition, location of points for discharge of cleaning and testing water shall be approved in advance by the department:

(a) Erosion or siltation are to be minimized.

(b) Appropriate releases from the affected riparians shall be obtained where the rate at which water is taken to fill a pipe is more than 5% of the flow at the time or if a state owned lake or reservoir is exhausted beyond 15% of the total volume.

(c) Water containing detergent or rust from the pipe itself shall be dis-charged so as to prevent its flowing into any stream, lake or reservoir except where a special request for this specific procedure is made.

(d) Water used for hydrostatic testing shall be discharged in a manner and at a location which minimizes erosion or siltation to any stream or public reservoir, and which does not result in thermal pollution of any trout waters.

(e) The rights of downstream riparians shall be recognized and observed regardless of approval or a no objection statement from the department.

R 281.841. Bulkhead lines.

Rule 31. (1) An application by a local unit of government for the establish-ment of a bulkhead line pursuant to section 9 of the act shall be made by resolution adopted thereby requesting the department to hold a public hearing for the purpose of considering establishment thereof. The hearing shall be held in the applicant's jurisdiction pursuant to section 6 of the act.

(2) An ordinance adopted by a local unit of government to exercise control landward of an established bulkhead line shall be consistent with the act and in accordance with these rules. The local unit of government shall submit a proposed ordinance to the department for review and approval prior to formal adoption thereby. A copy of an application received by a local unit of government pursuant to its ordinance shall be forwarded to the hydrological survey division prior to issuance of a permit. Variance from the ordinance shall not be granted unless approved by the department.

(3) When establishing a bulkhead line on its own application, the department may retain jurisdiction over the area landward of the bulkhead line to the ordinary high water mark.

R 281.842. Notification of pending applications.

Rule 32. The list prepared and mailed by the department pursuant to subsection (1) of section 6 of the act will include permit applications received during each week and projects for which permits have been issued. The list shall be mailed weekly to each subscriber. The list includes information on: process number, job name, applicant name and address, watercourse, watershed, location of proposal by town, range and section and project description.

R 281.843. Hearings.

Rule 33. (1) The department may hold a public informational hearing when a proposed project appears to be controversial, or where additional information is desired prior to action by the department. The department shall make a determination on the permit application within 30 days following the hearing.

(2) All other hearings shall be conducted in accordance with subsection (2) of section 11 of the act.

(3) All persons who receive notification under subsection (1) of section 6 of the act shall receive at least 10 days prior notification of any hearings held under this act.

R 281.844. Inspection and certification of completed project.

Rule 34. (1) The applicant shall notify the hydrological survey division within 48 hours of completion of the project to facilitate scheduling a final inspection prior to certification.

(2) The department shall schedule its field inspection of a completed project only when weather conditions will permit a thorough inspection thereof.

R 281.845. Special conditions.

Rule 35. Whenever vertically upward bottomland displacement, also called surcharge, results from filling or other activity immediately adjacent to the displacement area by the applicant, he shall be responsible for its timely removal at the direction of the department.

R 281.846. Rescission.

Rule 36. The rules of the department entitled "Inland Lakes and Streams" being R 281.801 to R 281.810 of the Michigan Administrative Code and appearing on pages 4120 to 4122 of the 1967 Annual Supplement to the Code, are rescinded.