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DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

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GROUND-WATER FLOW AND QUALITY NEAR THE UPPER GREAT LAKES CONNECTING CHANNELS, MICHIGAN

Administrative Report

Prepared for the
U.S. ENVIRONMENTAL PROTECTION AGENCY

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GROUND-WATER FLOW AND QUALITY NEAR THE UPPER GREAT LAKES CONNECTING CHANNELS, MICHIGAN

by J.L. Gillespie, D.H. Dumouchelle, and T.R. Cummings

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U.S. ENVIRONMENTAL PROTECTION AGENCY

Lansing, Michigan

1988

DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

ADMINISTRATIVE REPORT

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CONVERSION FACTORS AND ABBREVIATIONS

For the convenience of readers who may prefer to use metric (International System) units rather than the inch-pound units used in this report, values may be converted by using the following factors:

Multiply inch-pound unit	By	To obtain metric unit
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
foot per second (ft/s)	0.3048	meter per second (m/s)
foot per day (ft/d)	0.3048	meter per day (m/d)
cubic foot per second (ft^3/s)	28.32	liter per second (L/s)
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	10.93	liter per second per square kilometer [$(L/s)/km^2$]
gallon per day per square foot [$(gal/d)/ft^2$]	40.7	liter per day per square meter
ton per day (ton/d)	907.2	kilogram per day (kg/d)

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Sea Level Datum of 1929".

GROUND-WATER FLOW AND QUALITY NEAR THE UPPER GREAT LAKES CONNECTING CHANNELS, MICHIGAN

By John L. Gillespie, Denise H. Dumouchelle, and T. Ray Cummings

ABSTRACT

The Upper Great Lakes connecting channels are the St. Marys, St. Clair and Detroit Rivers, and Lake St. Clair. The effect of ground water on the connecting channels is largely unknown, and the controls on its movement and quality are undefined. Geologic, hydrologic, and environmental conditions near the channels have been examined for this investigation. Included in the study area is a 50-mile reach of channel beginning at Whitefish Bay and extending to Neebish Island, and a 90-mile reach of channel between Port Huron and Pointe Mouillee in Lake Erie.

Glacial deposits, which transmit most ground water to the channels, range from less than 100 feet in thickness in the southern part of the St. Clair-Detroit River area to more than 250 feet in thickness in the northern part. Marine seismic surveys were used at some locations to determine the thickness of deposits. Glacial deposits in the St. Marys River area range from less than 10 feet to more than 300 feet in thickness. Permeable bedrock in the southern reach of the Detroit River area and throughout most of the St. Marys River area may contribute substantial amounts of water to the channels. Total ground-water discharge to the channels, by area, is estimated as follows: St. Marys area, 76 cubic feet per second; St. Clair area, 11 cubic feet per second; Lake St. Clair area, 46 cubic feet per second; and Detroit area, 54 cubic feet per second.

More than 200 waste sites have been identified in an area extending 12 miles inland from the channels. Primarily these include landfills, hazardous-waste disposal sites, and regulated-storage sites. Each of the sites has been ranked using the U.S. Environmental Protection Agency's DRASTIC[1] procedure.

Analyses of water from 31 wells, 25 of which were installed by the U.S. Geological Survey, were made for organic compounds, trace metals, and other substances. Volatile hydrocarbons, and base neutral, acid extractable, and chlorinated neutral compounds were not detectable in water at most locations. Concentrations of trace metals, however, were higher than common in natural waters at some locations.

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[1] DRASTIC is an acronym for a rating system designed to help prioritize the vulnerability of areas to ground-water contamination. The acronym stands for the rating factors used in the system: Depth to water, net Recharge, Aquifer media, Soil media, Topography, Impact of the vadose zone, and hydraulic Conductivity of the aquifer.

INTRODUCTION

The Upper Great Lakes Connecting Channels (UGLCC) are the St. Marys, St. Clair and Detroit Rivers, and Lake St. Clair. These bodies of water function as conduits for the waters of the upper lakes (Superior, Michigan, and Huron) to drain into the lower lakes (Erie and Ontario).

The channels provide water for public supply for cities in the southeastern corner of Michigan's Lower Peninsula and for the city of Sault Ste. Marie in the Upper Peninsula. Water is also withdrawn for a variety of other uses, the largest of which are industrial use and thermoelectric power generation. Serious degradation of water of the channels, if it occurred, could have a detrimental effect on public health, the regional economy, and the biota of the channels. Protection of the water of the connecting channels is, therefore, of major importance to citizens of both the United States and Canada.

This investigation was undertaken as part of a larger study by United States and Canadian government agencies to determine existing environmental conditions, to assess problems, and to recommend remedial measures and corrective actions where appropriate. Early in the planning stages of the study it was recognized that such a comprehensive evaluation need to take into account the role of ground water. Information on its movement and on its transport of contaminants and other dissolved substances was inadequate. Factors that affect ground-water quality had not been adequately assessed. A main factor is the presence of more than 200 waste sites near the connecting channels. The upward movement of chemical substances from deep geologic strata, either from natural sources or from areas where deep injection of wastes has occurred, also was recognized as a possibility.

Purpose and Scope

This report summarizes information collected by the U.S. Geological Survey from April 1985 through September 1987 in areas bordering the Great Lakes connecting channels in Michigan. Information on geology, ground-water flow, waste sites, a waste-site ranking system, and land-use data are included. Water-quality data collected by U.S. Geological Survey and similar data from other sources are summarized. Needs for more detailed studies, including mathematical modeling of ground-water flow, also have been identified.

Description of Study Areas

Figure 1 shows the two major areas of investigation in this study. These areas comprise zones extending 12 mi (miles) inland along the St. Marys River, and along a reach of the St. Clair River, Lake St. Clair, and Detroit River between Port Huron and Lake Erie. At places in this report, the major study areas are referred to as "the St. Marys area" and as the "St. Clair-Detroit area". To distinguish more precisely, the terms "St. Clair area" and "Detroit area" are also used.

The St. Marys River begins at Whitefish Bay at an elevation of 602 ft (feet) above sea level and flows to the Soo Locks. Downstream from the Locks, the elevation of the river at Neebish Island is 582 ft above sea level. The

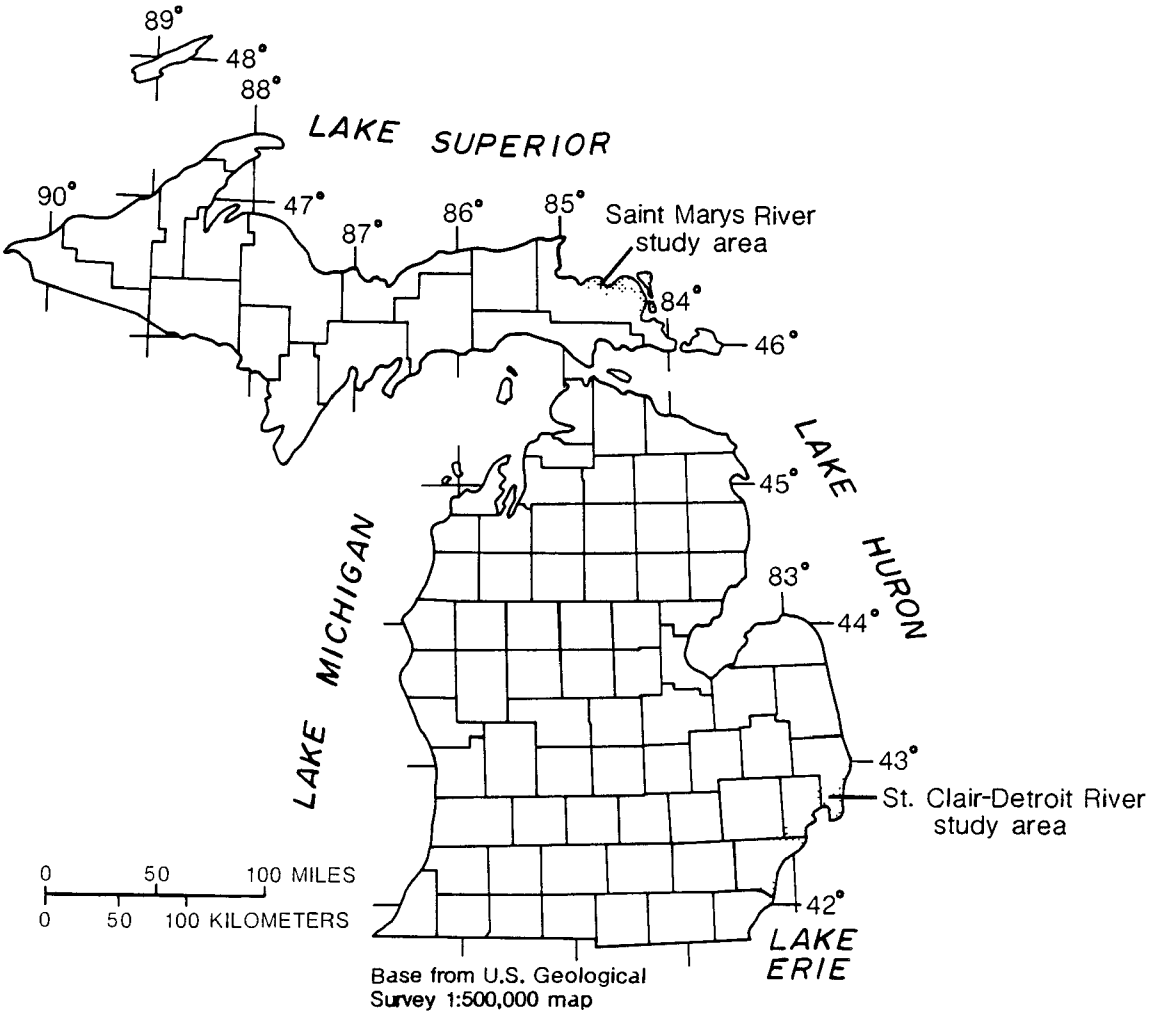


Figure 1.--Location of Upper Great Lakes connecting channels study areas.

Waiska and Charlotte Rivers are the principal tributaries to the St. Marys River on the United States side. The drainage basin for the river is about 350 mi^2 (square miles). Elevation of the land surface ranges from about 580 ft above sea level at Neebish Island to 1,045 ft at Mission Hill; in most of the area, the elevation of the land surface ranges from 600 to 750 ft. About 22,000 people reside in the study area; 14,500 reside in Sault Ste. Marie, the area's largest community.

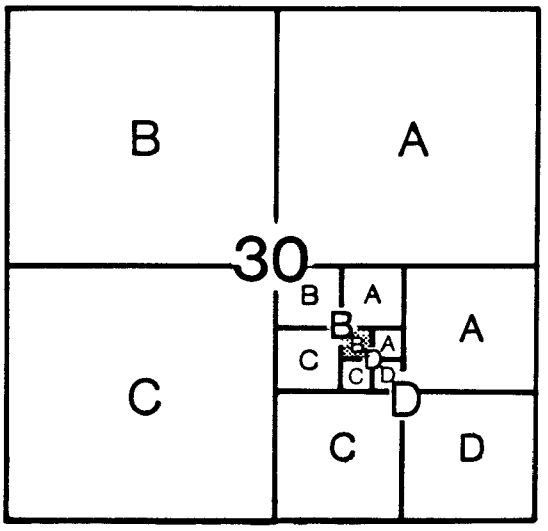
The St. Clair-Detroit area, which begins at the northern edge of Port Huron and extends generally southwestward to Pointe Mouillee, is about 90 mi long. The elevation of the St. Clair River at Port Huron is 580 ft; the elevation of the Detroit River at Point Mouillee is 572 ft. The St. Clair River is about 35 mi long; the Detroit River is about 30 mi long. Principal tributaries in the St. Clair-Detroit area in the United States are the Black, Pine, Belle, Clinton, and Huron Rivers, and River Rouge. Elevation of the land surface ranges from about 575 ft near Pointe Mouillee to about 660 ft just west of Port Huron. In most of the area, the elevation of land surface ranges from 580 to 625 ft. The study area includes parts of Macomb, Monroe, Oakland, St. Clair, and Wayne Counties. About 2.5 million people reside in the 900-mi^2 area; it is the most populated and heavily industrialized in Michigan.

Methods of Data Collection and Analysis

The study of ground water near the Upper Great Lakes connecting channels is part of the larger joint United States-Canadian effort to evaluate environmental conditions in channel areas. Methods and procedures were established before initiating work, to ensure that investigators in both countries obtained comparable and high-quality data. Quality-assurance and quality-control procedures were determined by an international technical committee. For ground-water investigations conducted by the U.S. Geological Survey, the Survey and the U.S. Environmental Protection Agency prepared a quality assurance/quality control plan. The plan covered all aspects of sample collection and analysis, and well-drilling techniques. A copy of the approved plan is given in Appendix A.

Site-Location System

The site-location number indicates the location of sites within the rectangular subdivision of land with reference to the Michigan meridian and base line. The first two segments of the site number designate township and range, the third designates successively smaller subdivisions of the section as shown below. Thus, a well designated as 4S10E30DBDB would be located within a 2.5-acre tract, as indicated by the shaded area in section 30. The number following the section subdivision identifies the wells in sequence.



Acknowledgments

Numerous agencies contributed data for use in this study. In addition to the U.S. Environmental Protection Agency's (USEPA) Waste Management and Water Divisions, personnel of the Michigan Department of Natural Resources (MDNR) in the Environmental Response, Waste Management, Environmental Enforcement, and Geological Survey provided waste-site information and water-well records. Special acknowledgment is due Mr. Frank Belobraidich, Groundwater Quality Division of MDNR, whose assistance early in the study made initial U.S. Geological Survey work more productive than it otherwise would have been. Acknowledgment also is made of the help received from the County Health Departments in Chippewa, Macomb, Monroe, Oakland, St. Clair, and Wayne Counties, who provided copies of well logs and chemical analyses of water. Waste-site information and related data were also made available by the Southeast Michigan Council of Governments.

GEOLOGIC SETTING

Geology in the UGLCC study area consists of sedimentary rocks of Precambrian and Paleozoic age overlain by unconsolidated Quaternary deposits. Sedimentary rocks include sandstone, shale, limestone, and dolomite. These rocks are part of the Michigan structural basin in which all beds dip toward the structural center. The St. Marys area is located on the northern rim of the basin, and thus bedrock formations dip toward the south. In the St. Clair-Detroit area, on the southeast rim of the basin, the rocks dip to the northwest. Unconsolidated Quaternary deposits are till, glaciolacustrine, and glaciofluvial; alluvium occurs near streams. These deposits are the result of continental glaciation and subsequent high water stages of the Great Lakes. Although similar geological processes have operated in both study areas, the stratigraphic relationship between bedrock and glacial deposits is different between and within the two study areas.

Stratigraphy

St. Clair-Detroit River Study Area

The St. Clair-Detroit area has two general lithologic sequences that are recognizable in the Paleozoic rocks (fig. 2). Rocks of Silurian to Late Devonian age subcrop beneath glacial deposits from Pointe Mouillee to just north of Belle Isle. These rocks are primarily an evaporite-carbonate sequence that include, in ascending order, the Bass Islands Dolomite, Detroit River Group, Dundee Formation and the Traverse Group (table 1). These geologic units consist of limestone, dolomite, and minor beds of gypsum and salt. In the Detroit River Group, sandstone is present.

Bedrock beneath the St. Clair area is of Devonian-Mississippian age. These rocks are a clastic sequence that includes the Antrim Shale, Bedford Shale, Berea Sandstone, Sunbury Shale, and Coldwater Shale; they consist mostly of shale (table 1). The most extensive unit in the St. Clair area is the Antrim Shale.

The relation between geologic units beneath channels is shown in a section from Lake Erie to Lake Huron (fig. 3). The dip of beds to the north is about 10 ft/mi (feet per mile). Pleistocene glacial deposits are overlain by Holocene lacustrine deposits in Lake St. Clair.

Bedrock topography slopes gently eastward toward the connecting channels. The bedrock surface is dissected by erosional valleys that generally trend east-west. There is no surface expression of these valleys because they are filled with glacial deposits.

The surficial features of glacial deposits are shown in figure 4. These features generally parallel present shorelines, indicating source direction of deposits. Glacial deposits range in thickness from less than 100 ft in the southern part of the area to nearly 250 ft at places in the northern part. Deposits are usually till or glaciolacustrine and consist of fine-grained sand, silt, and clay. Glaciofluvial deposits are absent at the surface in the study area.

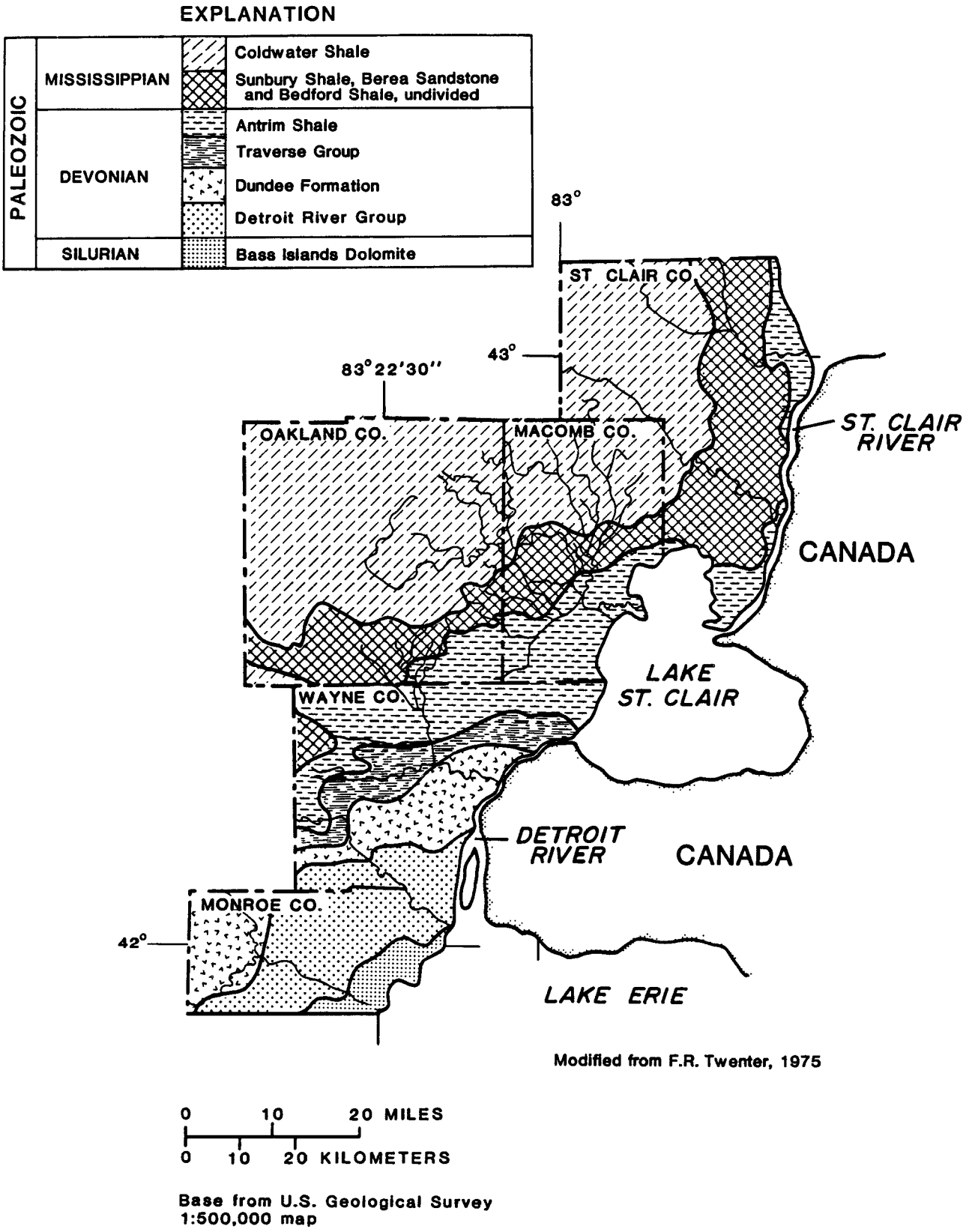


Figure 2.--Bedrock geology of St. Clair-Detroit River study area.

Table 1.--Description of geologic units in St. Clair-Detroit River study area

Geologic unit (age)	Lithology
Coldwater Shale (Early Mississippian)	Primarily a micaceous, blue, blue-gray to green-gray shale but locally is reddish and sandy in the upper part. The weathered upper surface at the base of the glacial drift can be mistaken for glacial clays. Thin lenses of limestone, dolomite, sandstone, and siltstone are interspersed with the shale.
Sunbury Shale (Early Mississippian)	A dark brown, gray, or black, hard shale that locally is dolomitic. Usually less than 50 ft thick; absent at some locations.
Berea Sandstone (Early Mississippian)	White to gray or brown, fine to coarse grained, micaceous sandstone, 50 to 120 ft thick. Gray to blue-gray calcareous shales are locally interbedded with the sandstone. Contact between the Berea Sandstone and Bedford Shale is difficult to delineate, and they are commonly treated as one unit.
Bedford Shale (Early Mississipian and Late Devonian)	Light gray, calcareous or sandy shale with sporadic lenses of sandstone, limestone and/or dolomite. Where the formation is distinguishable, its thickness is as great as 300 ft.
Antrim Shale (Late Devonian)	Gray to black, thin bedded to fissile carbonaceous shale, with pyritic nodules and large bituminous concretions; the formation ranges from about 125 to 170 ft in thickness.
Traverse Group (Late to Middle Devonian)	Varicolored interbedded shales, limestones, and dolomites. Bedding varies from thin to massive. Total thickness of the group ranges from 200 to 350 ft. Shales commonly are calcareous, limestones and dolomites can be cherty, and some limestones are highly fossiliferous.
Dundee Formation (Middle Devonian)	Primarily a gray, fossiliferous brown- to buff-limestone and dolomite. It is 150 to 250 ft thick.

Table 1.--Description of geologic units in St. Clair-Detroit River study area--Continued

Geologic unit (age)	Lithology
Detroit River Group (Middle Devonian)	The Detroit River Group underlies the drift in southern Wayne and northeastern Monroe County. The formation consists of gray to buff, thin-bedded dolomite, with some limestone, anhydrite, salt and sandstone.
Bass Islands Dolomite (Late Silurian)	Consists of light gray, brown- to buff-, dense, finely crystalline dolomites, and some shaly dolomites. Gypsum and anhydrite are common.

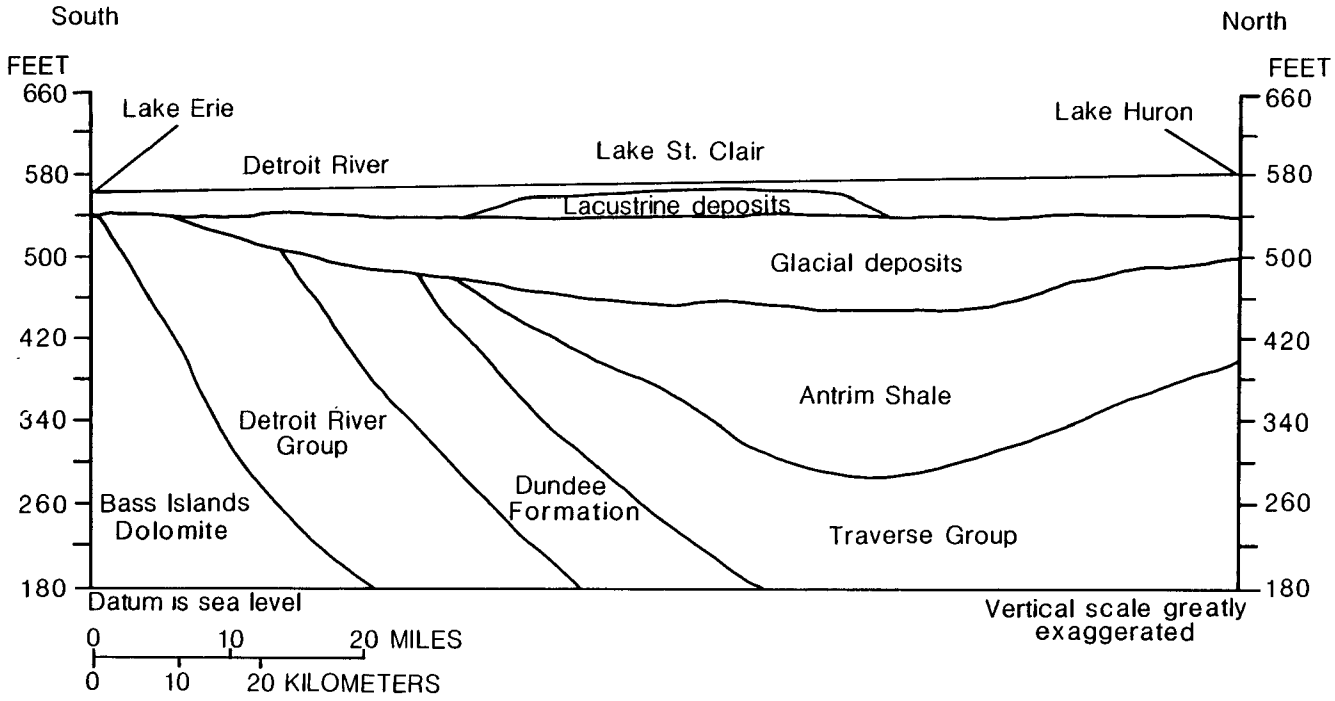


Figure 3.--Generalized geologic section showing dip of bedrock and relation of bedrock and glacial deposits from Lake Erie to Lake Huron.

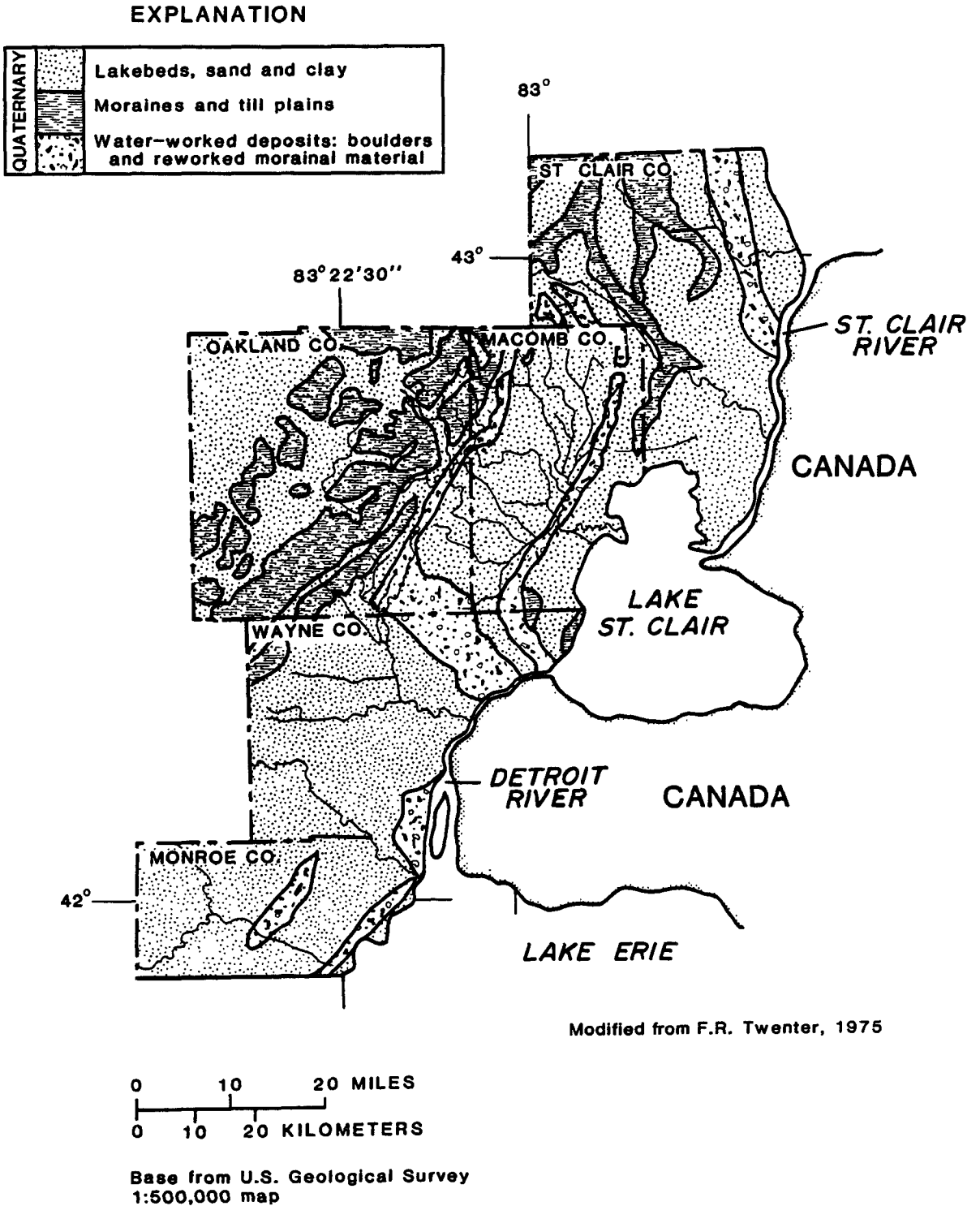


Figure 4.--Surficial glacial features of St. Clair-Detroit River study area.

Geologic sections in the study area are given in Appendix B, and are shown on figure 5. Sections A-A' through J-J', with the exception of section E-E', suggest the lack of significant sand and gravel bodies at depth. Section E-E' shows a sand and gravel body at depth near the city of Fraser; this sand and gravel could be of glaciofluvial origin. All other significant coarse-grained materials occur at the interface of glacial deposits and bedrock, and they are usually discontinuous.

St. Marys River Study Area

Bedrock geology of the St. Marys area consist of a clastic-carbonate sequence that ranges from Precambrian to Ordovician age (fig. 6). These rocks include the Jacobsville Sandstone and Munising Formation (table 2). The Jacobsville Sandstone underlies glacial deposits in the St. Marys River from Whitefish Bay to the southern end of Sugar Island. At Sault Ste. Marie, the Jacobsville Sandstone underlies the river channel which creates the rapids in the St. Marys River. South of Sugar Island, limestones and dolomites of the Black River and Trenton Limestones (table 2) underlie the St. Marys River. These rocks are of Ordovician age and are the youngest rocks in this study area.

Bedrock topography of this area has higher relief than that in the St. Clair-Detroit area. This high relief is shown in geologic sections K-K' and L-L' (Appendix B), the locations of these sections are shown on figure 7. The resistant limestone beds form a bedrock high in the southern part of the study area, which also forms the southern boundary of a major buried valley system that trends east-west. Another major buried valley trends north-south in the vicinity of the Waiska River.

Glacial features are less pronounced in this area than in the St. Clair-Detroit area. Thickness of glacial deposits ranges from less than 10 ft at Sugar Island to more than 300 ft in bedrock valleys. Deposits are largely fine-grained lacustrine deposits, coarser-grained tills (due to the underlying bedrock) and glaciofluvial deposits. Geologic section K-K' shows that significant deposits of sand and gravel are present at depth.

Table 2.--Description of geologic units in St. Marys River study area

Geologic unit (age)	Lithology
Trenton and Black River Limestones (Middle Ordovician)	Composed predominantly of buff to brown and gray fossiliferous, finely crystalline to medium-crystalline limestone. Shale layers are common near the base of the Trenton Limestone.
Munising Formation (Late Cambrian)	A medium-grain, competent sandstone and poorly sorted, friable sandstone.
Jacobsville Sandstone (Precambrian)	Mottled red to reddish-brown feldspathic sandstone containing lenses of red or gray conglomerate and some red shale.

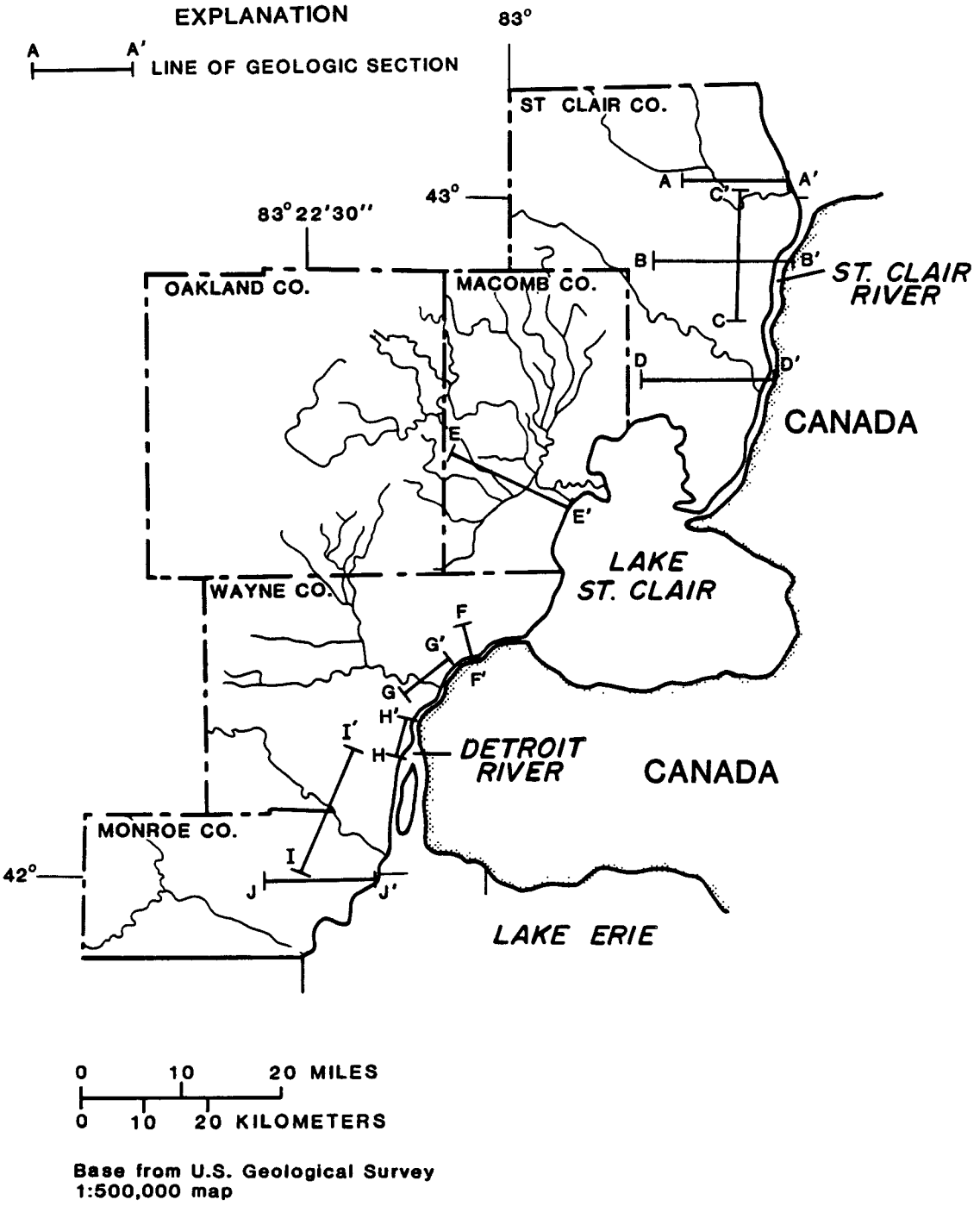


Figure 5.--Locations of geologic sections in the St. Clair-Detroit River study area.

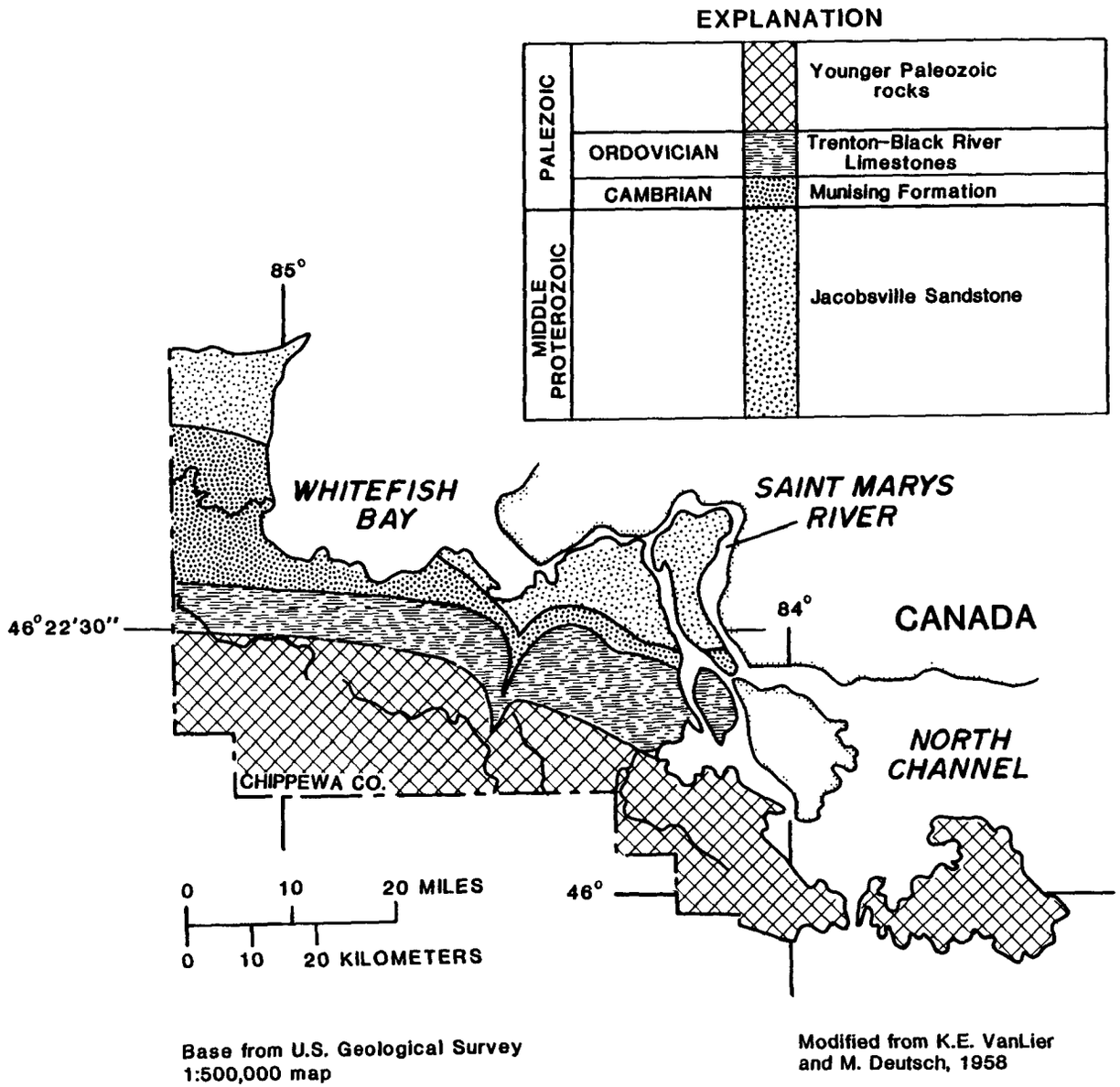


Figure 6.--Bedrock geology of St. Marys River study area.

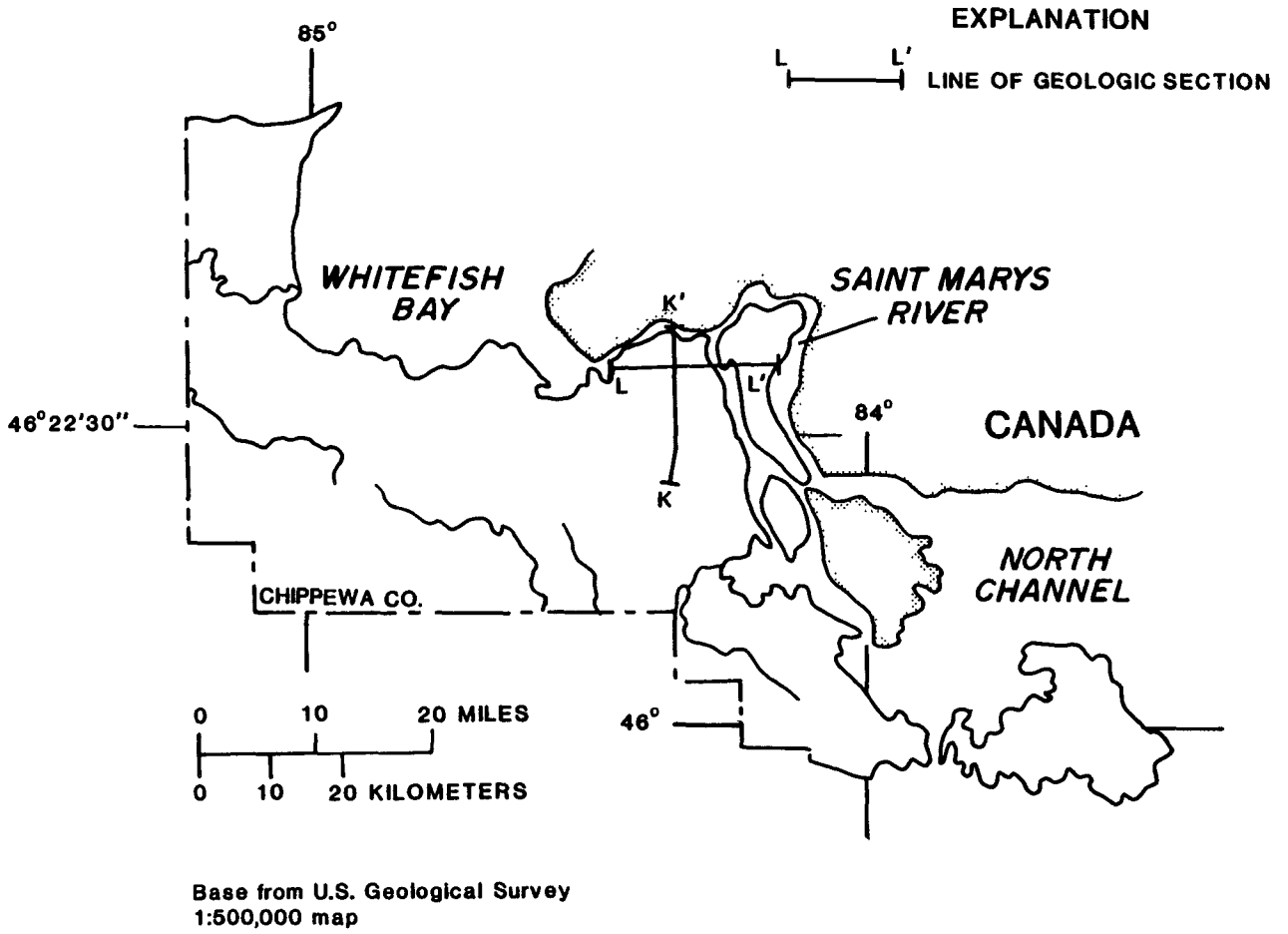


Figure 7.--Locations of geologic sections in the St. Marys River study area.

Stratigraphic Relations from Seismic Studies

A high-resolution marine seismic survey[2] was conducted to improve the definition of the geologic framework of the connecting channels in southeastern Michigan. Bedrock geology, bedrock topography, and drift thickness maps are available for only the Detroit River area (Mozola, 1969). In other parts of the study area, the depth to bedrock and thickness and characteristics of glacial deposits in the channel areas were unknown. The seismic profiles helped define the stratigraphy of the channels and delineate the hydrogeologic boundaries. Seismic profiles and locations of survey lines for the St. Clair River, Lake St. Clair, and Detroit River are given in Appendix C.

Interpretation of seismic records for the St. Clair River indicate that glacial deposits range from 50 to 100 ft in thickness, depending on channel depth. The bedrock surface is relatively flat, although minor undulations occur. Figure 8 is a continuous seismic-reflection profile typical of the St. Clair River. (Figure 8 corresponds to USGS line 20 C-C' in Appendix C.) Water well and oil and gas well logs close to the St. Clair River were used to confirm interpretations. Bedrock beneath the channel are the Bedford Shale and the Antrim Shale of Mississippian and Devonian age. In the seismic profile, the Antrim Shale, which is harder than the Bedford Shale, is indicated by the strong seismic reflection it produced. The Bedford Shale is defined on the basis of oil and gas logs which identify it as a semi-consolidated shale. Well G2 near Port Huron is the only well installed by the U.S. Geological Survey for the UGLCC study in the St. Clair study area that reached bedrock. (Data for U.S. Geological Survey wells are given in Appendix D.) Some surficial sand deposits, 5 to 10 ft thick, and at least 50 ft of silty-clay glacial deposits, were found when wells were installed. During drilling of well G2, silty-clay glacial deposits extending to bedrock were encountered. Till and lacustrine deposits could not be differentiated. Contacts or sedimentary structures within deposits are not visible in the seismic section because they are either poor reflectors or they are obscured by acoustical interference.

In Lake St. Clair, glacial deposits, including Holocene lacustrine deposits, range from 75 to more than 150 ft in thickness. Interpretations of the seismic profiles are difficult because of the lack of borehole data within Lake St. Clair. Shallow borings made by the U.S. Army Corps of Engineers for navigational light placement, a study by Brigham (1971), and logs of oil and gas wells located on shore, provide generalized information.

Figure 9 shows a continuous seismic reflection profile in the southern half of Lake St. Clair where lacustrine deposits overlie till. (Figure 9 corresponds to USGS line 14 in Appendix C.) Bedrock of this area in Lake St. Clair is the Traverse Group which consists of limestones and shales. The lack of sedimentary structures visible in the seismic section as well as the glacial history of the area, suggest that till underlies the lacustrine unit.

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[2] Theories, techniques, and methods used in the survey are outlined by Hanei and Melvin (1984) and by Hanei (1986).

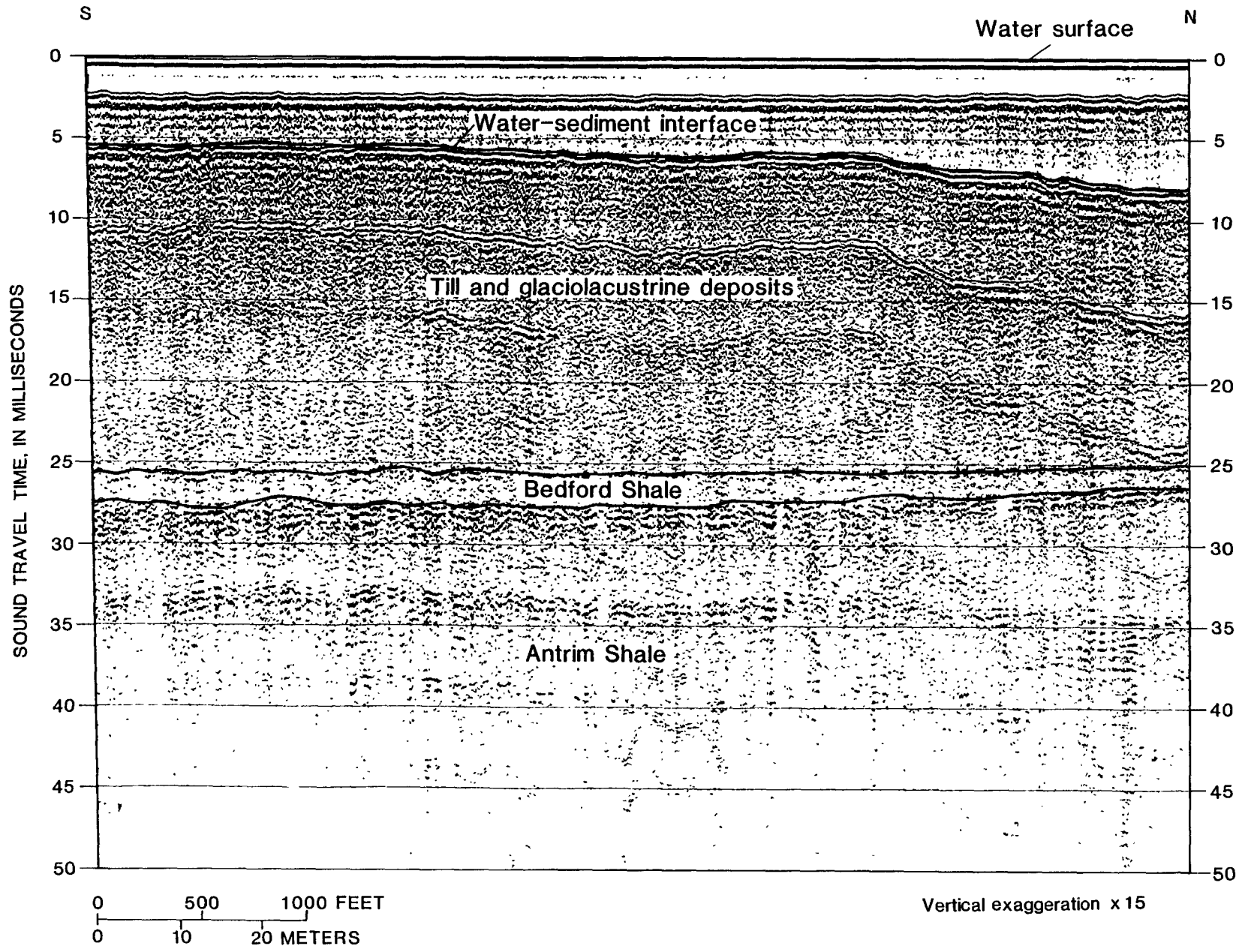

Figure 8.--Continuous seismic-reflection profile in the St. Clair River near Marine City.

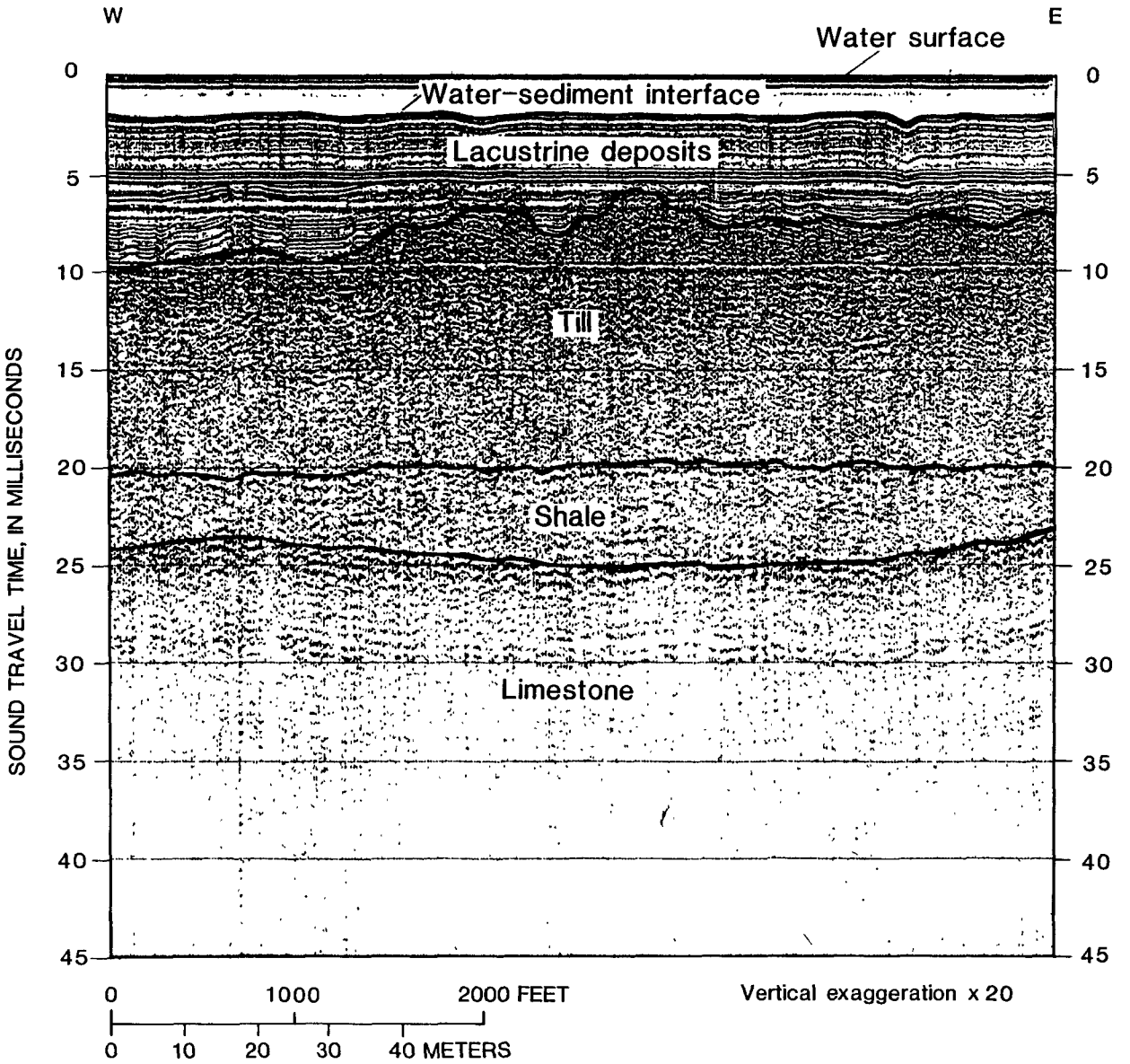

Figure 9.--Continuous seismic-reflection profile in southern Lake St. Clair showing lacustrine deposits overlying till.

The till also may contain some intercalated lacustrine deposits laid down in the subaqueous depositional environment postulated by Leverart and Taylor (1915). The lacustrine unit is post glacial. The unit thins toward the south.

Glacial deposits beneath the Detroit River range from less than 10 to 70 ft in thickness. In the southern reach of the Detroit River, glacial deposits are absent; bedrock forms the channel bottom.

Figure 10, a continuous seismic-reflection profile in northern reach of the Detroit River, shows that Pleistocene lacustrine deposits overlie glacial till. (Figure 10 corresponds to USGS line 22 B-B' in Appendix C.) Interpretation of the seismic profile is based on borings, on a study by VanWyckhouse (1966), and on the sedimentary structures and nature of the contacts shown in the seismic section. In this area, bedrock is the Dundee Formation of Middle Devonian age (Mozola, 1969).

The presence of till is suggested by strong reflectors forming the basal unit of the glacial deposits. VanWyckhouse (1966) refers to this unit as the "hardpan" or "lower drift unit"; it is distinguished by its hardness. Records of borings and wells in the Detroit area describe the unit, although it is discontinuous and only 5 to 20 ft thick. The origin of the unit is uncertain. The basal till may have formed from till that has been overridden by glacial ice or by leaching of carbonate ions from the underlying bedrock.

The basal till unit is overlain by a second unit lacking internal structure or bedforms. The nature of the contact with the overlying lacustrine deposits suggests that it is a till. This unit also was recognized by VanWyckhouse (1966), who described it as a gray, medium-hard till. He reported a thickness of 35 to 40 ft.

A lacustrine unit also can be identified on the basis of seismic and borehole information (fig. 10). The sedimentary structures are quite evident in the seismic record; the contact with the underlying till is unconformable.

The hydraulic significance of these glacial units is uncertain because the data are sparse. These units are fine grained; significant sand deposits seem to be absent. However, the heterogenous nature of the deposits suggest that coarse-grained materials may be present at some locations.

GROUND-WATER FLOW

Altitude of Water Table and Direction of Ground-Water Flow

The water table in the UGLCC study areas is shown on plates 1-5. Water-table maps were constructed from well driller's records obtained from the Michigan Department of Natural Resources, Geological Survey Division, and from files of the U.S. Geological Survey. Well-record coverage for St. Clair, Macomb, Monroe, and Chippewa Counties is adequate, except in areas close to the channels. In Wayne County, coverage is very sparse within the study area, and limited mostly to historical data. In areas where data are not available, streams and other surface-water features were used to estimate the altitude of the water table.

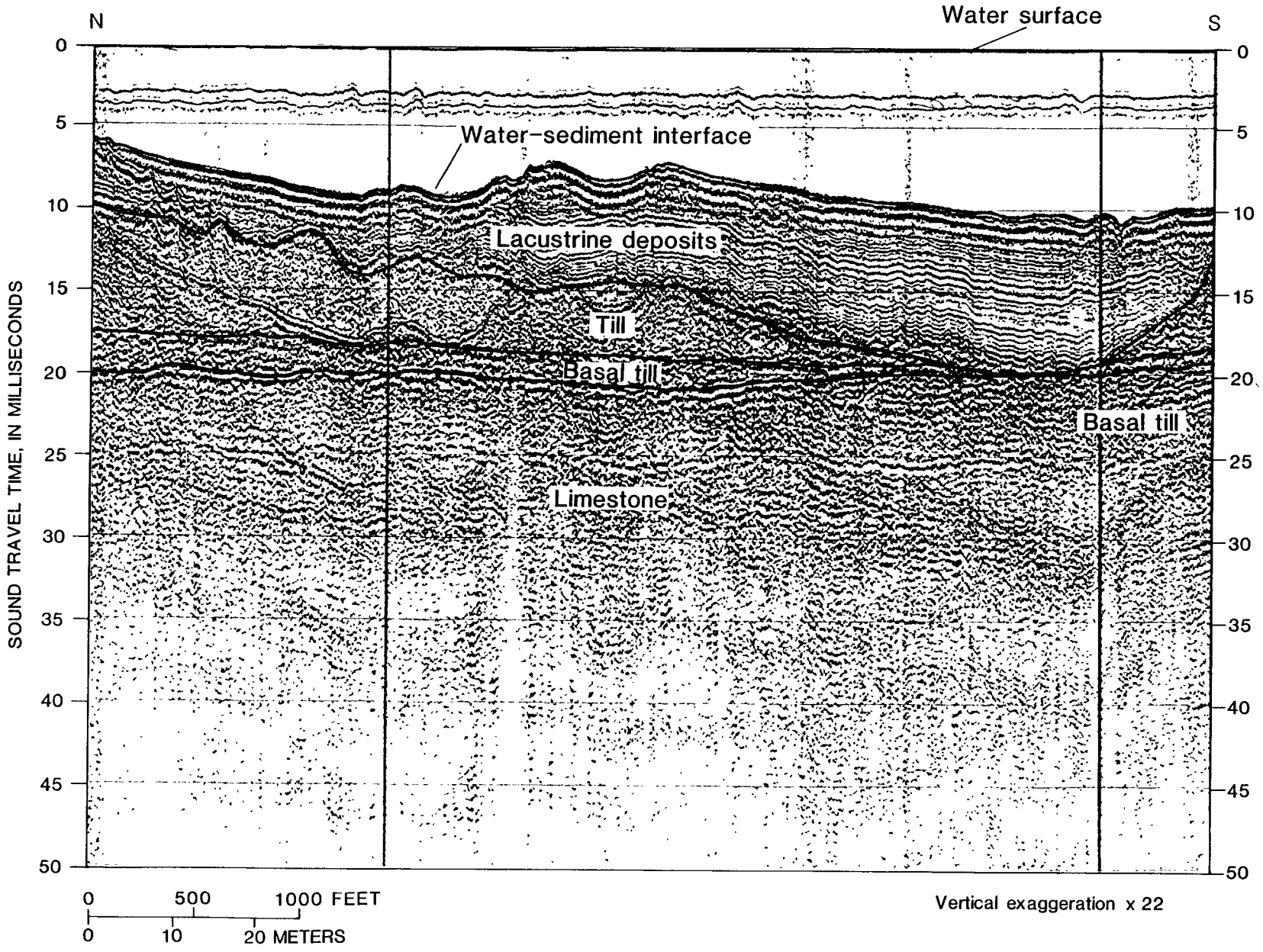

Figure 10.--Continuous seismic-reflection profile in the Detroit River near Belle Isle showing Pleistocene lacustrine deposits overlying glacial till.

In southeastern Michigan, ground-water flows eastward to the St. Clair River, Lake St. Clair and Detroit River (plates 1-4). In Chippewa County, in the Upper Peninsula, ground water flows radially toward St. Marys River (plate 5). The direction of ground-water flow in the study areas is influenced by surface-water drainage, dewatering projects, and glacial landforms. These factors, in conjunction with water-level measurements, are the basis for differentiating ground-water discharge areas shown on plates 6-10. Ground water within these areas discharges directly to connecting channels; at places outside of discharge areas, ground water discharges to tributaries of the connecting channels.

Dewatering projects create cones of depression which may be extensive. In Wayne County, dewatering of Sibley Quarry has created a cone with an area of about 4 mi^2 (plate 4). Other quarry dewatering projects have a pronounced effect near the cities of Rockwood and Flatrock (plate 4). Glacial landforms, such as end moraines, also control water-table configuration (plate 2). The Mount Clemens moraine, which trends northeast-southwest, causes a number of streams to flow into the main branch of the Clinton River near Mount Clemens. The Emmet moraine near New Baltimore increases the altitude of the water table. These end moraines form subtle topographic highs. They are composed of fine-grained material characteristic of the water-laid till in the area.

Generalized subsurface ground-water flow paths to connecting channels are shown in figure 11. In the St. Clair area, where the bedrock is predominantly shales, most discharge to the streambed would be from the glacial deposits (fig. 11a). In the southern reaches of the Detroit River, and parts of the St. Marys area where the silty-clay glacial materials are thin or absent, the discharge to the rivers from the more permeable underlying bedrock increases (fig. 11b).

Ground-Water Discharge

Ground water discharges to the connecting channels from glacial deposits and bedrock formations that form and underly channels. The unique geologic settings and environmental problems associated with the different reaches of the channels required the identification of each significant hydrogeologic unit. For this study the units are shallow glacial deposits, glacial-bedrock interface, and bedrock units. Separate estimates of flow from each unit have been made.

Hydrogeologic Units

Shallow glacial unit.--The shallow glacial unit consists entirely of Pleistocene age glacial deposits. In southeastern Michigan these are mostly silty-clay till and glaciolacustrine deposits that contain discontinuous stringers of sand and gravel. In the Upper Peninsula, significant deposits of sand and gravel are at land surface and are also within the underlying till and glaciolacustrine deposits. These sand and gravel deposits have significantly higher ground-water runoff rates and, thus, discharge a greater volume of ground water to the connecting channels.

Glacial-bedrock interface unit.--The glacial-bedrock interface unit separates the shallow glacial unit and the bedrock unit. The discontinuous interface unit is usually 5 to 20 ft of unconsolidated silty sand, gravel, and

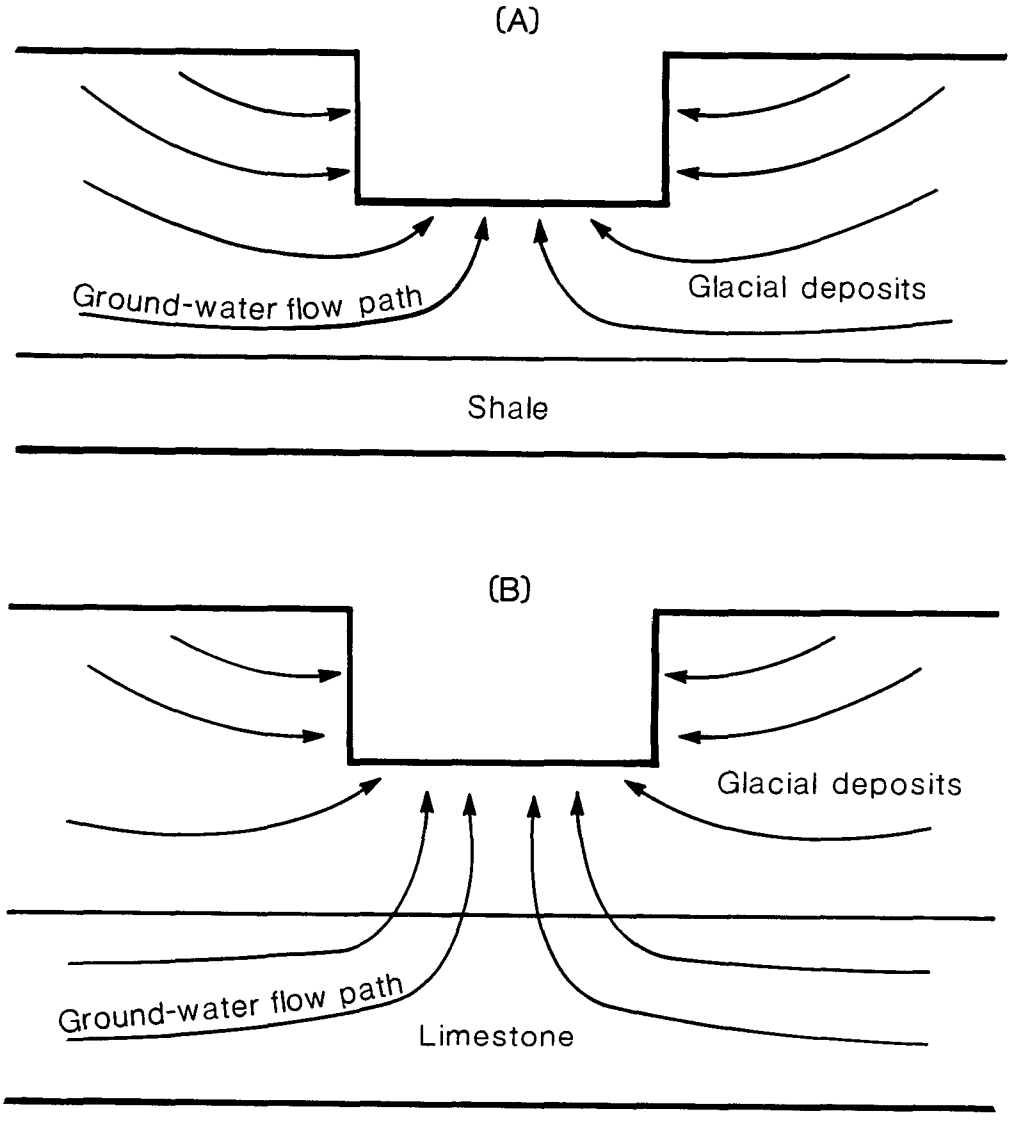

Figure 11.--Generalized ground-water flow paths to connecting channels.

weathered or fractured bedrock surface. The unit is only of significance in the St. Clair River and possibly the Lake St. Clair part of the study area where the Antrim and Bedford Shales are the principal bedrock units. The interface unit is assumed to be continuous for the purpose of estimating flow to the St. Clair River and Lake St. Clair because of the unique role it may play as an avenue of contaminant transport. For example, in the St. Clair River area, past deep injection of wastes into shallow horizons in the Detroit River Group near Sarnia, Ontario, caused overpressurization of the reservoir rock. During the injection process, the pressure front forced oil, gas, and water up through unplugged oil and gas wells. An environmental concern is that high heads in the Detroit River Group resulting from the injection process could cause waste fluids to migrate through fractures or more permeable horizons in the rock. The glacial-bedrock interface unit could, therefore, be one pathway through which waste fluids could reach the channels or contaminate adjacent ground water. No evidence exists that this has occurred in Michigan. Water from well G2, drilled to a depth of 112 ft near Port Huron, did not contain chemical substances in concentrations higher than common in natural waters; this suggests that no modification of water quality by wastes has occurred at that depth. Analyses of water from greater depths have not been made. In general, the glacial-bedrock interface unit discharges less water to the connecting channels than does the shallow glacial unit.

Bedrock unit.--For this study, the bedrock unit is defined as the first bedrock aquifer lying directly beneath the connecting channels. From Port Huron to southern Lake St. Clair, the bedrock unit includes all carbonate rocks of the Traverse Group at depths of 100 to 300 ft beneath the Antrim Shale. From Lake St. Clair to near Fighting Island in the Detroit River, the bedrock unit includes the carbonate rocks of the Traverse Group and Dundee Formation that underlie at least 50 ft of glacial deposits. South of Fighting Island, the bedrock unit is composed of limestone, dolomite, and sandstone of the Detroit River Group, which lies beneath about 25 ft of fine-grained glacial deposits. In an area near the mouth of the river, however, the Detroit River Group forms the river channel. In the St. Marys area, the bedrock unit is Jacobsville Sandstone. At some locations, it is exposed at the surface; at other locations, it is beneath as much as 300 ft of glacial deposits. At most places in both northern and southeastern Michigan, bedrock units discharge less water to the connecting channels than do either the shallow or glacial-bedrock interface units. In the lower reach of the Detroit River, however, discharge from the bedrock unit is substantially greater than at other locations.

Estimated Rates

Ground-water discharge from the shallow glacial unit to the connecting channels was estimated by analyzing base flow at gaging stations on streams in southeastern Michigan. Ground-water discharge from the glacial-bedrock interface and bedrock units was estimated by using Darcy's Law of ground-water flow and information on the hydraulic properties of glacial and bedrock deposits beneath the channels.

Shallow glacial unit.--Base flow of perennial streams, which is largely ground-water runoff, was used to estimate the ground-water discharge to the connecting channels from the shallow glacial unit. Flow records collected at the U.S. Geological Survey streamflow-gaging stations (table 3) were used to

Table 3.--Characteristics of stream basins

[mi^2, square mile; ft^3/s, cubic feet per second; $(ft^3/s)/mi^2$, cubic feet per second per square mile]

River basin	Station number and name	Period of record	Drainage area (mi^2)	Discharge at 60-percent duration (ft^3/s)	Discharge rate [$(ft^3/s)/mi^2$]
Black River	04160050 Black River near Port Huron	1933-43	684	34.3	0.05
	04159500 Black River near Fargo	1945-85	480	39.3	.08
	04159900 Mill Creek near Avoca	1964-75	169	15.2	.09
Belle River	04160600 Belle River at Memphis	1963-85	151	20.1	.13
Clinton River	04165500 Clinton River at Mount Clemens	1935-85	734	241	.33
	04164500 North Branch Clinton River near Mount Clemens	1948-85	199	26.2	.13
	04164000 Clinton River near Fraser	1948-85	444	218	.49
River Rouge	04168500 Lower River Rouge at South Brady Road near Dearborn	1931-33	91.9	6.0	.07
	04168000 Lower River Rouge at Inkster	1948-85	83.2	9.3	.11
	04167000 Middle River Rouge near Garden City	1931-85	99.9	27.4	.27
	04166100 River Rouge at Southfield	1959-85	87.9	24.6	.28
	04166500 River Rouge at Detroit	1931-85	187	40.6	.22

Table 3.--Characteristics of stream basins--Continued

River basin	Station number and name	Period of record	Drainage area (mi^2)	Discharge at 60-percent duration (ft^3/s)	Discharge rate [$(ft^3/s)/mi^2$]
River Raisin	04176500 River Raisin near Monroe	1938-85	1,042	247	0.24
Pine River	04127918 Pine River near Rudyard	1973-85	184	112	.61

determine base flow. In previous studies by the U.S. Geological Survey, the 55th to 60th percentile of annual flow duration (amount of time that flow in an average year is equaled or exceeded) has been considered a representative value for average annual ground-water runoff (U.S. Geological Survey, 1968; Cummings and others, 1984). For this study, the 60th percentile of annual flow duration was used to estimate base flow. With the exception of the Pine River near Rudyard, which is in the St. Marys area, gaging stations locations are shown on figure 12.

Ground-water discharge per square mile was then calculated for the gaged basins, and a rate of discharge was determined. Stream basins that have higher discharge rates are in areas where surficial sand deposits overlie fine-grained till and lacustrine deposits intercalated with deposits of sand and gravel. Discharge rates are lower in stream basins underlain predominantly by fine-grained till and lacustrine deposits.

Rates of ground-water discharge determined for gaged basins were used to estimate rates in the ground-water discharge areas shown on plates 6-10. Because the geological settings of discharge areas and gaged stream basins are similar, the following rates were considered appropriate: 0.10 $(ft^3/s)/mi^2$ (cubic feet per second per square mile) for fine-grained lacustrine deposits; 0.13 $(ft^3/s)/mi^2$ for areas of fine-grained till and lacustrine deposits; 0.18 $(ft^3/s)/mi^2$ for areas of some surficial sand overlying fine-grained till and lacustrine deposits; 0.25 $(ft^3/s)/mi^2$ where the area is mostly covered with surficial sands overlying fine-grained till and lacustrine deposits; 0.35 $(ft^3/s)/mi^2$ where surficial sands overlie till and lacustrine deposits that contain intercalated sand and gravel deposits; and 0.50 $(ft^3/s)/mi^2$ where thick surficial sand deposits are found in parts of the basin.

Rates of ground-water discharge per unit area are higher near the St. Marys River than in southeastern Michigan because of the presence of coarse-grained materials. The estimated total ground-water discharge to the connecting channel in the St. Marys area and the St. Clair-Detroit area from the shallow glacial unit is given in table 4.

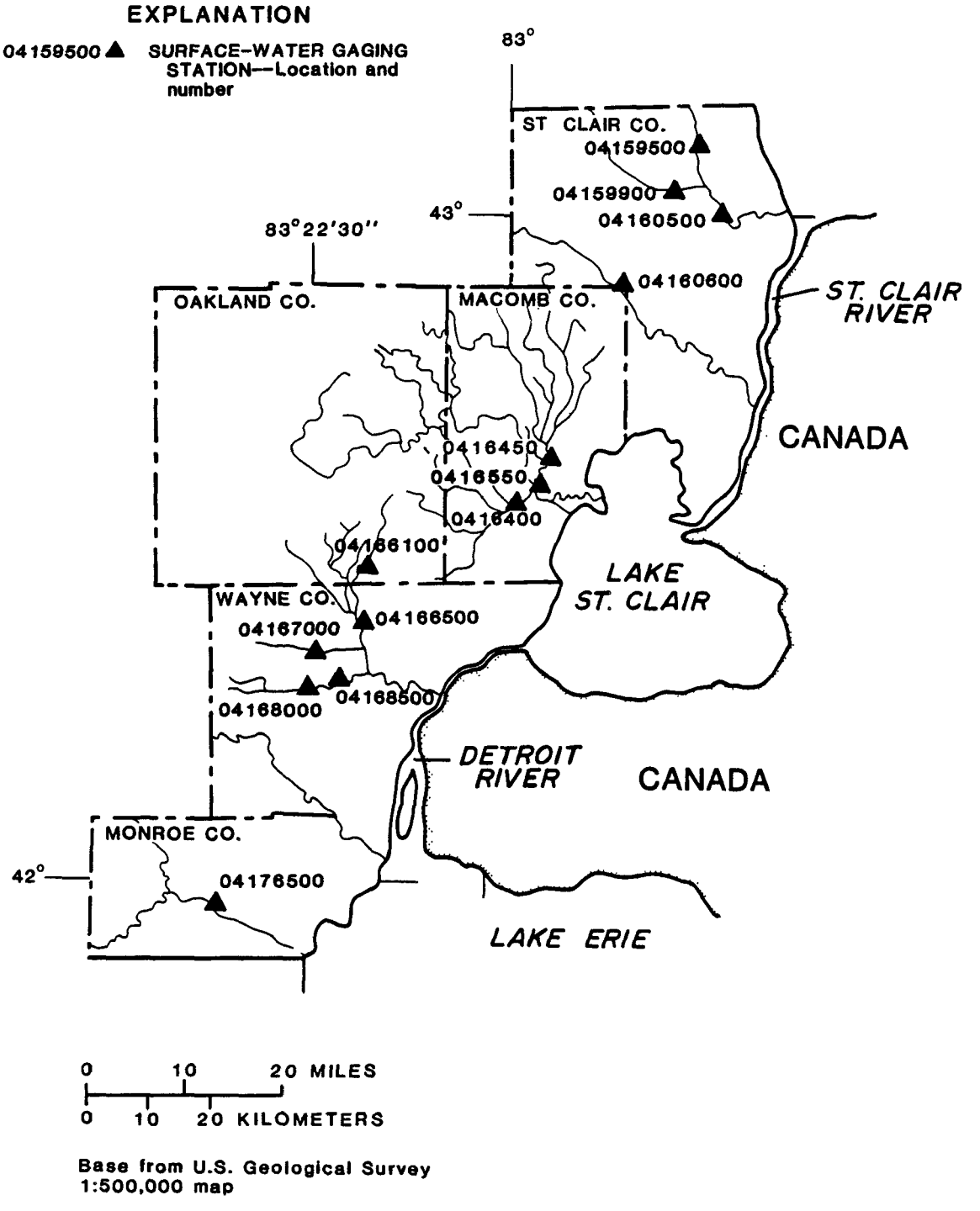

Figure 12.--Location of surface-water gaging stations in southeastern Michigan.

Table 4.--Ground-water contribution to connecting channels

[mi^2, square mile; mi, mile; $(ft^3/s)/mi^2$, cubic feet per second per square mile; ft^3/s, cubic feet per second]

Location	Area[1] number	Area[2] (mi^2)	Shorelength (mi)	Discharge rate for shallow glacial unit [$(ft^3/s)/mi^2$]	Discharge from hydro-geologic units (ft^3/s)	Total discharge from area (ft^3/s)
St. Clair River	1	S 1.9	1.98	0.25	0.48	0.52
		G .43			.047	
		B .43			.001	
	2	S 32.3	11.69	.18	5.81	6.15
		G 3.05			.33	
		B 3.05			.007	
	3	S 11.4	8.41	.13	1.48	1.70
		G 1.96			.21	
		B 1.96			.005	
	4a	S 18.8	6.67	.13	2.44	2.62
		G 1.69			.18	
		B 1.69			.004	
Lake St. Clair	4b	S 27.5	13.26	.10	2.75	6.37
		G 32.41			3.54	
		B 32.41			.080	
	5	S 80.4	15.78	.13	10.45	13.79
		G 32.58			3.56	
		B 32.58			.080	
	6	S 4.7	7.37	.13	.61	4.14
		G 31.60			3.46	
		B 31.60			.070	
	7a	S 103.9	16.36	.13	13.51	22.18
		G 77.61			8.49	
		B 77.61			.18	
Detroit River	7b	S 79.4	10.84	.13	11.62	12.74
		B 4.34			1.12	
	8	S .50	.92	.25	.13	.25
		B .29			.12	

Table 4.--Ground-water contribution to connecting channels--Continued

Location	Area[1] number	Area[2] (mi^2)	Shorelength (mi)	Discharge rate for shallow glacial unit [$(ft^3/s)/mi^2$]	Discharge from hydro-geologic units (ft^3/s)	Total discharge from area (ft^3/s)
Detroit River (continued)	9	S 4.60	3.53	0.13	0.60	1.05
		B 1.13			.46	
	10	S 6.0	5.37	.13	.78	3.13
		B 5.72			2.35	
	11	S 26.5	11.54	.13	3.45	36.85
		B [3]5.37			2.20	
		B [3]9.67			31.20	
St. Marys River	12	S 21.4	9.95	.50	10.70	14.05
		B 10.37			3.35	
	13	S 65.8	32.18	.35	23.03	30.71
		B 23.81			7.68	
	14	S 7.8	7.46	.35	2.73	3.17
		B 1.35			.44	
	15	S 52.1	37.45	.25	13.03	22.44
		B 29.17			9.41	
	16	S 22.0	20.12	.25	5.50	5.75
		B 4.63			1.50	

[1] See plates 6-10 for location of area.
[2] S is area contributing flow to the channels from the shallow glacial unit in till and lacustrine deposits; G is flow to the channels from the interface of glacial deposits and bedrock; and B is flow to channels from the bedrock unit.
[3] Area 11 is divided on basis of channel geology changing from glacial deposits to limestone.

Glacial-bedrock interface and bedrock units.--Discharge of ground water from the glacial-bedrock interface and bedrock units to the connecting channels was calculated by estimating vertical hydraulic conductivity, hydraulic gradient, and the thickness of fine-grained glacial deposits and bedrock beneath the channels. Generalized sections showing the hydraulic conductivity and relative thickness of deposits are shown in figure 13. Discharge rates from the glacial-bedrock interface and bedrock units in table 4 were derived by using the highest hydraulic conductivities thought possible for geologic materials in the study area. The following equations (Freeze and Cherry, 1979) were used to make estimates of discharge rates:

$$K_z = \frac{d}{\sum_{i=1}^{n} \frac{d_i}{K_i}} \qquad (1)$$

and

$$Q_z = K_z \frac{\partial h}{\partial z} A, \qquad (2)$$

where K_z = equivalent vertical hydraulic conductivity of system of n layers (L/T),
d = total thickness of geologic units (L),
d_i = thickness of layer i (L),
K_i = vertical hydraulic conductivity of layer i (L/T),
n = number of layers (dimensionless),
$\frac{\partial h}{\partial z}$ = vertical hydraulic gradient (dimensionless),
A = area in which vertical flow occurs (L^2), and
Q_z = vertical flow rate (L^3/T).

Calculations using these equations indicate that deposits with the lowest vertical hydraulic conductivity control the vertical movement of ground water to the connecting channels. Hydrogeologic units with the lowest vertical hydraulic conductivity are fine-grained glacial deposits, glacial till and glaciolacustrine deposits, and shale. Sand and gravel, limestone, and sandstone have the highest vertical hydraulic conductivity.

Estimates of vertical hydraulic conductivity for fine-grained glacial deposits were based on work by Desaulniers and others (1981) and on Mason and others (1986). Desaulniers and others (1981) determined the vertical hydraulic conductivity of glacial till and glaciolacustrine deposits of southwestern Ontario to range from 0.00003 ft/d to 0.0003 ft/d (foot per day). Seepage-meter studies by Mason and others (1986) suggested that the streambed hydraulic conductivity of the St. Clair River was at least two orders of magnitude higher than values determined by Desaulniers and others (1981). Based on these data, a vertical hydraulic conductivity of 0.03 ft/d for till is used in calculations for this study.

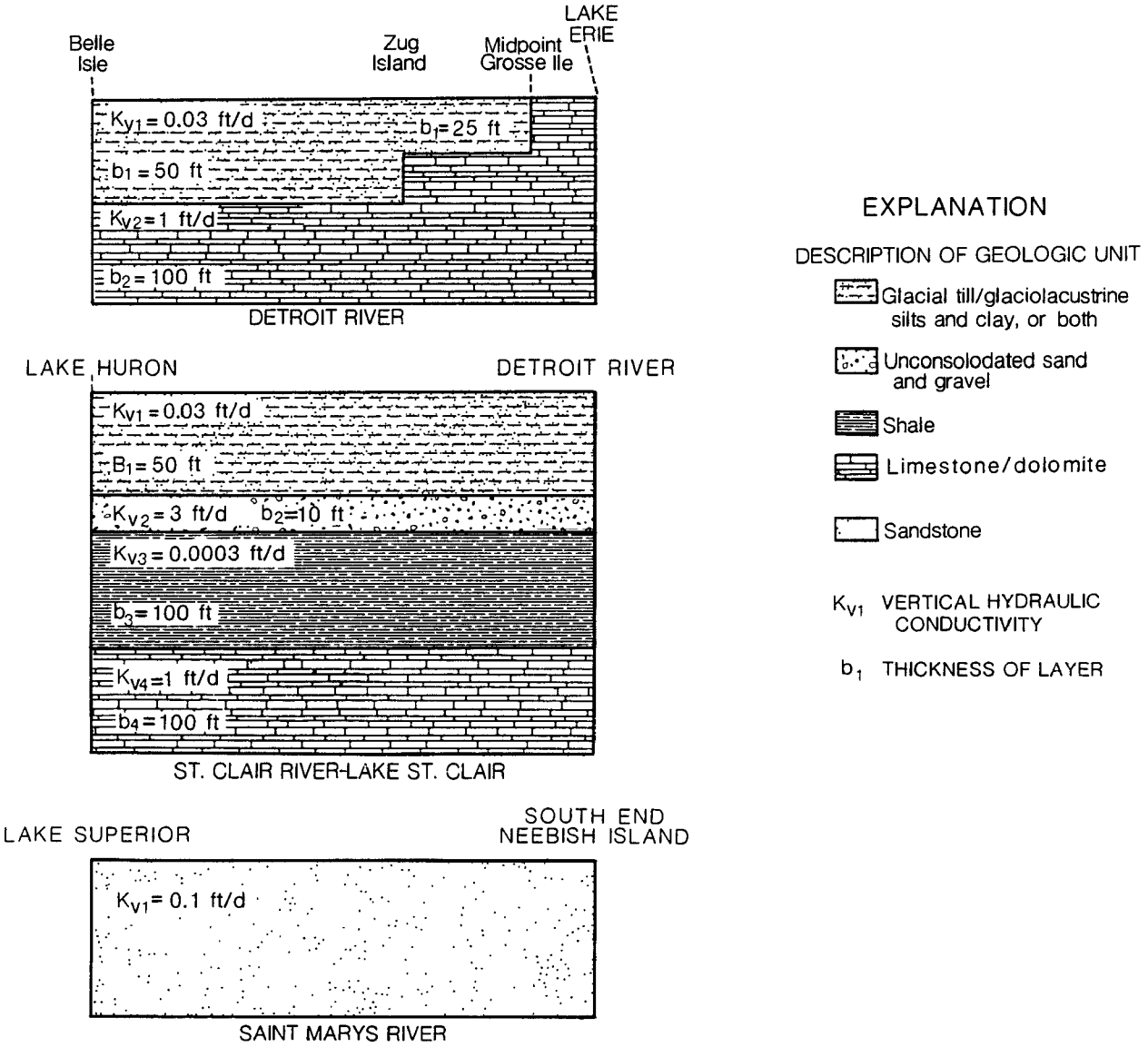

Figure 13.--Generalized geologic sections underlying connecting channels.

Vertical hydraulic conductivities of the shale were estimated by reviewing published values for other shale units. Bredeheoft and others (1983) reported vertical hydraulic conductivities for South Dakota shales ranging from $3x10^{-6}$ ft/d to $3x10^{-8}$ ft/d. Because some evidence exists that shales in the connecting channels study area have been fractured, a vertical hydraulic conductivity of 0.0003 ft/d is used in ground-water discharge calculations.

In calculating ground-water discharge, a vertical hydraulic gradient of 0.01 has been assumed. This assumption is based on historical head data of the Detroit area (Sherzer, 1913) and on a report by Jackson (1987) on the St. Clair River Valley.

One well (G2), installed in the bedrock-glacial deposit interface near Port Huron, has an upward gradient. This is consistent with wells installed by Canadian investigators on the eastern side of the St. Clair River at similar distances from the river (Jackson, 1987).

Estimates of the thickness of geologic units beneath channels in the St. Clair-Detroit area were based on the seismic-reflection survey conducted by the U.S. Geological Survey. (See section "Stratigraphic Relations from Seismic Studies.")

Discharge to Connecting Channels

Total ground-water discharge to the connecting channels in the St. Clair-Detroit area from Port Huron to Pointe Mouillee is about 112 ft^3/s (table 4). Discharge rates increase southward because the fine-grained glacial deposits become thin, and because hydraulic conductivity of the bedrock increases. The highest discharge rate is in Area 11 south of Detroit (plate 9). In this area, glacial deposits are thin or absent; bedrock is limestone, dolomite, and sandstone. Discharge rates are lowest near the St. Clair River where glacial deposits are thick, fine grained, and underlain by shales.

Total ground-water discharge in the St. Marys area is about 76 ft^3/s (table 4). Although ground-water discharge to the connecting channel is about the same as in southeastern Michigan, discharge per square mile is much higher in the St. Marys area because of the extensive deposits of sand and gravel in the shallow glacial unit. Discharge from bedrock also is greater in the St. Marys area principally because permeable sandstones and limestones comprise a significant part of the bedrock.

Ground-Water Flow to Connecting Channels from Tributaries

All ground water within discharge areas (plates 6-10) enters the connecting channels directly; ground water outside these areas discharges to tributaries of the channels and, thus, becomes part of the surface-water discharge to the channels. Tracing the movement of ground-water contaminants to streams and subsequently to the connecting channels, however, was beyond the scope of this study.

An estimate of the amount of ground-water discharge to the connecting channels from tributaries can be made using long-term streamflow records and estimates of ungaged stream flow. Table 5 shows streamflow characteristics and resultant estimates of ground-water flow.

Table 5.--Estimates of ground-water flow to connecting channels from tributaries

[ft^3/s, cubic feet per second; mi^2, square mile]

	Black River	Pine River	Belle River	Clinton River	Rouge River	Waiska River	Charlotte River
Average discharge (ft^3/s)	420	110	140	560	300	185	72
Drainage area (mi^2)	711	194	230	760	240	252	83
Ground-water discharge (ft^3/s)	57	25	30	240	117	87	34
Drainage area (UGLCC portion only) (mi^2)	52	100	102	252	142	142	55
Ground-water discharge (UGLCC portion only) (ft^3/s)	9	10	10	83	26	87	34

In the St. Clair-Detroit study area, ground-water discharge to connecting channels from tributaries is about 10 percent of total flow of the tributaries. In the St. Marys study area, ground water contributes about 47 percent of total flow of tributaries to connecting channels.

Ground water may have a significant effect on tributaries at some locations. Usually the effect will be greatest in areas where geological conditions enhance the movement of ground water, such as in the Clinton, River Rouge, and Pine River basins (table 3).

Along Clinton River near Utica, in the southwestern quarter of T.3 N., R.12 E. (plate 7), several sites are located on a Pleistocene deltaic sand deposit. Two of these sites, G & H Landfill (Site MA12) (Frank Belobraidich, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987; Steve Cunningham, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987; Tom Work, Michigan Department of Natural Resources, written comm., 1986; Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987; Gorman and Akeley, 1978; U.S. Environmental Protection Agency, 1986a; and Ken

Westlake, U.S. Environmental Protection Agency, written comm., 1987) and Liquid Disposal Incorporated (Site MA33) (Frank Belobraidich, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987; Steve Cunningham, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987; Tom Work, Michigan Department of Natural Resources, written comm., 1986; Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987; U.S. Environmental Protection Agency, 1986a; and Ken Westlake, U.S. Environmental Protection Agency, written comm., 1987), have contaminated local ground water. Both of these sites are on the National Priorities List, and studies of these sites by the USEPA show that the ground water flows through the sand and gravel and discharges to the nearby Clinton River.

Red Run Drain Landfill (Site MA13) (Frank Belobraidich, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987; Steve Cunningham, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987; Tom Work, Michigan Department of Natural Resources, written comm., 1986; Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987; and Gorman and Akeley, 1978) is adjacent to Red Run Drain, a tributary to the Clinton River. This site, located in the southwestern corner of T.2 N.,R.12 E. (plate 7), is actually seven separate landfills, each of which is along the drain. Surficial sand deposits of the area are thin, but the proximity of these sites to Red Run Drain makes it likely that a substantial amount of ground water discharges to the stream.

The River Rouge drains some of the most heavily populated and industrialized areas of southeastern Michigan. Parts of the River Rouge drainage area contain surficial sand deposits associated with Pleistocene glacial lakes. Surficial sand deposits increase ground-water runoff in a stream basin (table 3). Sites that could have an affect on the River Rouge near the Detroit River are Edward C. Levy Company Plant No. 6 (Site WA50) (Richard Traub, U.S. Environmental Protection Agency, written comm., 1986; Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987), Edwards Oil Service (Site WA37) (Richard Traub, U.S. Environmental Protection Agency, written comm., 1986, David Slayton, Michigan Department of Natural Resources, written comm., 1986 and 1987), and Rouge Steel Company (Site WA58) (Richard Traub, U.S. Environmental Protection Agency, written comm., 1986). These sites are industrial sites regulated by the Resource Conservation and Recovery Act (RCRA). This area is one of lakebed sand and alluvium; industrial development has altered surface deposits at some locations, however.

Drainage ditches, which are common in southeastern Michigan, also can intercept shallow ground water. For example, Monguogon Creek, near the city of Riverview, drains to the Trenton channel from an area that contains waste sites that rank among those most potentially hazardous. These include Industrial Landfill (Site WA22) (Frank Belobraidich, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987; Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987; and Steve Cunningham, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987), Federal Marine Terminal Properties (Site WA15) (Frank Belobraidich, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987; Michigan Sites of

Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987; and Steve Cunningham, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987), and Edward C. Levy Company-Trenton Plant (Site WA51) (Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987). Sites WA22 and WA15 are recognized by the Michigan Department of Natural Resources as ground-water-contamination sites; site WA51 is an industrial site regulated under RCRA. Although drainage ditches generally are shallow, they can provide a pathway for discharge of contaminated ground water to the connecting channels.

Identification of Areas Suitable for Simulation of Ground-Water Flow

The estimates of the quantity of ground water flowing to the connecting channels could be improved if digital computer models were developed for selected areas. Factors that determine the feasibility or desirability of simulating ground-water flow in UGLCC study areas include (a) geologic and hydrologic characteristics, (b) occurrence of serious or potentially serious ground-water contamination problems, and (c) a determination that the benefits gained from an increased understanding of the flow system justify the cost of model development.

Detroit River Study Area

Along the southern reach of the Detroit River, between the city of Ecorse and Huron River (plate 9), 15 waste sites either are degrading or are suspected of degrading the quality of ground water that moves to the Detroit River. Several hydrogeologic studies of shallow ground-water flow at specific sites in this area have been conducted. Unfortunately, some investigations did not extend beyond the boundaries of a site. A ground-water model would be useful in determining the local direction of flow at sites, and in making channel loading estimates, and could be used if remedial actions were undertaken.

Model development also would be valuable in understanding the effect of quarrying operations on shallow ground-water movement. Near Trenton, for example, waste sites lie between the Sibley quarry and the Detroit River; water from these sites may discharge to the quarry.

Development of a ground-water flow model will require installation of additional wells to determine the hydrologic relation between the glacial deposits and underlying bedrock. At present, little is known about the hydrologic characteristics of the limestone and dolomite bedrock units. In order to make loading estimates, simulation efforts would need to be accompanied by the collection of a substantial amount of water-quality data.

St. Clair River Study Area

The first subsurface disposal wells in Ontario were installed at Sarnia, which is located on the eastern shore of the St. Clair River across from Port Huron, Michigan. By the late 1960's, a total of 15 wells were injecting industrial waste into the Detroit River Group; three additional wells injected waste into a brine cavity in the Saline Formation.

In 1966-67, pressure caused by deep-well injection forced pore fluids in unplugged wells in the Detroit River Group to the land surface near Port Huron and north of Marine City, Michigan. The potential for contaminating the St. Clair River and shallow water-supply aquifers was apparent.

Geology and hydrology of this area are only generally understood. During this project one well (G2) was installed in the glacial-bedrock interface unit. The water level of this well indicates an upward gradient from the interface to the shallow flow system and possibly to the river. A ground-water flow model of the area from Port Huron south to Marine City would be valuable in assessing the effects of waste injection on the quality of water in shallow aquifers. A thorough definition of potential problems would require installation of several deep wells and the collection of additional water-quality data.

GROUND-WATER QUALITY

Although substantial amounts of water-quality data are available in the UGLCC study areas, little information has been obtained in Michigan on the concentrations of many of the metals and organic compounds identified by UGLCC study planners as necessary for adequate assessment of water-quality conditions. In addition, only sparse data are available downgradient from waste sites, principally because of the closeness of many sites to the connecting channels.

In an attempt to increase the data base, 25 observation wells were installed during the project (Appendix D). An effort was made to install one to three wells in most of the 16 ground-water discharge areas (plates 6-10). The actual locations of the wells depended on the number of waste sites upgradient, on the size of the ground-water discharge area, and on permission for drilling from land owners. Permission to install wells was denied in most instances in the Detroit area where legal actions have been taken with respect to some waste sites and where ground-water contamination is thought to be most prevalent. Because property on which many waste sites are located extends to the connecting channel, no alternative locations downgradient were available. At such waste sites, even though contaminants in ground water or on soils have been identifed, the low permeability of the deposits prevents establishing contaminant movement based on the direction of ground-water flow alone.

Samples for analyses were collected from the 25 wells installed by the U.S. Geological Survey and from six private wells. Analyses were made for volatile, base-neutral, acid-extractable, and chlorinated neutral-extractable hydrocarbons, trace metals, and other chemical substances. These analyses are given in Appendix D. Analyses of samples collected for quality assurance/quality control (QA/QC) also are given in these tables. (The QA/QC plan for this study is given in Appendix A.)

As part of QA/QC laboratory procedures, blanks, surrogate spike recoveries, and duplicate samples were analyzed.[3] Laboratory blank data for base/neutral/acid extractables (BNA) indicate that no significant contaminants occurred in the blanks. Phthalate esters detected by the target compound analysis, and other compounds in the sample extracts tentatively identified by mass spectral library search, indicate that those substances may be present at the corresponding sampling sites. It is possible, however, that they were introduced during sampling or shipment. A review of collection and shipping techniques did not suggest a source. No significant laboratory blank contaminants were observed during the analysis of chlorinated neutral extractables (CNE).

In the analysis of duplicate samples, there were not enough positive identifications to make a clear assessment of replicate precision. Qualitative identification of phthalate esters in BNA extracts was good in replicate analyses. However, the presence of such plasticizers in always suspicious.

In both BNA and CNE analyses, mean surrogate spike recoveries were not significantly different from those for distilled water or other sample surrogate spikes.

Matrix effects (high nondescript background) were considered to be a problem in all of the analyses, but most significantly in the CNE analyses due to the sensitivity of the electron-capture detector and dependence solely on retention-time data for identification at the submicrogram level. Many of the samples required dilution (reflected in the higher reporting thresholds) and/or additional fractionation by column chromatography. Thus, there is a possibility that the identifications made by this technique were false positives because analysis was attempted at low concentrations in a complex matrix.

Concentrations of trace metals, in a number of instances, are unusually high. Analyses of water were made for the total amount present in a sample in accordance with methods agreed on by UGLCC study participants. The deposits in many areas, even after lengthy periods of well pumping, yielded water containing finely divided particulate matter. It is believed that this particulate matter may have contributed significantly to the measured concentrations, and if so, concentrations of trace metals in ground water discharged to the connecting channels could be much lower than analyses indicate.

Appendix E gives chemical analyses of water and soils made by various State, Federal, and private laboratories at waste sites. Some of the analyses are of soil or water near a point of contamination, and thus reflect on-site

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[3]Laboratory blank contaminant data, nontarget library search results (GC/MS), surrogate recovery data, chromatograms, and target compound data are on file with the U.S. Environmental Protection Agency, Chicago, Illinois. Copies may also be obtained from the U.S. Geological Survey, Water Resources Divison, Lansing, Michigan.

conditions rather than representing the effect of downgradient transport. Appendix D gives the analyses of ground water made by the U.S. Geological Survey at 31 locations. About a third of the wells sampled by the U.S. Geological Survey were downgradient from a waste or spill site; other locations were chosen to provide background information.

For this study, analyses by county Health Departments also were assembled and reviewed. However, only a few of the most common constituents found in ground water are determined by Health Departments, and the number of domestic wells located near the connecting channels are comparatively few. As a result the usefulness of these analyses in this study was minimal.

Study Areas

St. Marys River Study Area

Chemical analyses of water from seven wells in three ground-water discharge areas in the St. Marys study area were made by the U.S. Geological Survey. (These wells are numbered G22 to G25, and P4 to P6, in Appendix D; the locations are shown on plate 10.) It was possible to locate two wells near waste sites. Well G23 was installed at Cannelton Industries tannery disposal (Site CH5) (Mark Petrie, Michigan Department of Natural Resources, written comm., 1986; Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources, 1986 and 1987), and well G24 was installed downgradient from Sault Ste. Marie disposal (Site CH4) (Mark Petrie, Michigan Department of Natural Resources, written comm., 1986; Michigan Sites of Environmental Contamination-Priority List, Act 307,ist, Act 307, Michigan Department of Natural Resources, 1986 and 1987).

Analyses of water from each of the seven wells indicated that concentrations of the volatile hydrocarbons, if present, did not exceed the detection limit of 3.0 µg/L (micrograms per liter). Base neutral compounds and chlorinated neutral extractable compounds were also less than the detection limit, with exception of water from wells G23 and G24, which contained phthalates. Water of well G23 had the highest concentration--95 µg/L bis (2-ethyl hexyl) phthalate. Analyses made by laboratories other than that of the U.S. Geological Survey (Appendix E) did not provide data on organic compounds in ground water.

Trace-metal analyses of water from the seven wells sampled by the U.S. Geological Survey indicated concentrations exceeding USEPA (1986b,c) drinking water standards[4] in only one sample. Water from well G23 contained 320 µg/L of chromium and 8.4 mg/L of zinc. Analyses of trace metals by other laboratories showed considerably higher concentrations in ground water at Sites CH4 and CH5. Maximum concentrations of 300 µg/L arsenic, 410,000 µg/L

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[4]USEPA maximum contaminant levels for trace metals in drinking water are: arsenic, 50 µg/L; barium, 1,000 µg/L; cadmium, 10 µg/L; chromium, 50 µg/L; lead, 50 µg/L; mercury, 2 µg/L; selenium, 10 µg/L; and silver, 50 µg/L. Secondary maximum contaminant levels are: copper, 1 mg/L; iron, 300 µg/L; manganese, 50 µg/L; and zinc, 5 mg/L.

aluminum, 440,000 µg/L chromium, 2,400 µg/L lead, 570 µg/L nickel are reported.

St. Clair River Study Area

Chemical analyses of water from eight wells in four discharge areas in the St. Clair River study area were made by the U.S. Geological Survey. (These wells are numbered G1 to G8 in Appendix D; the locations are shown on plates 6 and 7.) It was possible to locate two wells downgradient from waste sites. Well G3 was installed downgradient from A and B Waste Disposal (Site SC16) (Frank Belobraidich, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987; Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987; and Steve Cunningham, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987). Well G4 was installed downgradient from Wills Street dump (Site SC15) (Frank Belobraidich, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987; Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987; and Steve Cunningham, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987).

Analyses of water from each of the eight wells indicated that concentrations of volatile hydrocarbons were less than the detection limit. Base neutral compounds and chlorinated neutral extractable compounds were detected in water from five of the wells. Well G3, downgradient from Site SC16, contained 1,500 µg/L of bis (2-ethyl hexyl) phthalate--the highest concentration of an organic compound detected in the study (Appendix D). Analyses of soil and water by laboratories other than that of the U.S. Geological Survey (Appendix E) detected chlorinated hydrocarbons, phenols, and aroclor 1260 on soils at Site SC15. Organic compounds in ground water at Site SC16 are reported, but concentrations are unknown.

Analyses of water for trace metals by the U.S. Geological Survey showed unusually high concentrations of trace metals in ground water. Maximum concentrations were 6,300 µg/L lead, 390,000 µg/L zinc, 2,100 µg/L barium, 500,000 µg/L iron. It is believed that these high concentrations are due, in part, to the finely divided particulate matter in the samples. Analyses made by other laboratories (Appendix E) provide no data on trace metals.

Lake St. Clair Study Area

Chemical analyses of water from eight wells in four ground-water discharge areas in the Lake St. Clair study area were made by the U.S. Geological Survey. (These wells are numbered G9 through G16 in Appendix D; the locations are shown on plates 7 and 8.) Two wells (G9 and G13) were installed downgradient from waste sites. Well G9 was installed downgradient from the Clay Township sanitary landfill (Site SC7) (Frank Belobraidich, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987; Tom Work, Michigan Department of Natural Resources, written comm., 1986; and Gorman and Akeley, 1978); well G13 is downgradient from the west ramp and northwest sanitary landfill at Selfridge Air National Guard Base (Site MA41a) (Steve Cunningham, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987; Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987).

Previous work by other investigators had not detected contaminants at Site SC7; petroleum hydrocarbons, chlorinated hydrocarbons, and trace metals have been found in ground water at Site MA41a (Appendix E).

Analyses of water from each of the eight wells indicated that concentrations of volatile hydrocarbons, if present, are consistently less than the detection limit. Benzene, however, was detected in well G14 (3.1 µg/L). Base neutral compounds and chlorinated neutral extractables generally were absent. Phthlates were in water from all but well G10. The highest concentration found was that of bis (2-ethyl hexyl) phthalate, 560 µg/L, in water from well G11. Traces of DDT and lindane were detected in water from wells G9, G11, and G15. Analyses of water by laboratories other than that of the U.S. Geological Survey for organic compounds indicate that petroleum hydrocarbons, chlorinated hydrocarbons, and phenols are in ground water at Site MA41a. Benzene, toluene, methylene chloride, trichloroethylene, dichloroethylene, and ethyl benzene are reported in concentrations generally less than 100 µg/L. A vinyl chloride concentration of 45 µg/L has been reported. Di-n-octylphthalate was found at a concentration of 650 µg/L.

Analyses of water for trace metals by the U.S. Geological Survey indicated high concentrations at some locations. Maximum concentrations included 4,000 µg/L barium, 580,000 µg/L iron, 600 µg/L lead, and 74,000 µg/L zinc. All of these values are well in excess of USEPA drinking-water regulations. A pH greater than 11 was measured at one location. It is believed that the high trace metal concentrations were caused, in part, by finely divided particulate matter in the samples. Trace metals are frequently adsorbed on particulate matter. Other laboratories also report high concentrations of trace metals in water. At one site, a copper concentration of 1,900 µg/L was found in ground water.

Detroit River Study Area

Chemical analyses of water from eight wells in the Detroit River study area were made by the U.S. Geological Survey. (These wells are numbered G17 to G21, and P1 to P3, in Appendix D; the locations are shown on plates 8 and 9.) Wells G17 and G20 were located downgradient from waste sites. In addition, two private wells, located on waste-site property, were sampled. Well G17 is downgradient from Petro-Chem Processing, Inc. (Site WA70) (Richard Traub, U.S. Environmental Protection Agency, written comm., 1986; David Slayton, Michigan Department of Natural Resources, written comm., 1986 and 1987), where low levels of organic compounds have been detected in ground water (Appendix E). Analyses of water from well G17 show significant concentrations of base neutral compounds (Appendix D). Concentrations of inorganic substances are also significantly higher than those found at most other locations. Well G20 is downgradient from McLouth Steel Corporation (Site WA5) (Frank Belobraidich, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987; Tom Work, Michigan Department of Natural Resources, written comm., 1986) where the concentrations of inorganic compounds ground water are higher than common in natural waters. Ground water at Michigan Consolidated Gas Company's Riverside Park (Site WA23) (Frank Belobraidich, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987; Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987; and Steve Cunningham, Michigan Department of Natural Resources, written comm., 1985,

1986, and 1987), where well P1 is located, is contaminated by organic compounds and metals (Appendixes D and E). Ground water at Pennwalt Corporation (Site WA57) (Richard Traub, U.S. Environmental Protection Agency, written comm., 1986; Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987; and Steve Cunningham, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987), where well P2 is located, is contaminated by organic and inorganic compounds and trace metals (Appendixes D and E).

Analyses of water from each of the eight wells indicated that concentrations of volatile hydrocarbons are less than the detection limit, with the exception of water from well P1 that contained concentrations of 270 µg/L benzene, 410 µg/L ethyl benzene, and 740 µg/L xylenes. Base neutral and chlorinated extractable compounds were more frequently detected in the Detroit area than in the other three study areas. Eighteen organic compounds were detected in water of well P2; the highest concentration was that of bis (2-ethyl hexyl) phthalate (150 µg/L). Analyses of water by other laboratories at several locations showed even higher concentrations of organic compounds (Appendix E). Maximum concentrations of some of the organic compounds include benzene, 23,000 µg/L; xylenes, 42,340 µg/L; trichloroethylene, 2,785 µg/L; chloroform, 8,500 µg/L; naphthalene, 810,000 µg/L; acenaphthylene, 360,000 µg/L; and benzo (a) pyrene, 820,000 µg/L.

Analyses of water by the U.S. Geological Survey indicate that concentrations of trace metals commonly are high in ground water. For example, a copper concentration of 2,500 µg/L (well G17), a lead concentration of 4,700 µg/L (well G17), and a nickel concentration of 1,500 µg/L (well P2) were found. A pH greater than 11 was measured. Analyses by other laboratories indicate even higher concentrations at some locations. Maximum concentrations in ground water as great as the following have been found: chromium, 26,600 µg/L; lead, 62,400 µg/L; mercury, 4,900 µg/L; and zinc, 67,500 µg/L. High concentrations of chloride (54,400 µg/L), cyanide (58,800 µg/L), and dissolved solids (197,000 mg/L) were also reported in ground water.

Transport of Chemical Substances to Connecting Channels by Ground Water

A computation of the loading of the connecting channels by chemical substances transported by ground water does not seem feasible on the basis of data currently available. Concentrations of organic compounds generally were less than the detection limit; this makes loading computations impractical. It is believed that samples collected for trace-metal analyses, because they contained finely divided particulate matter in a number of instances, yielded higher concentrations when analyzed than otherwise would have been the case.

Relation of land use to the chemical characteristics of ground water

U.S. Geological Survey land-use and land-cover maps (1979, 1984) were used to determine land use in each of the ground-water discharge areas. The results are summarized in table 6. Urban or built-up land includes residential, commercial, industrial, transportation and other urban land. Agricultural land is mostly cropland or pasture. Forests are deciduous, evergreen, or a mixture of both types. Wetlands consist of both forested and nonforested land. Barren lands in the study area are quarries, gravel pits, or transitional areas. Land use designated as water in table 6 is either a

Table 6.--Land use in the ground-water-discharge areas

[Unit is square mile. -- means that land of that category is not present. Data from U.S. Geological Survey, 1979 and 1984]

Area number	Urban or built-up land	Agricultural land	Forest land	Wetland	Barren land	Water	Total area
1	1.8	--	0.1	--	--	--	1.9
2	9.3	21.7	6.7	--	--	3.3	41.0
3	1.3	8.2	1.6	--	0.3	--	11.4
4a	1.0	13.7	3.8	0.3	--	--	18.8
4b	2.2	16.5	5.2	3.6	--	--	27.5
5	13.7	62.1	3.7	--	.6	.3	80.4
6	2.5	.8	.4	.9	--	.1	4.7
7a	100.3	2.5	.7	--	.4	--	103.9
7b	79	--	--	--	.4	--	79.4
8	.5	--	--	--	--	--	.5
9	4.6	--	--	--	--	--	4.6
10	6.0	--	--	--	--	--	6.0
11	9.4	14.9	1.7	.3	.2	--	26.5
12	1.0	.8	18.5	.9	--	.2	21.4
13	7.4	31.1	23.7	2.2	1.4	--	65.8
14	--	.6	6.4	.8	--	--	7.8
15	.2	6.3	42.2	3.4	--	--	52.1
16	--	1.8	18.4	1.6	.2	--	22.0

reservoir or a lake; surface streams and the connecting channels are not included.

Partial chemical analyses made by county Health Departments commonly report concentrations of iron, chloride, nitrate, sodium, and fluoride, and values of hardness and specific conductance. These chemical characteristics of ground water were found to be unrelated to land use in all discharge areas. Similarly, results of analyses of water from U.S. Geological Survey wells did not indicate a relation. Nitrogen and phosphorous concentrations were higher in the Detroit area, probably because of the urban and industrial environment rather than any specific use of land. Additional data will be necessary to establish, for example, the effect of agricultural chemicals on ground water and, ultimately, their effect on the connecting channels.

SUMMARY

The Upper Great Lakes Connecting Channels (UGLCC) are the St. Marys, St. Clair and Detroit Rivers, and Lake St. Clair. These bodies of water function as conduits for the waters of the upper lakes (Superior, Michigan, and Huron) to drain into the lower lakes (Erie and Ontario).

Bedrock of the St. Clair-Detroit area consists predominantly of shales and limestones. Sandstone is the dominant bedrock type in the St. Marys area. Glacial deposits range from less than 100 ft in thickness in the southern part of the St. Clair-Detroit River area to more than 250 ft in thickness in the northern part. A high-resolution seismic survey showed that the thickness of the glacial deposits directly beneath the channels range from about 50 to 100 ft in the St. Clair River, from about 70 to over 150 ft in Lake St. Clair, and from less than 10 to about 70 ft in the Detroit River. Seismic surveys also show variability in types of deposits. Glacial deposits consist predominantly of silty clay tills and lacustrine deposits containing minor beds of sand and gravel.

Wells were installed at 25 locations throughout the four study areas. All wells were completed in glacial deposits except three which were completed in bedrock. Of these three, one well, near Port Huron, was completed in shale and two wells, south of Detroit, were completed in limestone. Lithologic data obtained during drilling confirmed and added detail to existing rock descriptions.

Water-level data indicate that ground-water movement is toward the connecting channels in all areas. Ground water discharges directly to connecting channels from 16 areas. Five of these are in the St. Marys River area, four are in the St. Clair River area, four are in the Lake St. Clair area, and five are in the Detroit River area.

Base flow of perennial streams and Darcy's Law are the basis for ground-water discharge estimates. Discharge to the channels is higher where more permeable bedrock forms the channel, such as in the southern reach of the Detroit River and in most of the St. Marys River. The following ground-water flow rates have been estimated for each study area: St. Marys River area, 76 ft^3/s; St. Clair River area, 11 ft^3/s; Lake St. Clair area, 46 ft^3/s; and Detroit River area, 54 ft^3/s.

Analyses of organic compounds, trace metals, and other dissolved substances were made on water from 31 wells to determine the chemical characteristics of ground water. Concentrations of volatile hydrocarbons generally were less than the detection limit and, therefore, estimates of transport to connecting channels was impractical. Base neutral and chlorinated neutral extractable compounds were detected more frequently than were volatile hydrocarbons, but information also is insufficient to make valid estimates of amounts entering the connecting channels. Estimates of the amounts of trace metals and other dissolved substances transported by ground water were not made because of the finely divided particulate matter in the water. Trace metals may have been adsorbed on the particulate matter, and thus, contributed significantly to the measured concentrations. If so, concentrations of trace metals in ground water discharged to the connecting channels could be much lower than anlayses indicate. No relation between water quality and land use was evident.

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DEFINITION OF TERMS

Altitude. Vertical distance of a point or line above or below sea level. In this report, all altitudes are above sea level.

Altitude contour. An imaginary line connecting points of equal altitude, whether the points are on the land surface or on a potentiometric or water-table surface.

Aquifer. A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs. It is also called a ground-water reservoir.

Base flow. The discharge entering stream channels as inflow from ground water or other delayed sources; sustained or fair weather flow of streams.

Bedrock. Designates consolidated rocks underlying glacial deposits.

Concentration. The weight of dissolved solids or sediment per unit volume of water expressed in milligrams per liter (mg/L) or micrograms per liter (µg/L).

Connecting channels. In this report, these bodies of water serve as conduits for the waters of the Upper Great Lakes (Superior, Michigan, and Huron) to drain into the lower Lakes (Erie and Ontario). The channels are the St. Marys, St. Clair and Detroit Rivers, and Lake St. Clair.

Discharge. The rate of flow of a stream; reported in cubic feet per second (ft^3/s). Also, in this report, the rate of flow of ground water to surface water bodies; reported in cubic feet per second per square mile [$(ft^3/s)/mi^2$].

Elevation. Vertical distance of a point on land or surface-water surface above or below sea level.

Grain size. The classification range for the diameter of particles, in millimeters, is as follows:

Gravel	greater than 2.0
Sand, very coarse	1.0 - 2.0
Sand, coarse	0.5 - 1.0
Sand, medium	0.25 - 0.5
Sand, fine	0.125 - 0.25
Sand, very fine	0.0625 - 0.125
Silt and clay	less than 0.0625

Ground water. Water that is in the saturated zone from which wells, springs, and ground-water runoff are supplied.

Ground-water runoff. Ground water that has discharged into stream channels by seepage from saturated earth materials.

Head. The height of the surface of a water column above a standard datum that can be supported by the static pressure at a given point.

Hydraulic conductivity. The volume of water at the prevailing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow. In general terms, hydraulic conductivity is the ability of a porous medium to transmit water.

Hydraulic gradient. The change in static head per unit distance in a given direction. If not specified, the direction is generally understood to be that of the maximum rate of decrease in head.

Permeability. A measure of the relative ease with which a porous medium can transmit a liquid under a potential gradient. It is a property of the medium alone, and is independent of the nature of the fluid and of the force field.

Potentiometric surface. In aquifers, the levels to which water will rise in tightly cased wells. More than one potentiometric surface is required to describe the distribution of head. The water table is a particular potentiometric surface.

Recharge. The process by which water is infiltrated and is added to the zone of saturation. It is also the quantity of water added to the zone of saturation.

Runoff. That part of precipitation that appears in streams; the water draining from an area. When expressed in inches, it is the depth to which an area would be covered if all the water draining from it in a given period were uniformly distributed on its surface.

Specific conductance. A measure of the ability of water to conduct an electric current, expressed in microsiemens per centimeter at 25 degrees Celsius (µS/cm). Because the specific conductance is related to amount and type of dissolved material, it is used for approximating the dissolved-solids concentration of water. For most natural waters, the ratio of dissolved- solids concentration (in milligrams per liter) to specific conductance (in µS/cm) is in the range of 0.5 to 0.8.

Water table. That surface in an unconfined water body at which the pressure is atmospheric. It is defined by levels at which water stands in properly constructed wells.

APPENDIXES

APPENDIX A: QUALITY ASSURANCE/QUALITY CONTROL PLAN FOR STUDY

Quality Assurance Project Plan
Upper Great Lakes Connecting Channels Study
U.S. Geological Survey
Denver, Colorado

APPROVED _____ DATE Sept 17, 1986
T. Ray Cummings, Project Officer
U.S. Geological Survey

APPROVED _____ DATE 9/25/86,
James L. Seeley, Chief, Branch of
Analytical Services, U.S. Geological Survey

APPROVED _____ DATE Sept. 17, 1986
John B. Miller, QA Officer
U.S. Geological Survey

APPROVED _____ DATE 10/20/86
, Project Officer
U.S. Environmental Protection Agency

APPROVED _____ DATE 11/3/86
, QA Officer
U.S. Environmental Protection Agency

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UPPER GREAT LAKES CONNECTING CHANNELS STUDY

Quality Assurance/Quality Control Plan [a/]

1. Project Name - Study of Ground-Water Movement near Upper Great Lakes Connecting Channels (Interagency Agreement No. DW14931558-01-0)
2. Date of Project Initiation - July 1, 1985
3. Project Officer - T. Ray Cummings
4. Project QA Coordinator - John B. Miller
5. Project Description -

A. Information and Objectives

Information on the movement of ground water to Great Lakes connecting channels in Michigan is inadequate for an evaluation of its impact on the water quality of the channels. Contaminants from landfills, waste-disposal sites, and areas of known ground-water contamination could be a significant factor in determining water quality of the Great Lakes, In areas adjacent to the St. Marys River, Lake St. Clair, the St. Clair River and the Detroit River, more than 100 hazardous waste sites lie within 12 miles of the channels. Five of these sites are on the National Priority List. Upward movement of chemical substances from deep geologic strata, either from natural sources or from areas of deep injection of wastes, is also a possibility.

The principal objectives of the study are to (1) determine the geologic conditions near connecting channels, (2) determine configuration of the water table and direction of ground-water flow, (3) determine the chemical and physical characteristics of ground water, with particular attention to characteristics near known hazardous-waste sites, (4) access the movement of dissolved substances from deep geologic strata to the connecting channels, and (5) assess the ground-water contribution of natural occurring substances to the connecting channels.

a/ The plan covers collection, sampling, and reporting of water-quality data. An Appendix providing related information on well installation is included.

B. Data Usage

Data on the chemical and physical characteristics of ground water must be collected to meet the principal objectives of the UGLCC (Upper Great Lakes Connecting Channels) project. Samples of water will be analyzed from wells installed at appropriate locations in the project area. These analyses, used in conjunction with existing chemical data, will form the basis for computing the amounts of dissolved chemical substances discharged to the connecting channels by ground water. In addition, chemical analyses will permit a determination of the relative importance of individual waste sites in affecting water quality of the channels, and suggest those locations where further monitoring and/or studies of a more detailed nature are merited.

C. Sampling Design and Rationale

Waste sites in the project area will be ranked using a modified DRASTIC procedure. Based on the ranking, those having the greatest potential for affecting the water quality of the connecting channels will be identified. Samples of ground water will be obtained for analysis from wells at, near, or downgradient from, each site. The specific locations of the sampling sites will be determined when ranking has been completed.

D. Sampling Parameters and Frequency of Collection

Samples for laboratory analysis of ground water will be collected at sites within a 12-mile band adjacent to the St. Marys River, the St. Clair River, Lake St. Clair, and the Detroit River in Michigan. Each well will be sampled once. Attachment 1 shows the chemical analyses to be made. Approximately 30 samples will be obtained.

E. Parameter Table (See Attachment 1)

F. Analytical Method and Documentation

Standard operating procedures are contained in Skougstad and others (1979), and Wershaw and others (1983), which are cited uner REFERENCES at the end of this plan. Footnotes to Attachment 1 also cite minor modifications methods.

6. Schedule of Tasks and Products

Attachment 2 shows the anticipated time frame for the sampling, laboratory analysis reporting, and interpretation of ground-water quality data obtained as part of this project.

7. Organization and Responsibility

A. Project

T. Ray Cummings, District Chief, WRD, USGS

(Overall Quality Assurance/Quality Control, Overall Project Coordination, Overall Data Interpretation and Reporting)

Sampling

B. Laboratory organization and responsibility

(Analytical work will be performed in the USGS Denver Laboratory. Telephone numbers are FTS 303-776-5345, commercial (303-236-5345)

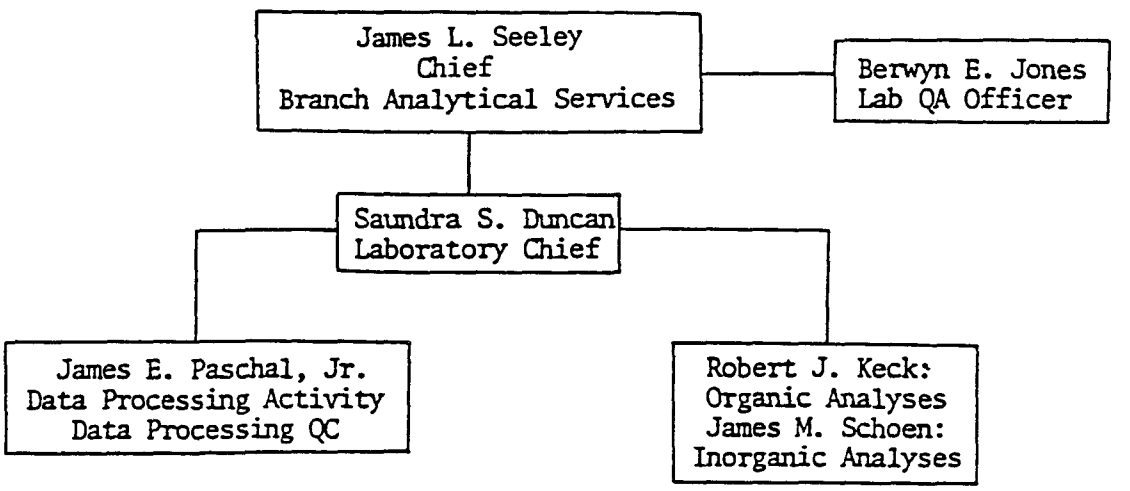
Laboratory Analyses - Robert J. Keck
James H. Schoen

Laboratory QC - Berwyn E. Jones

Data Processing Activity - James E. Paschal, Jr.

Data Processing QC - James E. Paschal, Jr.

Laboratory organization and responsibility - Continued



8. Data Quality Requirements and Assessments (See Attachment 3)

(a) Accuracy

Accuracy will be measured by calculating % Recovery of Surrogate and/or matrix spikes. % Recovery is calculated as follows:

$$R=\frac{100(F-I)}{A}$$

where R = % recovery

F = analytical result obtained on the spiked sample (μg/L)

I = analytical result obtained on unspiked sample (μg/L)

A = concentration of spike added to the sample (μg/L)

Surrogate spikes will be added to every sample, blank and standard for VOC, BNA, and CNE. Matrix spikes will be employed, as applicable, for other parameters.

(b) Precision

Precision will be measured by calculating the Relative Percent Difference (RPD) between duplicate analyses. RPD is calculated as follows:

$$RPD=\frac{200(A-B)}{A+B}$$

where RPD = Relative Percent Difference

A = Analytical result obtained on one of two duplicate analyses

B = Analytical result obtained on second duplicate analyses

(c) Data Completeness

The following will be used as validation criteria for data completeness:

1. The samples will be analyzed for all parameters requested.
2. Acceptance criteria rely more heavily on surrogate recoveries than on matrix recoveries and duplicate values:

   a. If all surrogate and matrix spikes recovery values are within acceptance limits, and there is no blank contamination, all data are acceptable.

b. For organic analyses, the blank shall not contain more than the quantitation limit of any analyte except methylene chloride, benzene, toluene, and common phthalate esters. The above named constituents in a blank shall not exceed two times the quantitation limit.

For inorganic analyses, the blank shall not contain more than two times the quantitation limit for any analyte.

c. Duplicate values exceeding the relative percent difference limit do not by themselves warrant data rejection. Duplicate values should be evaluated with other QA data on a case-by-case basis.

d. Matrix recovery values which exceed acceptance limits do not by themselves warrant data rejection. Matrix recovery values should be evaluated with other QA data on a case-by-case basis.

e. Recovery values of matrix spikes that fall outside the acceptance limits are considered on a case-by-case basis. Generally, if more than half of the recovery data are outside acceptance limits, the data are rejected.

9. Sampling Procedures

Samples of water from wells will be collected using a custom fabricated all Teflon Kemmerer sampler, or by using a submersible pump and R-3400 Tygon tubing. Prior use in the field sampling equipment will be scrubbed with tap water (and detergent if necessary), and rinsed with tap water, followed by several rinses with distilled water. A final rinse and/or wiping with alcohol will be made. In the field, samplers will be rinsed and/or wiped with alcohol and allowed to dry between samplings. Water from the sampler will be transferred to sample containers with minimum agitation. USGS Central Laboratories Request Forms (Attachment 4) will be completed in the field at the time of sampling. Samples will be placed in a cooler in ice for air mailing to the laboratory. Samples for analysis of organic compounds will be double (zip-locked) bagged.

Sample containers will be obtained from the USGS Denver Central Laboratory. Glass containers for organic analyses will be washed, rinsed with organic compound-free water and fired overnight at 350°C. Polyethylene and glass containers for inorganic trace-metal constituents will be acid-rinsed with dilute nitric acid. The following table shows sample size and type of container.

Parameter	Sample Size	Container
VOC	40 mL[1/]	Glass
BNA	1000 mL	Glass
CNE	1000 mL	Glass
4-AAP phenols	1000 mL	Glass
Solvent Extractables	1000 mL	Glass
Nutrients	250 mL	High density polyethylene
TOC	125 mL	Glass
Cyanide	250 mL	High density polyethylene
Mercury	200 mL	Glass
Trace metals	1000 mL	High density polyethylene
As, Se, Sb	250 mL	High density polyethylene

[1/] Duplicate samples are to be submitted for VOC.

10. Sample Tracking Procedures

A. Source of containers

1. 40-mL VOC vial glass, washed, rinsed with deionized water, and fired.
2. 1-L glass bottle, washed, rinsed with deionized water, and fired.
3. 4-oz. glass TOC, washed, rinsed with deionized water, and fired.
4. 8-oz. glass Hg, washed with dilute HNO_3, and rinsed with deionized water.
5. 8-oz., 32-oz. Polyethylene, washed with dilute HNO_3, and rinsed with deionized water.
6. 8-oz. Polyethyene, non-acid-rinsed.

B. Quality control of containers

Field personnel will order the entire season's anticipated container requirements by April. All containers of each type will be prepared in a single batch and capped immediately to avoid contamination. For each container type, 3 percent of the shipment will be taken as a random sample for quality control.

In the quality control procedure, containers will be filled with Type I water, and the appropriate preservative, if any, added. The water will be submitted to the laboratory as sample for analysis. If any analyte is found at a concentration greater than three times the quantitation limit, a new batch of the bottle type will be prepared. Containers will be immediately sealed after preparation and, if found free of contamination, will be shipped to the field office.

11. Calibration Procedures and Preventive Maintenance

Procedures for calibration and quality control for inorganic and gas chromatographic determinations are contained in Friedman and Erdmann (1982).

Standard spectrometers are tuned to meet USEPA specifications using BFB and DFTPP for VOC and BNA, respectively. Organic standard solutions are obtained from USEPA or Supelco, Inc. Stock solutions are prepared in the laboratory. Pesticide grade solvents are used (Burdick and Jackson, or equivalent).

Most maintenance will be performed on an as-needed basis. Adequate supplies of field and laboratory materials will be maintained to be available as needed. Redundance of instrumentation is available and most instruments are under manufacturer's preventive maintenance contract.

An equipment log book, which remains with the instrument except when instrument is sent out for repairs, is maintained. The log book contains records of usage, maintenance, calibration, and repairs.

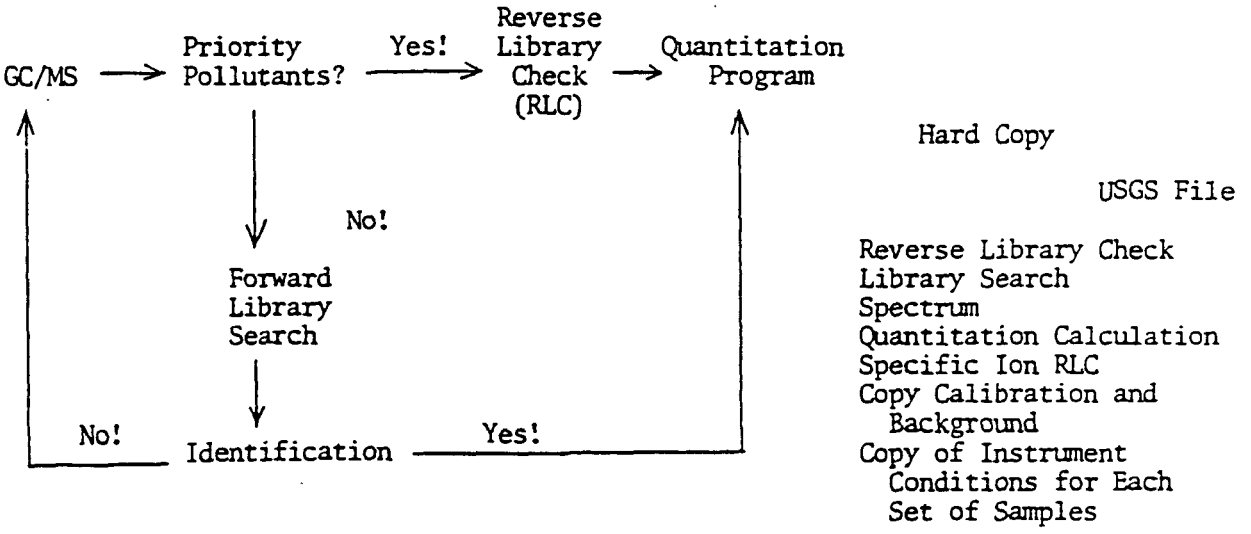
12. Documentation, Data Reduction, and Reporting

A. Documentation

Field data are recorded on USGS Central Laboratory Request Forms, and in U.S. Department of Interior approved DI-6 field note books.

B. Data Reduction and Reporting

The data reduction scheme, principal criteria used to validate data, and methods used to treat outliers are contained in Friedman and Erdman (1982), Wershaw and others (1983), and Skougstad and others (1979). The data flow and reporting scheme for organic compounds in the laboratory are as follows:



The key individual who handles data in the organic laboratory is Ralph White. A chemist will review the data and check for calculation errors for every analysis; a second chemist will review the data again for errors; data will be entered into the computer file, and then checked for data transfer errors. The key individual who handles data in the inorganic lab is James Schoen. Other chemists will check data and calculations; data will be entered into the computer file, and then will be checked for transfer errors.

13. Data Validation

Surrogate recoveries, precision estimates of the duplicate sample, and laboratory blanks will be checked.

The laboratory will perform checks by using replicates, spikes, and reagent blanks. Surrogates will be added to each organic compound analysis, and method blanks and matrix spikes will be used for each set. Control charts will be used as applicable for recovery and repeatability.

Data from the laboratory will be reviewed by the QA official for the project, and then will be sent to the District water-quality specialist. Data approved by the water-quality specialist or project chief will be placed in WATSTORE file, the QA official will check the data to assure accurate transcription.

14. Audits

U.S. Geological Survey laboratory has successfully performed when autited during the past six months.

15. Corrective Action

When routine QA/QC procedures indicate there is a problem with accuracy, precision, completeness, or representatives of data, then corrective action will be instituted. This action may include:

1. Repair or recalibration of equipment.
2. Retraining or reassignment of personnel.
3. Identifying and removing sources of contamination.

Field and laboratory personnel will report any problems with instruments, analysis, or anomalous data to supervisors. Supervisors will report problems and solution of problem to QA project member.

All data will be reviewed against QA requirements. Results not meeting these criteria will be rejected unless results are decided to be mutually acceptable to USEPA and USGS. If the data are rejected, samples will be reanalyzed. When samples are exhausted, a mutual decision between USGS and EPA will be made to determine wheter re-sampling will be done.

16. Reports

Laboratory reports will be provided for the overall project at the completion of sample analysis. The reports will contain quality assurance/ quality control information, results of any performance or system audits, and proposals for corrective action if required.

REFERENCES

American Public Health and others, 1985, Standard methods for the examination of water and wastewater (16th ed): Washington, D.C., American Public Health Association, Inc., 1268 p.

Friedman, L. C., and Erdmann, D. E., 1982, Quality assurance practices for the chemical and biological analyses of water and fluvial sediments: U.S. Geological Survey Techniques of Water Resources Investigations, Book 5, Chapter A6, 181 p.

Longbottom, J. E., and Lichtenberg, J. J., eds., 1982, Methods for organic chemical analysis of municipal and industrial waste water: U.S. Environmental Protection Agency, Report No. 600/4082-057.

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Wershaw, R. L., Fishman, M. J., Grabbe, R. R., and Lowe, L. E., eds., 1983, Methods for the determination of organic substances in water and fluvial sediments: U.S. Geological Survey Open-File Report.

APPENDIX

DESIGN AND CONSTRUCTION OF WELLS

General

Monitoring wells for collecting water-quality samples and observation wells for collecting water-level data will be installed by a contract drilling company according to USGS (U.S. Geological Survey) designed specifications. Personnel of the USGS will supervise well installation and will compile a written lithologic log as drilling progresses. Most drilling will be with a hollow-stem continuous auger and/or cable tool. At sites where bedrock is at or very near surface, air rotary may be used. The wells will be completed in either glacial deposits or bedrock and will penetrate to at least 5 feet below the water table or 4 feet into the aquifer. Casing and screens will be steam-cleaned to ensure that all oils, greases, and waxes are removed. Concrete grout will be used to seal the upper most 5 to 10 feet of annular space. All wells will be capped with a galvanized steel cap and locked.

Samples of rock materials will be collected at 5-foot intervals and at significant changes in lithology. A split-spoon sampler or bailer will be used to retrieve samples. Well development, with steam-cleaned equipment, will proceed until the discharge water is clean and free of sediment to the extent possible.

A survey point will be established, usually on the north side, from which water-level measurements are made. A survey will be made to determine the altitude of the point.

Monitoring Wells

All monitoring wells[a/] will be constructed of 4-inch diameter stainless steel 316 threaded casing in the saturated zone and 4-inch diameter galvanized steel in the unsaturated zone. The drilled hole will have a 6-inch diameter allowing for an annular space of about a 1-inch radius for placement of the filter pack and annular-space seal (bentonite pellets, bentonite, and neat cement). In bedrock, the zone being sampled will be finished as open hole with a filter pack (clean quartz sand or chemically inert beads. Annular-space seal will be installed around the casing above the open hole unless the formation is cohesionless sand or gravel. In glacial deposits, the zone being sampled will be finished with a 4-foot, stainless steel 316 screen set in place with a K-packer. A filter pack will be placed in the annular space around the screen and about 1-foot above. Annular-space seal will be added above the filter pack if the formation is other than cohesionless sand or gravel.

Observation Wells

All observation wells will be constructed of 4-inch diameter galvanized steel casing. The drilled hole will have the same diameter as the casing. During drilling the drill bit and casing will proceed down the hole almost simultaneously in order that no annular space will occur in the hole below a depth of 5 to 10 feet. No drilling mud will be used. In bedrock, the zone being tested will be finished with 4-foot stainless steel screen set in place with a K-packer. The annular space in the upper 5 to 10 feet of the hole resulting from removal of the work pipe will be grouted.

[a/] Monitoring wells will be constructed in accordance with Ground Water Technical Enforcement Guidance Document: March 21, 1985 prepared by the Office of Solid Waste and Emergency Response, USEPA.

ATTACHMENT 1

Parameter Table

Parameter	Analytical[1/] Method Reference	Sample Preservation	Maximum Holding Time
4-AAP Phenols	0-3110-83	LC 0052[2/]	14 days
Solvent Extractables	0-3108-83[3/]	LC 0127[4/]	30 days
Ammonia Nitrogen	I-4522-85	RC[5/]	4 days
Phosphorus	I-4600-78	RC	4 days
TOC	0-3100-83	LC 0114[6/]	14 days
Chloride	I-2188-83	FU[7/]	28 days
TDS	Std. Methods 209B	RU[8/]	30 days
Cyanide	I-4302-78	LC 0023[9/]	14 days
Arsenic	I-4062-78	RAH[10/]	6 months
Barium	I-1472-78[11/]	RA[12/]	6 months
Beryllium	I-1472-78	RA	6 months
Cadmium	I-3136-78 or I-1472-78	RA	6 months
Cobalt	I-3240-78 or I-1472-78	RA	6 months
Chromium, total	I-3238-78	RA	6 months
Copper	I-3271-78 or I-1472-78	RA	6 months
Iron	I-3381-78 or I-1472-78	RA	6 months
Mercury	I-3462-78	RAM[13/]	28 days
Nickel	I-3500-78	RA	6 months
Lead	I-3400-78	RA	6 months
Selenium	I-4667-78	RAH	6 months

Parameter Table (cont.)

Parameter	Analytical Method Reference	Sample Preservation	Maximum Holding Time
Zinc	I-1472-78	RA	6 months
Antimony	I-3055-78	RAH	6 months
VOC 14/	0-3115-83 or EPA Method 624	GVC 15/	14 days
BNA 16/	0-3118-83,0-3117-83 or EPA Method 625	GCC 17/	Extract sample - 7 days Analyze - 40 days
CNE 18/	0-3104-83 or EPA Method 608	GCC	Extract sample - 7 days Analyze - 40 days

FOOTNOTES

1/ As specified in REFERENCE Section.

2/ Add 2 mL 8.5% H_3PO_4 (to pH 4) and 10 mL $CuSO_4$ solution (100 g/L) to 1 L sample. Chill and maintain at 4°C.

3/ A FID scan with methylene chloride extraction will be used to obtain a detection limit of 0.01 mg/L if detection of solvent extractables is significant.

4/ Add 2.0 mL H_2SO_4 to 1 L (to pH 2). Chill and maintain at 4°C.

5/ Add 1 $HgCl_2$/NaCl tablet or ampoule, chill and maintain at 4°C.

6/ Acidify with H_2SO_4 to pH<2.0. Chill sample and maintain at 4°C.

7/ Filter sample.

8/ Untreated.

9/ Add NaOH to pH >12, chill and maintain at 4°C.

10/ Acidify with HNO_3 to pH <2. A separate bottle is required for the arsenic, selenium, and antimony determinations.

11/ ICP procedure will include digestion step.

12/ Acidify with HNO_3 to pH <2.

13/ Add 1 $HNO_3/K_2Cr_2O_7$, ampoule.

14/ VOC = Volatile Organics Compounds.

15/ Exclude air bubbles by completely filling vial. Protect sample from sunlight, chill, and maintain at 4°C.

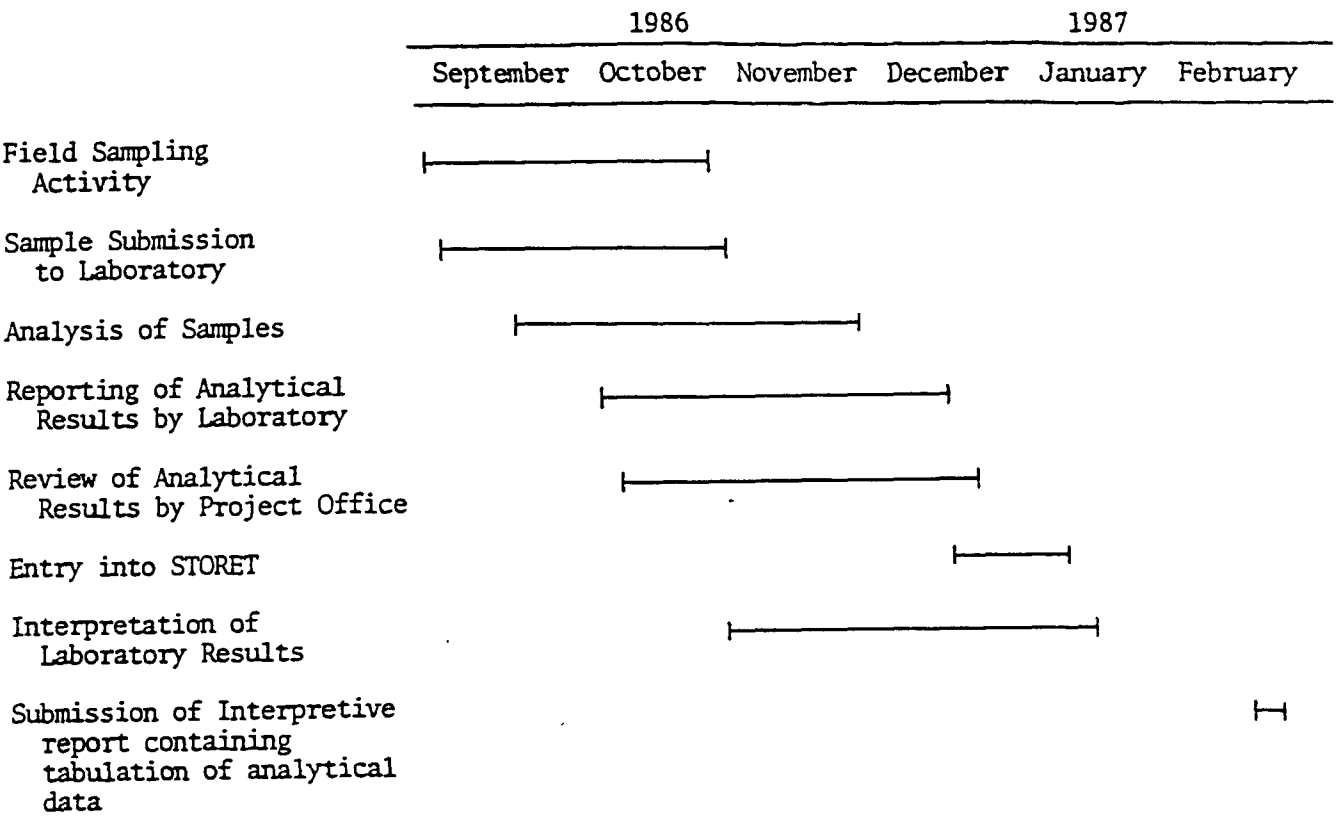
16/ BNA = Base/Neutral/Acid Extractables.

17/ Chill sample and maintain at 4°C.

18/ CNE = Chlorinated Neutral Extractables.

ATTACHMENT 2

Schedule of Activities



ATTACHMENT 3

Data Quality Requirements and Assessments

Parameter	Quantitation Limit (mg/L)	Sample Matrix	Estimated[1] Accuracy	Accuracy Protocol	Estimated[1] Precision	Precision Protocol
4-AAP phenols	0.001	G.W.[2]	70-130	SRM[3] MB[4]	<30% RPD	Replicate Sample
Solvent Extractions	1.0[3]	G.W.	70-130	MB	<30% RPD	"
Ammonia Nitrogen	.014	G.W.	80-120	SRM MB	<20% RPD	"
Phosphorus	.009	G.W.	"	SRM MB	"	"
TOC	0.5	G.W.	"	MS[5] MB	"	"
Chloride	1.0[6]	Filtered G.W.	"	SRM MB	"	"
TDS	2.0	G.W.	"	SRM MB	"	"
Cyanide	0.005	G.W.	"	SRM MB	"	"
Arsenic	0.001	G.W.	"	SRM MB	"	"
Barium	0.01	G.W.	"	"	"	"
Beryllium	0.001	G.W.	"	"	"	"
Cadmium	0.001	G.W.	"	"	"	"
Cobalt	0.002	G.W.	"	"	"	"
Chromium, total	0.002	G.W.	60-140	SRM MB	<40% RPD	"
Copper	0.001	G.W.	80-120	SRM MB	"	"
Iron	0.046	G.W.	"	SRM MB	"	"

Data Quality Requirements and Assessments (cont.)

Parameter	Quantitation Limit (mg/L)	Sample Matrix	Estimated Accuracy	Accuracy Protocol	Estimated Precision	Precision Protocol
Mercury	0.001	G.W.	80-120	SRM MB	<30% RPD	Replicate Samples
Nickel	0.001	G.W.	"	SRM MB	"	"
Lead	0.001	G.W.	70-130	SRM MB	"	"
Selenium	0.001	G.W.	80-120	SRM MB	"	"
Zinc	0.003	G.W.	"	SRM MB	"	"
Antimony	0.001	G.W.	"	SRM MB	"	"
VOC	1-5 µg/L	G.W.	70-130	SS 7/, MS MB	"	"
Base Neutral Extractables	5-10 µg/L	G.W.	40-120	SS, MS MB	"	"
Acid Extractables	5-40 µg/L	G.W.	20-120	SS, MS MB	"	"
CNE	0.005-0.040 µg/L	G.W.	70-130	SS, MS MB	"	"

FOOTNOTES

1/ At 10X quantitation limit.

2/ G.W. = Ground Water.

3/ SRM = Standard Reference Material.

4/ MB = Method Blank.

5/ MS = Matrix Spike.

6/ A quantitation limit of 1.0 mg/L is satisfactory because concentration levels in project study are known to exceed 1 mg/L.

7/ SS = Surrogate Spike.

Frequency: SRMs: 1 per 10 samples
Duplicates: 1 per 20 samples
Blanks: 1 per 20 samples
Matrix spikes: 1 per 10 samples
Each set of samples will contain at least one of each of the above.

CENTRAL LABORATORIES ANALYTICAL SERVICES REQUEST FORM ATTACHMENT 4

Special Handling (Circle as appropriate and explain in record 5)

Hazardous material

Field Sample ID

Site Type (circle one)

SW - Surface Water **LK - Lake**
GW- Ground Water **ES - Estuary**
PR - Precipitation **SP - Spring**

Station Name | Field Office | Project | Collector | Phone (FTS)

File Deposition (Circle one)

Q - WATSTORE
X - Lab File

Record 1 - Sample Identification

Laboratory ID | Station ID or Unique Number

Year | Month Day Begin Date | Time | Month Day Composite End Date | Time | State Code | District/ User Code | County Code | Project Account #

Record 2 - Analysis codes and schedules

Sample Medium | Geologic Unit | H or 9 Analysis Status | Analysis Source | Hydrologic Condition | Sample Type | Hydrologic Event

Schedule #1 | Schedule #2 | Schedule #3 | Schedule #4 | Schedule #5

Record 3 - Laboratory codes to be added to (A) or deleted from (D) above schedules

Code A/D Code A/D Code A/D Code A/D Code A/D Code A/D Code A/D Code A/D Code A/D

Code A/D Code A/D Code A/D Code A/D Code A/D Code A/D Code A/D Code A/D Code A/D

Record 4 - Field values to be added to analysis.

WATSTORE Code	Lab Code	Value	Remark Code	WATSTORE Code	Lab Code	Value	Remark Code	WATSTORE Code	Lab Code	Value	Remark Code
00065 Gage Height	332 (ft)			00061 Discharge,	61 Instantaneous (cfs)			72008 Well Depth	308 (ft)		
82398 Sampling	1201 Method Code			00020 Air Temp.	65 (C°)			00010 Water Temp.	64 (°C)		
00095 Specific	21 Conductance (umhos)			00400 pH, Field	51			00025 Barometric	1167 Pressure (mm µg)		
00300 Dissolved	25 Oxygen (mg/L)			00410 Alkalinity,	2 Field (mg/L)						

Records 5, 6 - Comments (limit to 138 characters)

Record 5

Record 6

Total Number of containers for this request: _____

GPO 677-533 1983

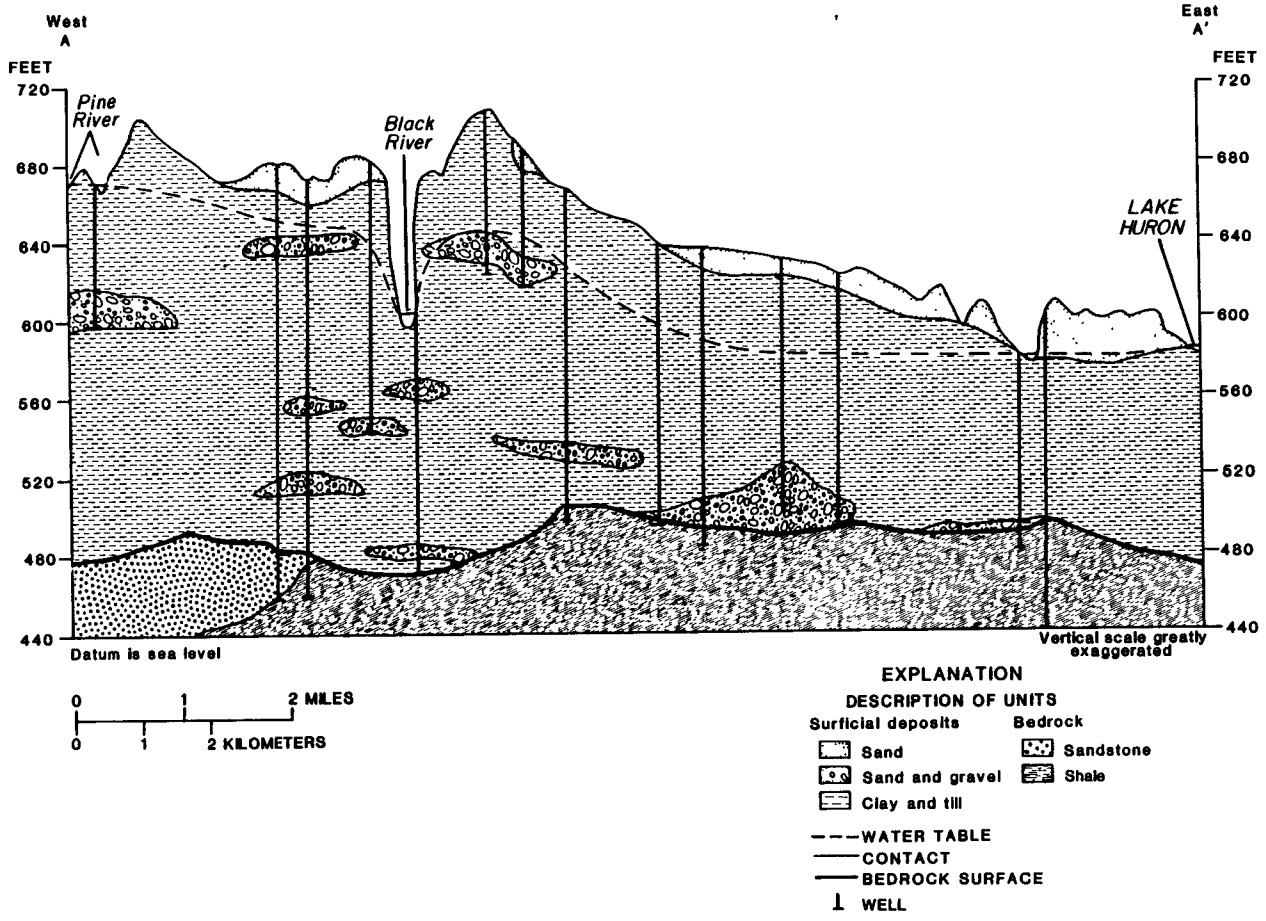


Figure 14.--Geologic section A-A', near Port Huron, Michigan.

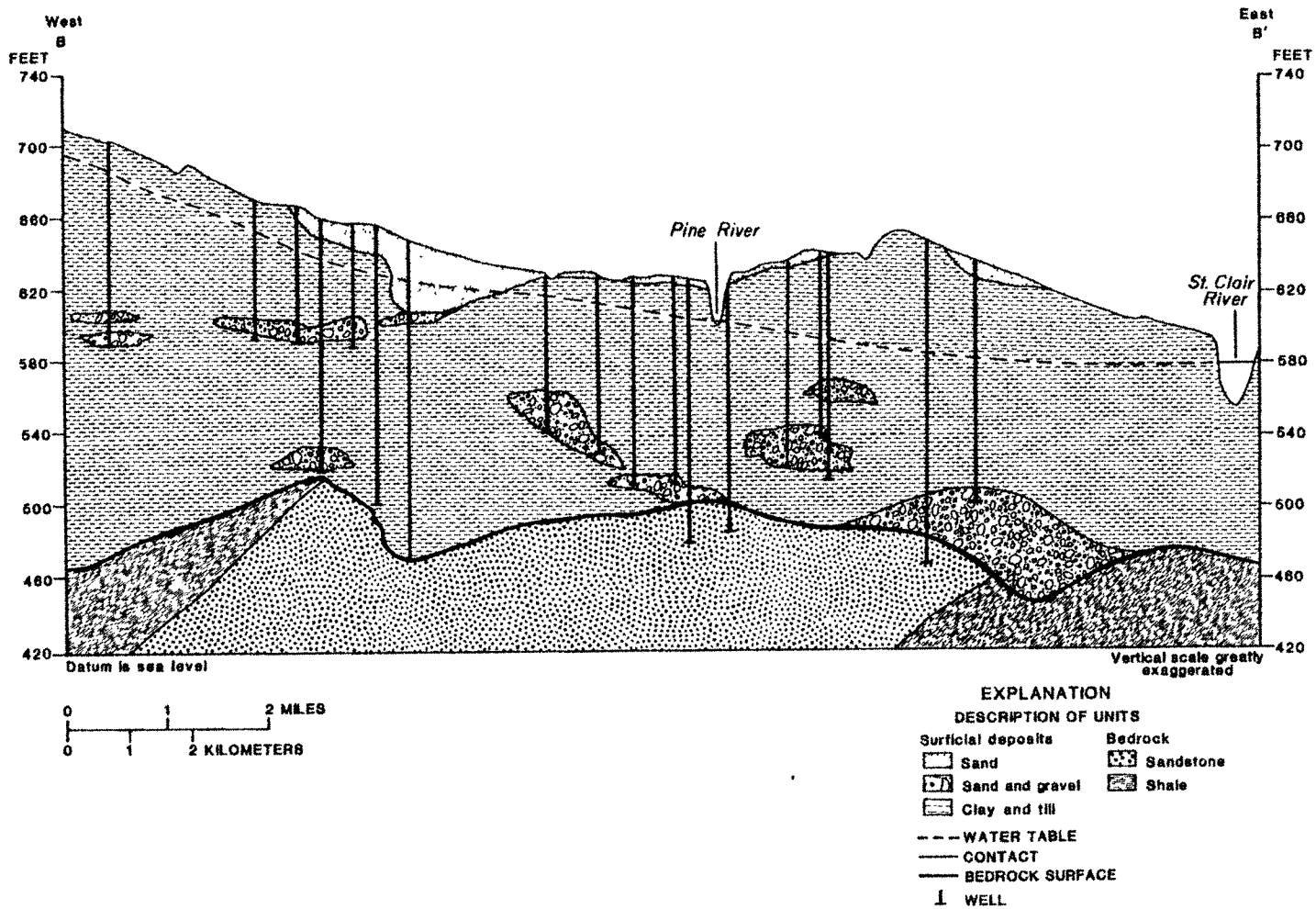


Figure 15.--Geologic section B-B', near Marysville, Michigan.

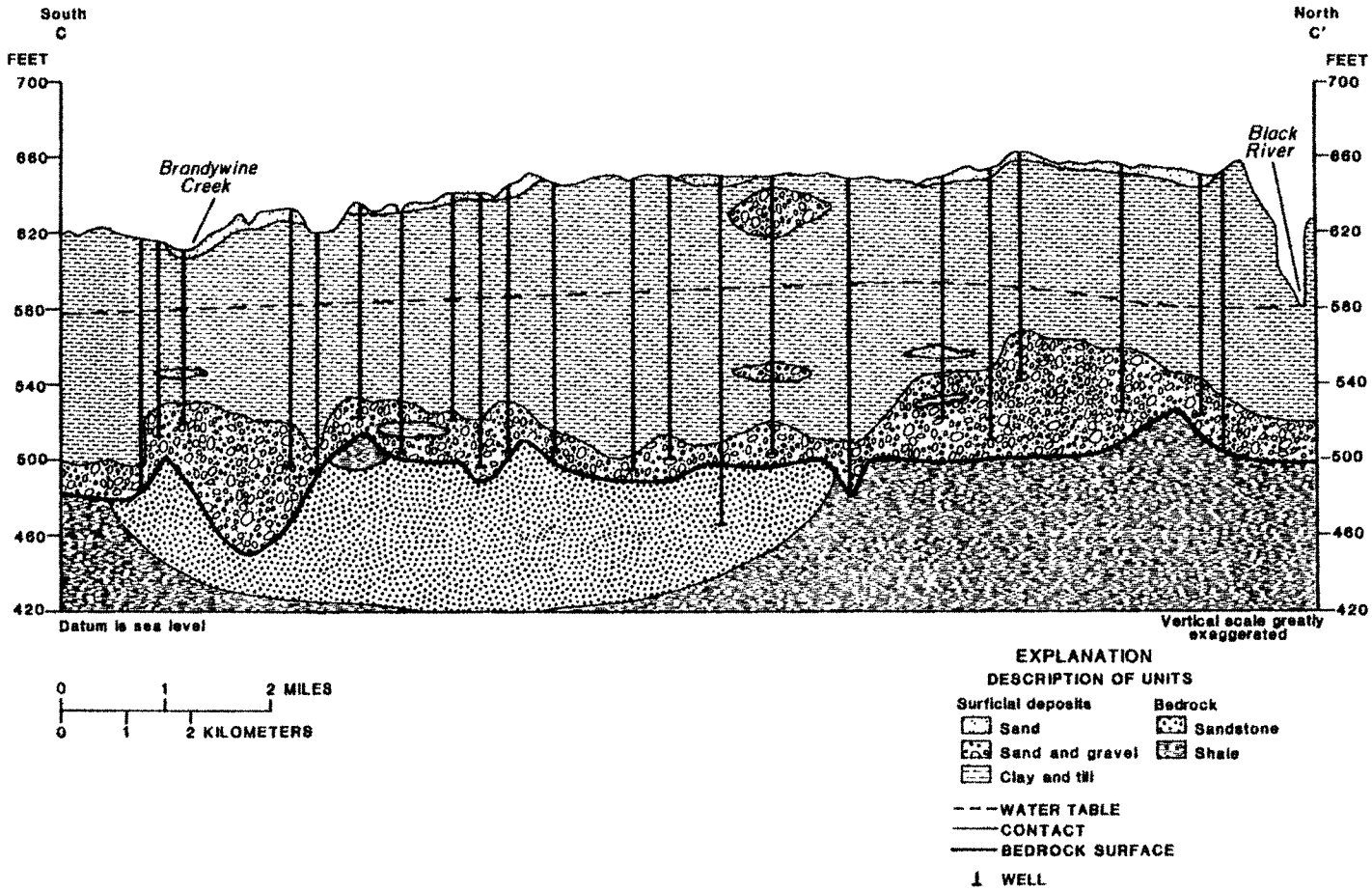


Figure 16.--Geologic section C-C', near Port Huron, Michigan.

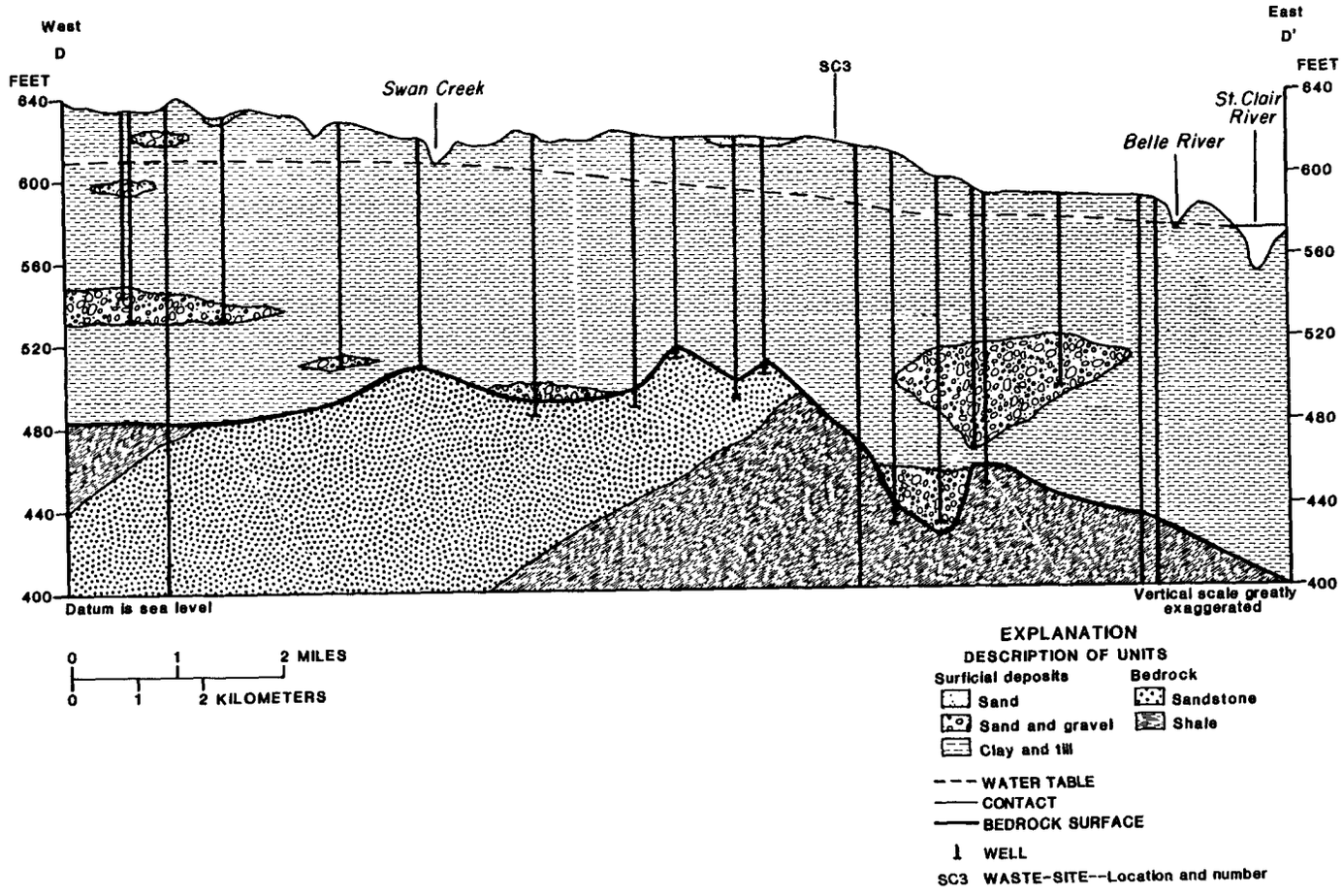


Figure 17.--Geologic section D-D', near Marine City, Michigan.

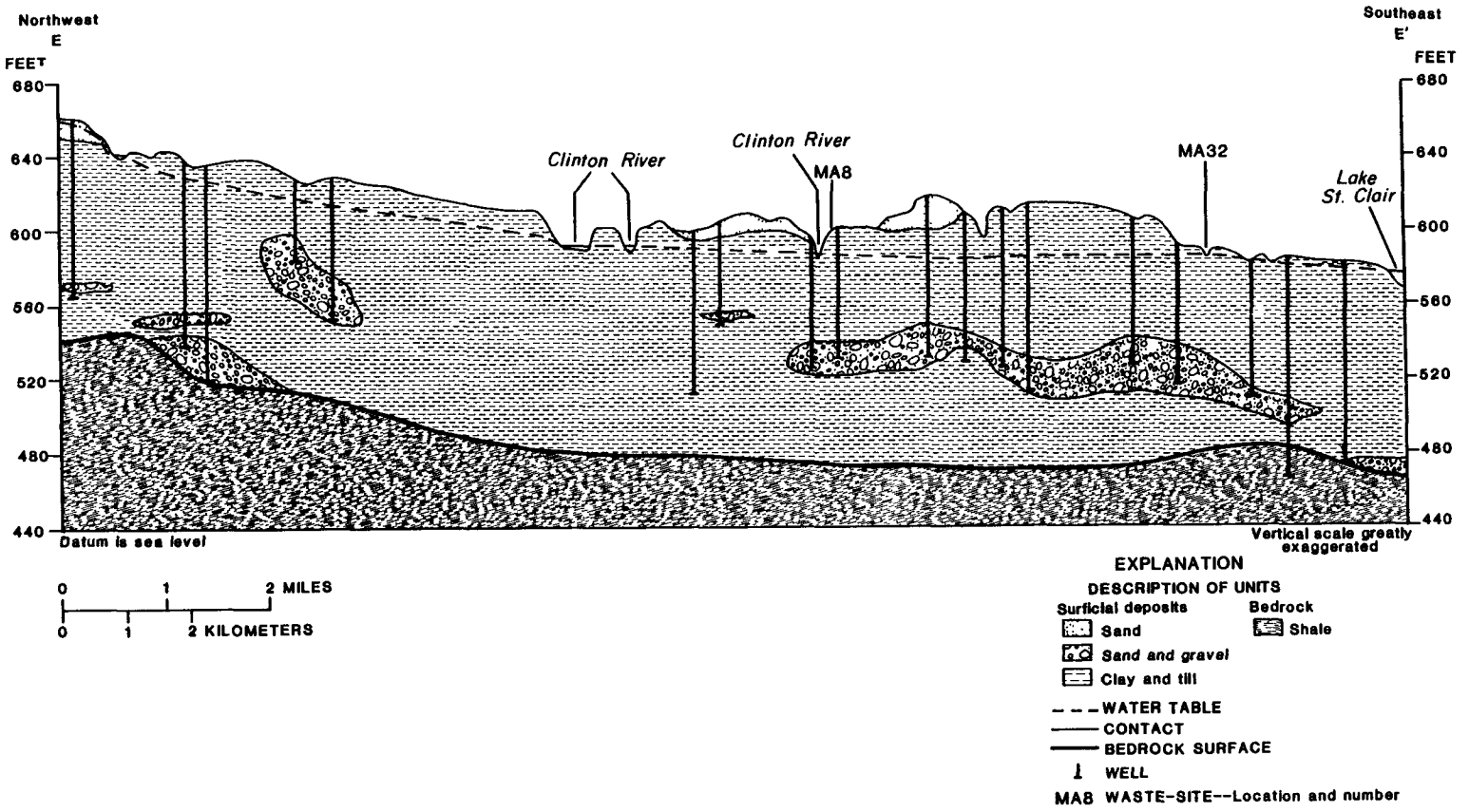


Figure 18.--Geologic section E-E', near Fraser, Michigan.

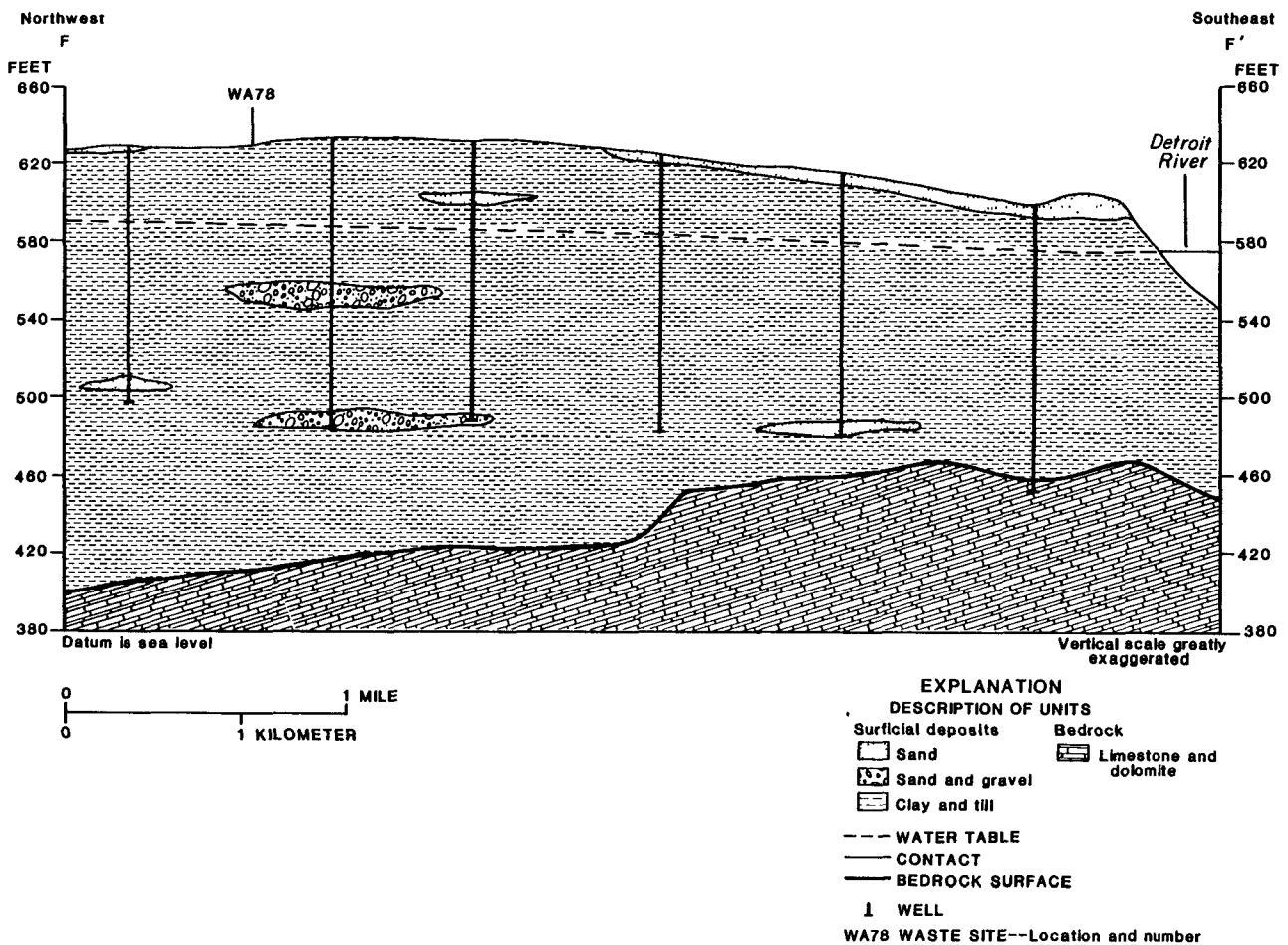


Figure 19.--Geologic section F-F', in Detroit, Michigan.

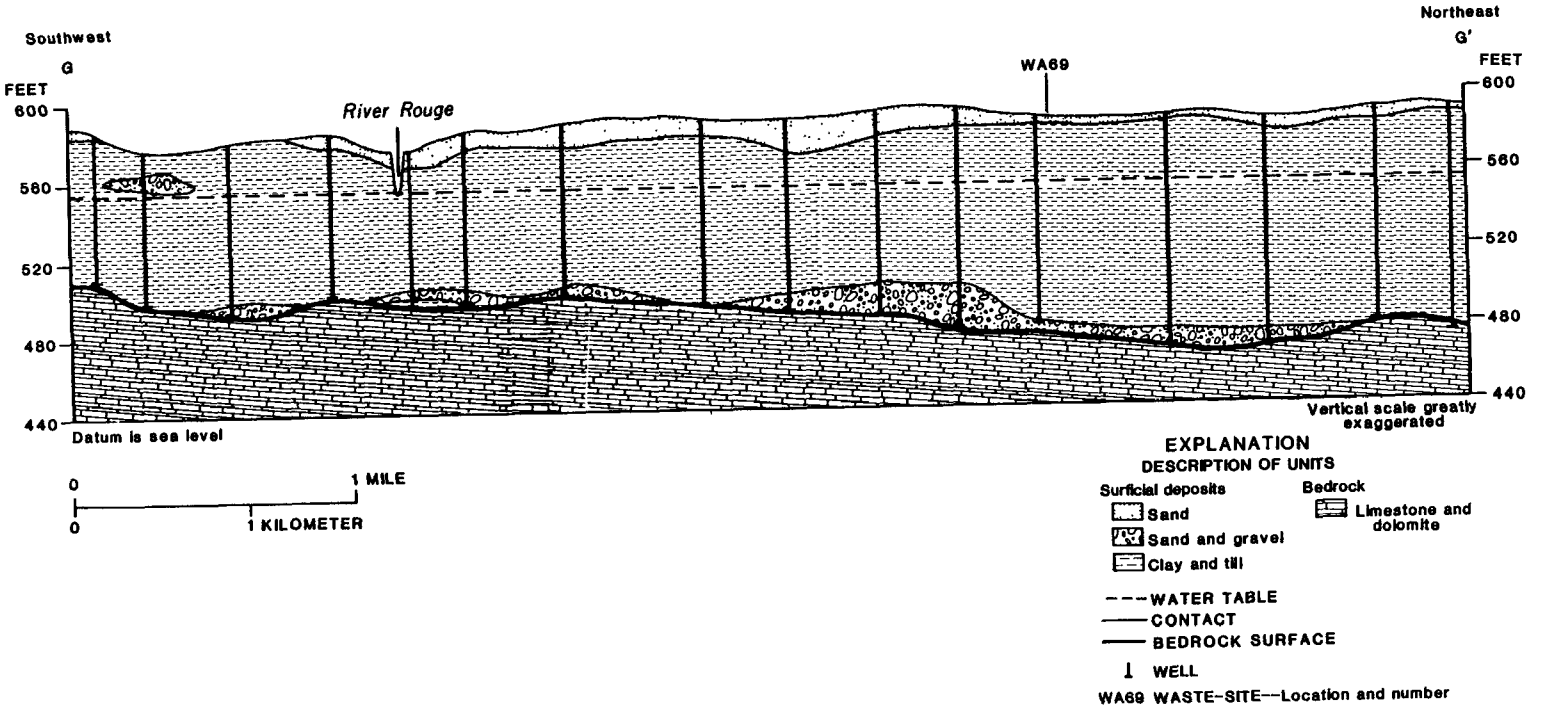


Figure 20.--Geologic section G-G', in Detroit, Michigan.

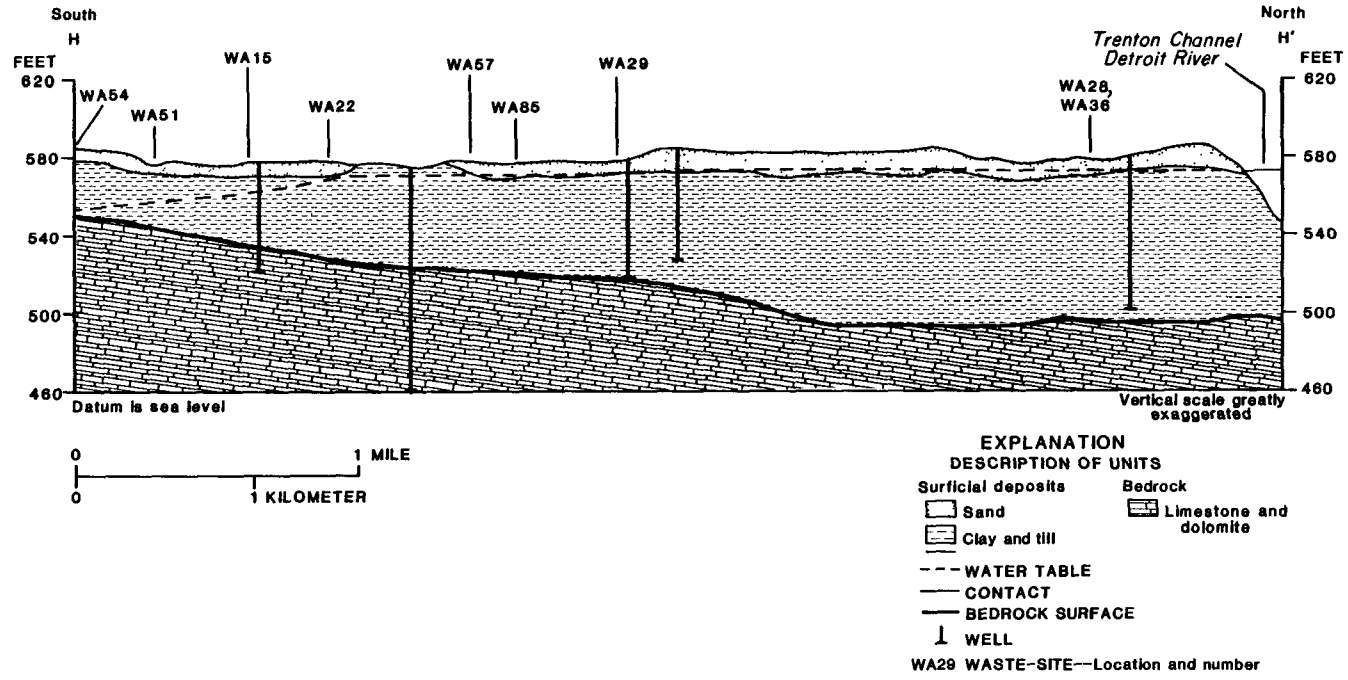


Figure 21.--Geologic section H-H', near Wyandotte, Michigan.

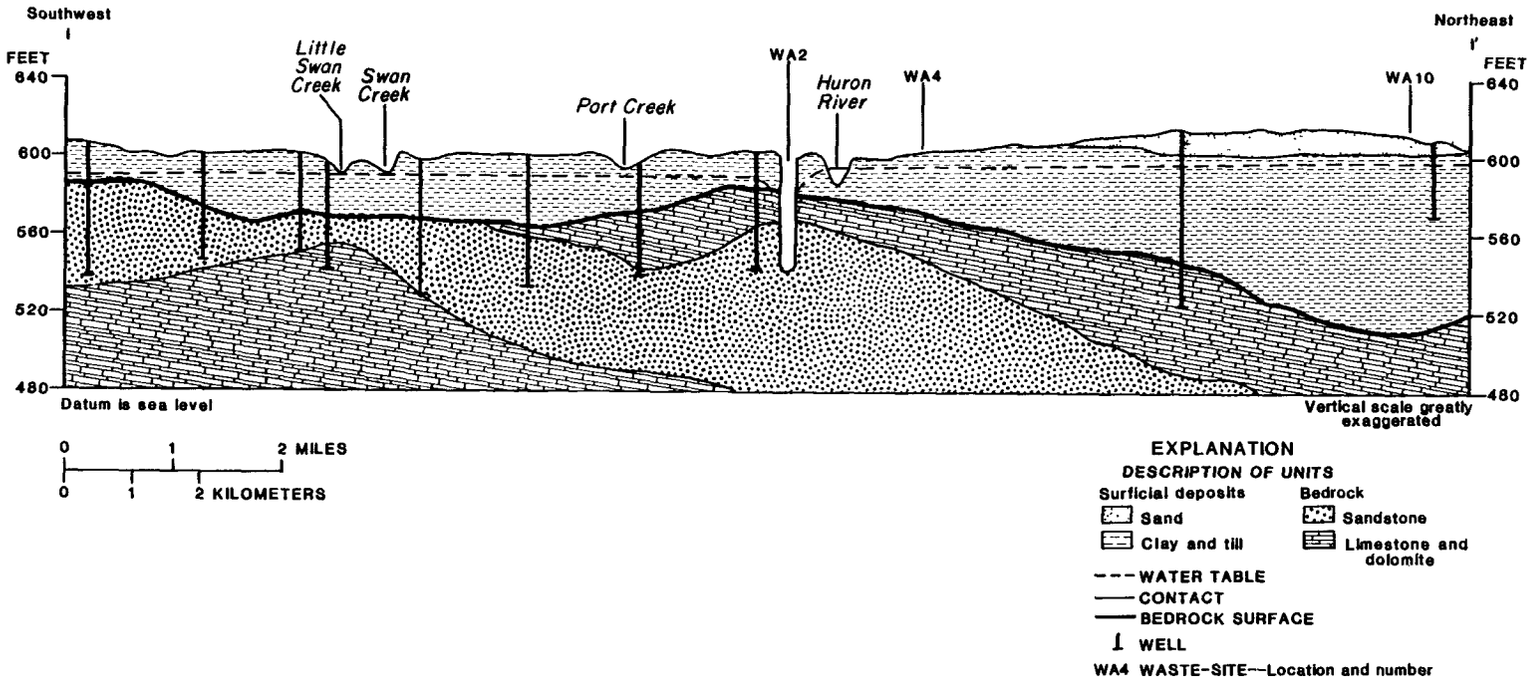


Figure 22.--Geologic section I-I', near Flat Rock, Michigan.

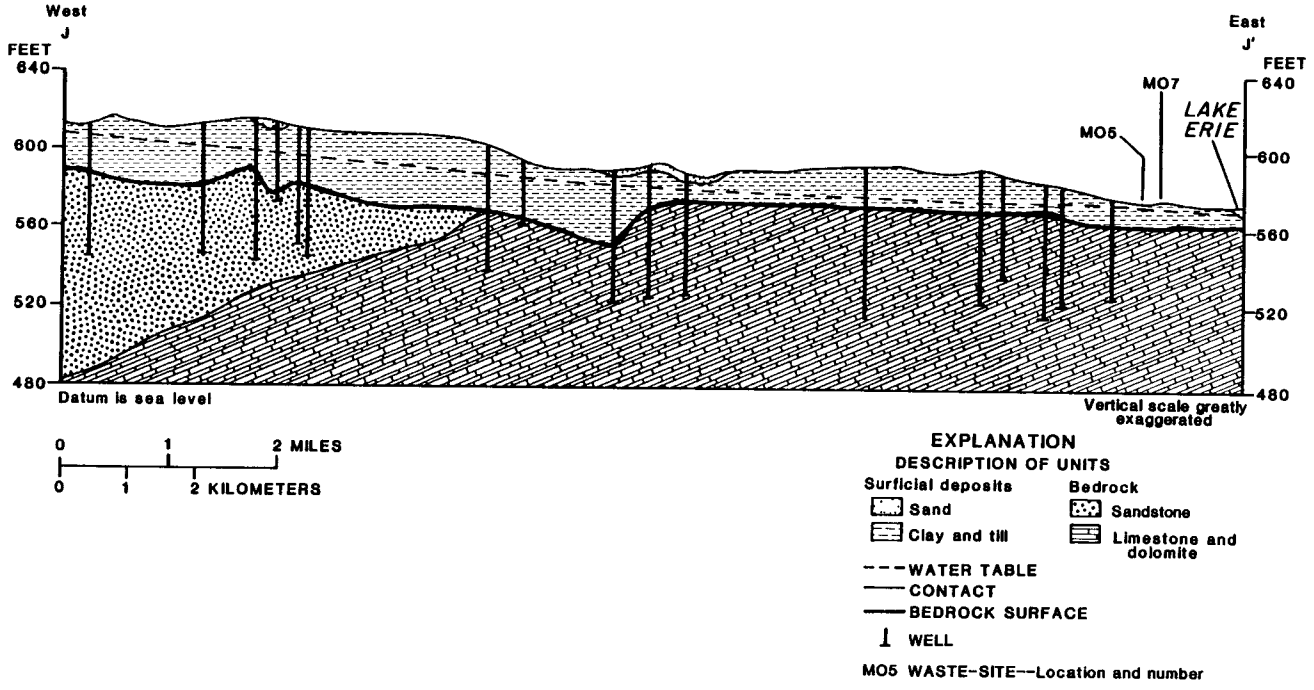


Figure 23.--Geologic section J-J', south of Rockwood, Michigan.

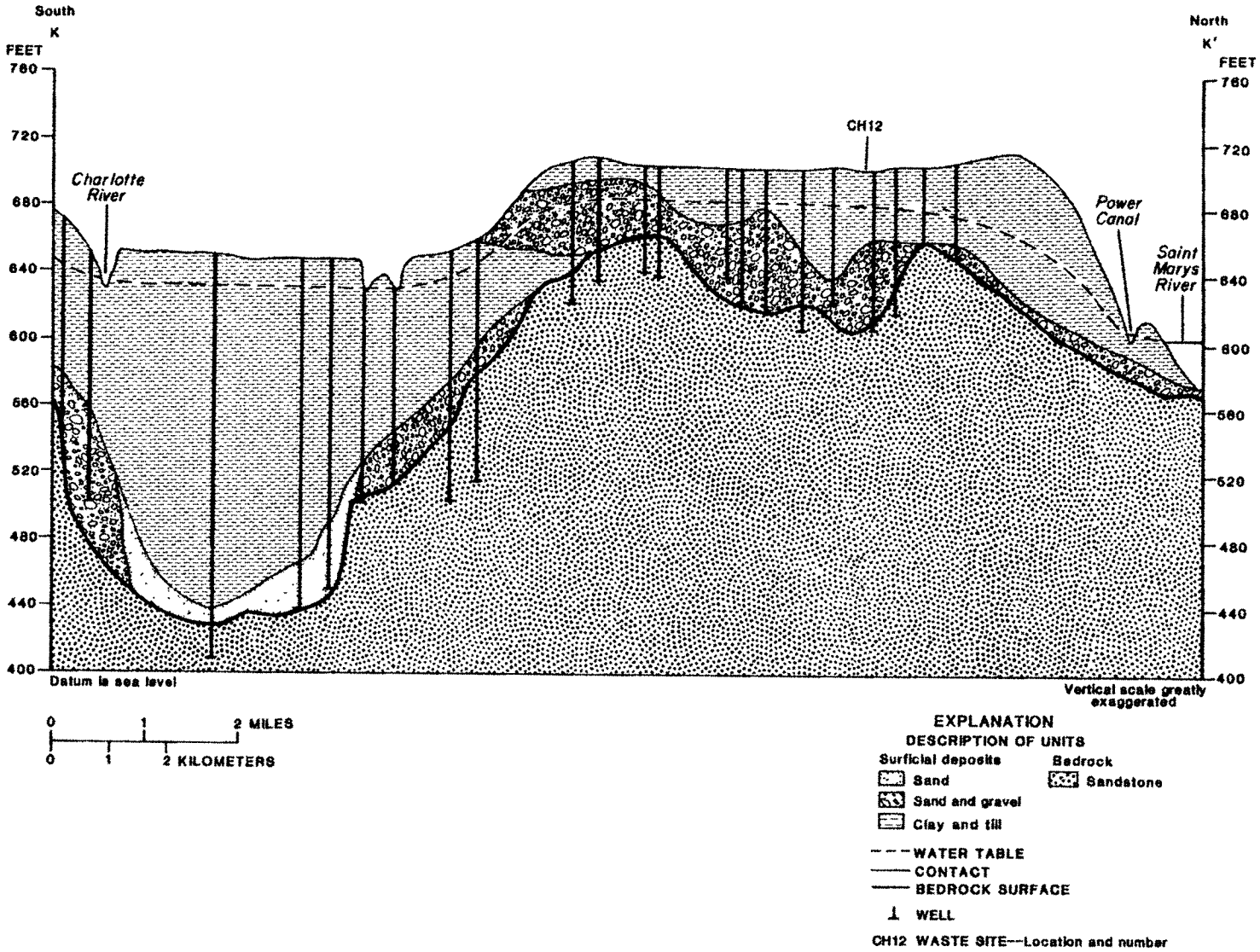


Figure 24.--Geologic section K-K', in Sault Ste. Marie, Michigan.

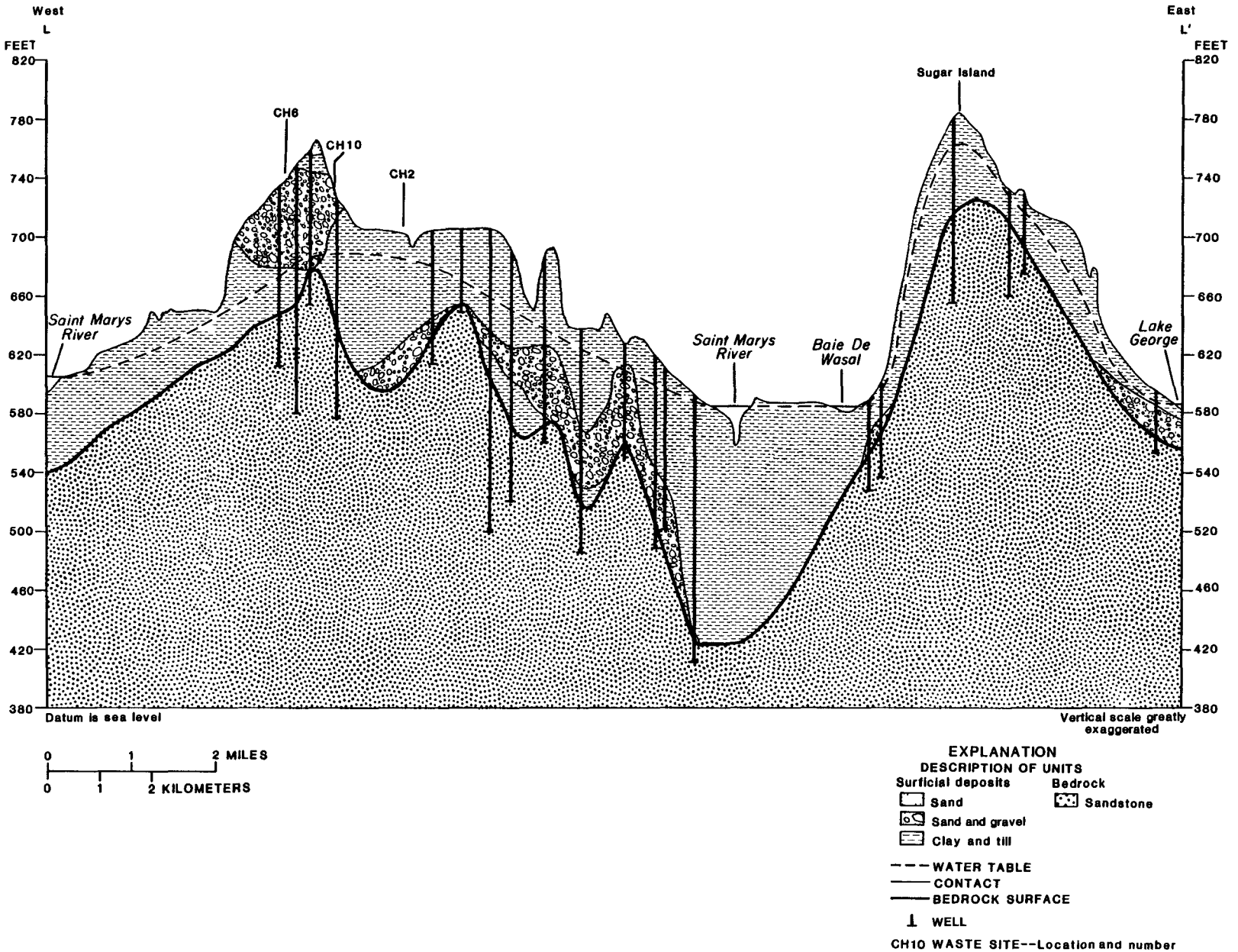


Figure 25.--Geologic section L-L', near Sault Ste. Marie, Michigan.

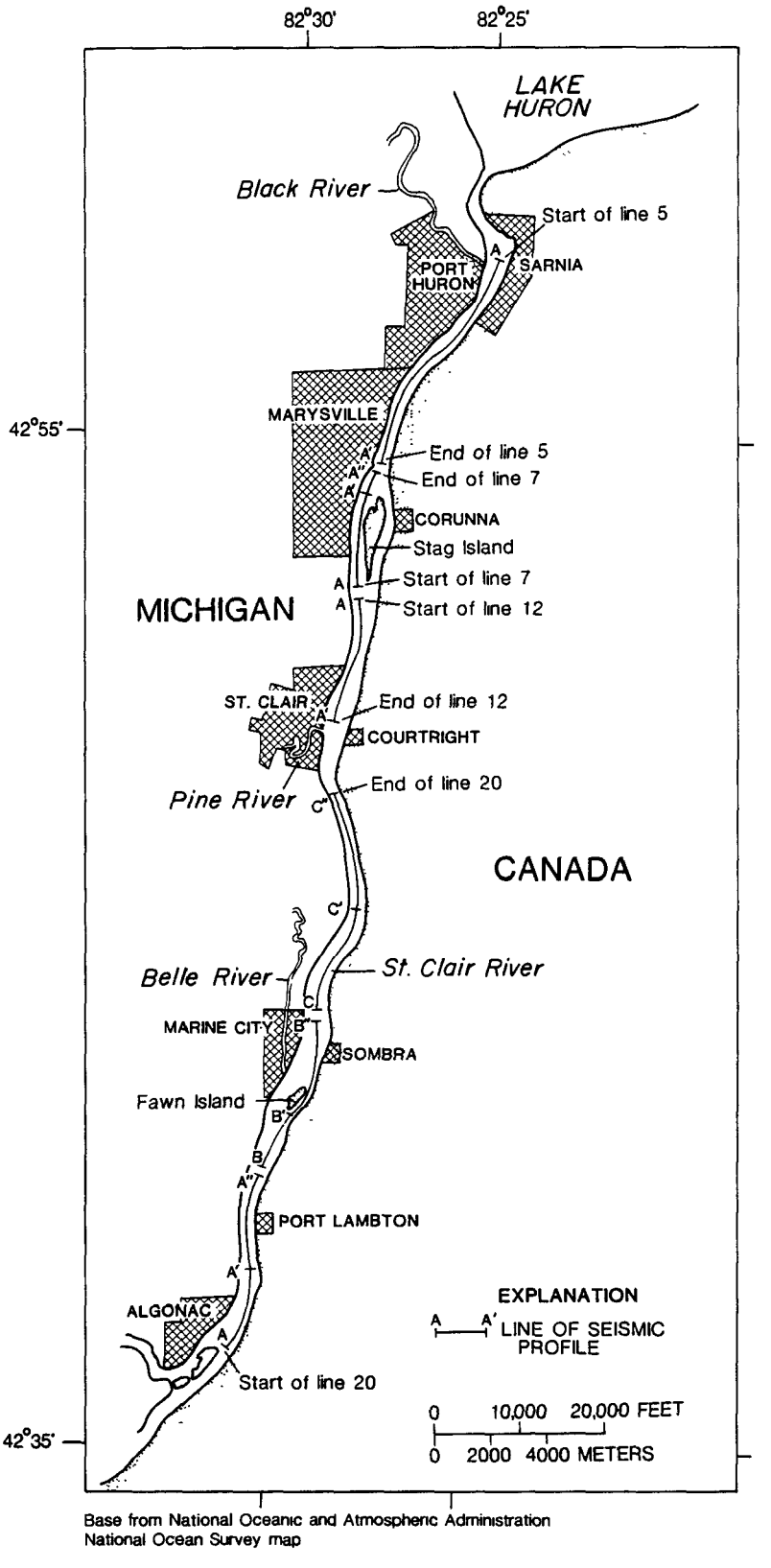


Figure 26.--Location of USGS seismic profiles in the St. Clair River.

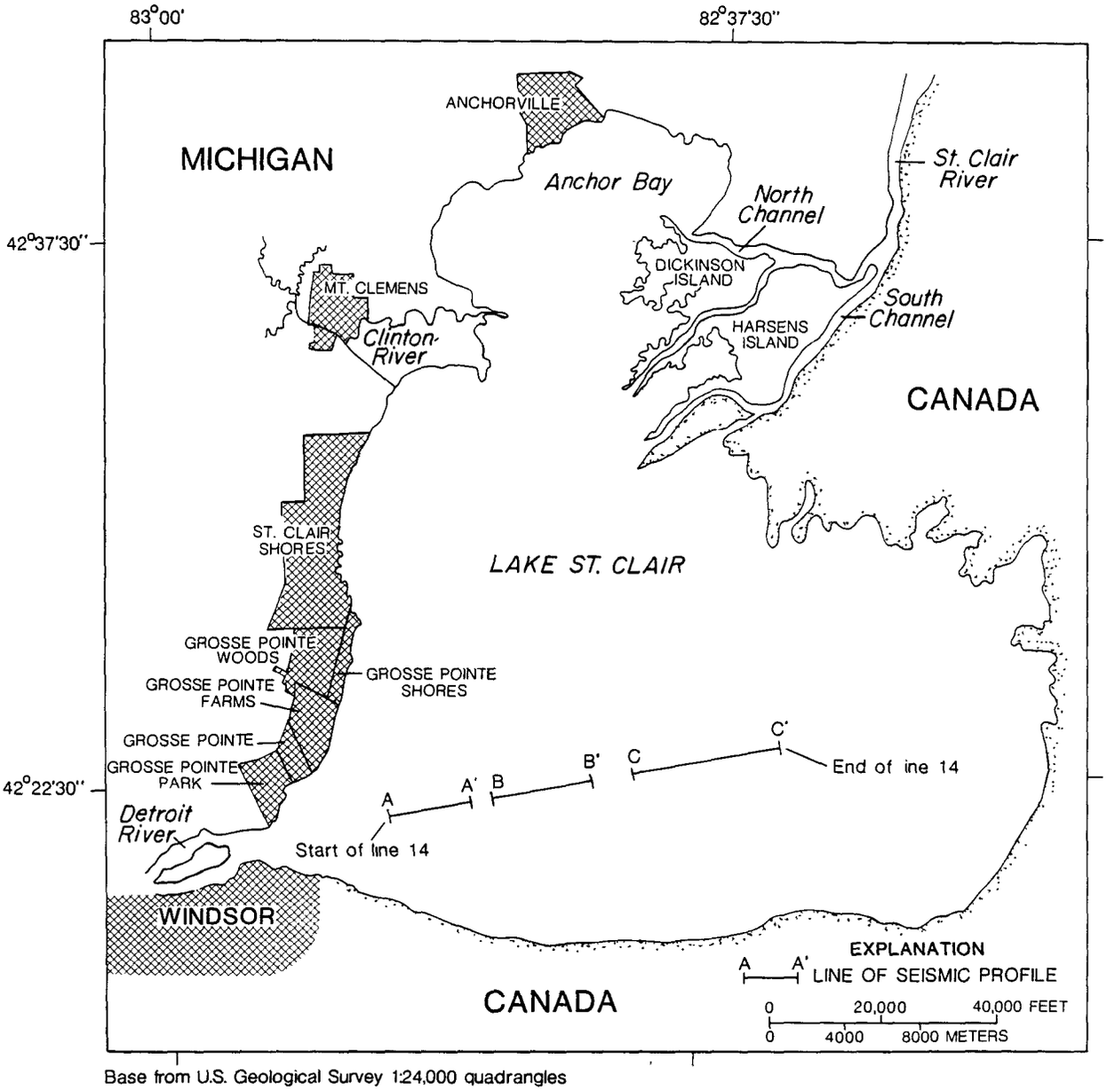
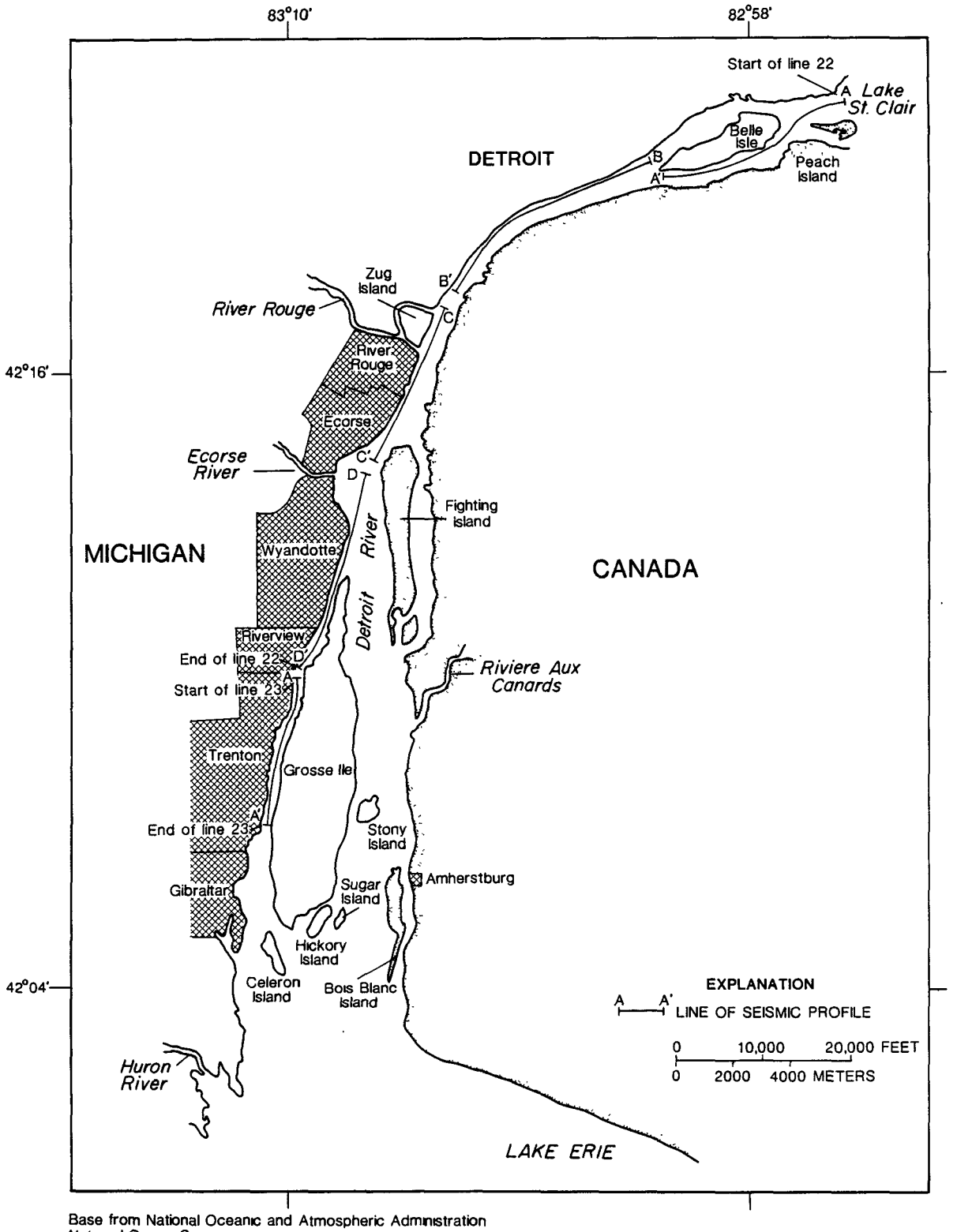


Figure 27.--Location of USGS seismic profiles on Lake St. Clair.



Base from National Oceanic and Atmospheric Administration
National Ocean Survey map

Figure 28.--Location of USGS seismic profiles on the Detroit River.

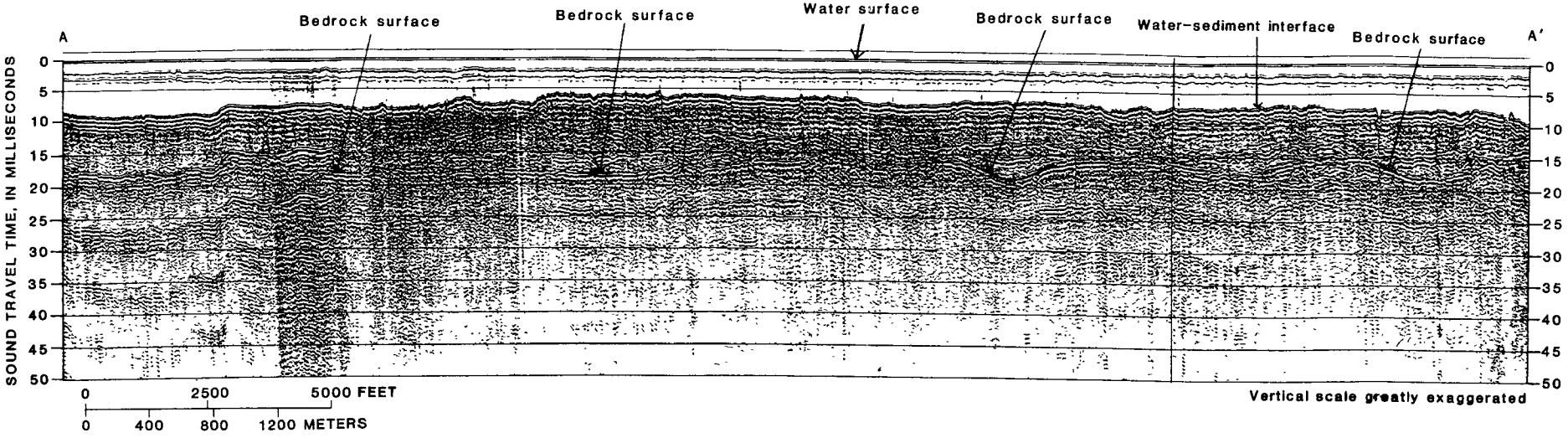
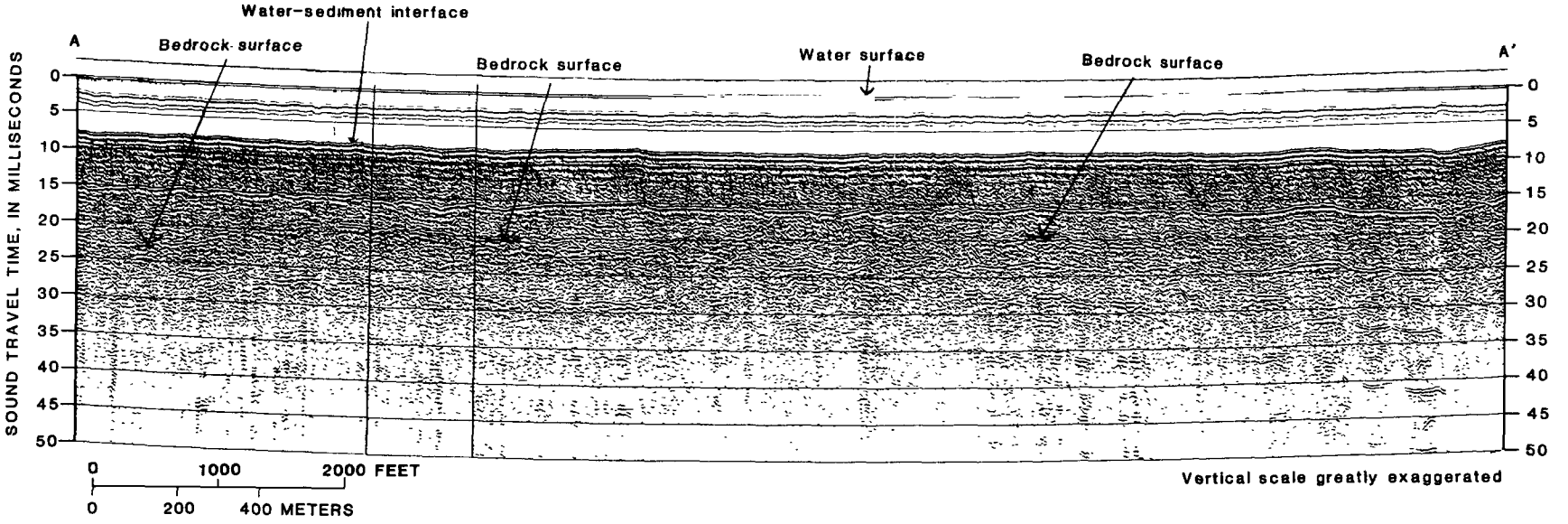


Figure 29.--USGS line 5 A-A', St. Clair River.



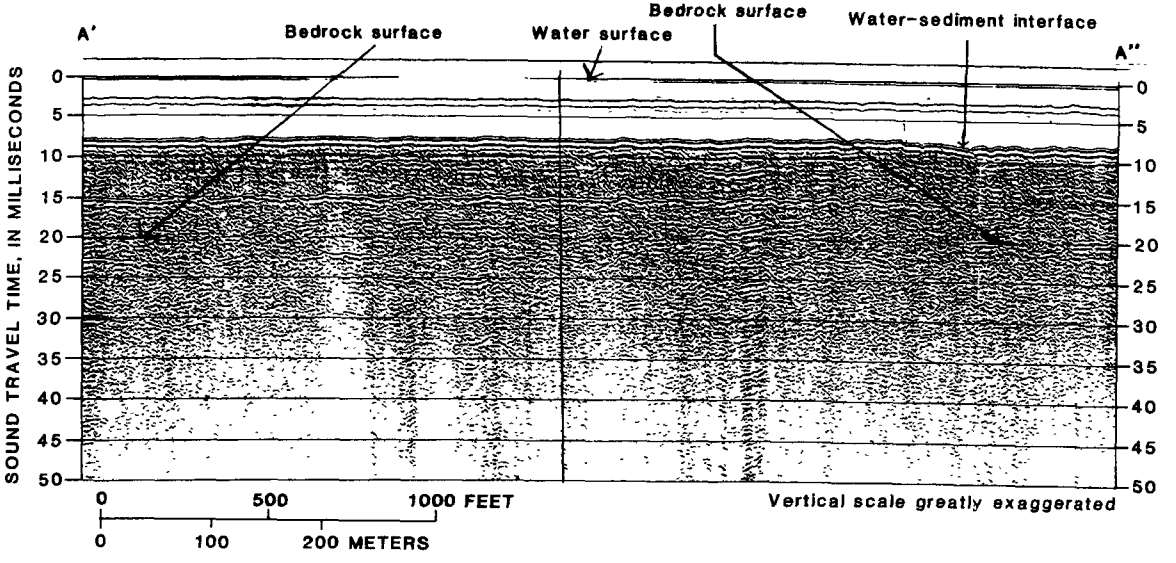


Figure 30.--USGS line 7 A-A'-A'', St. Clair River.

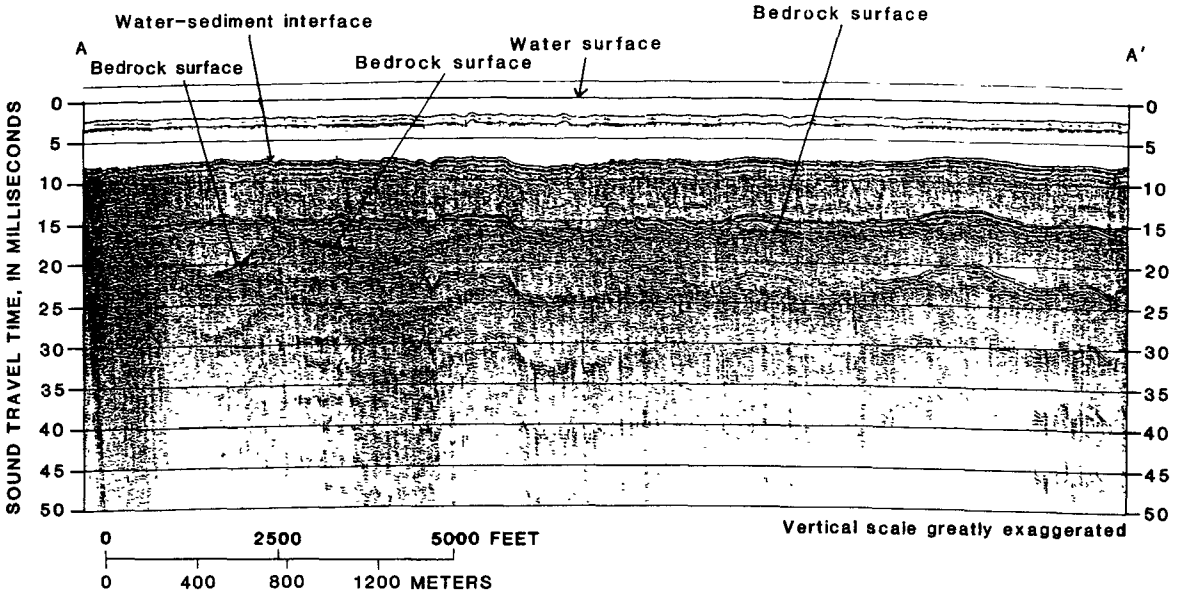
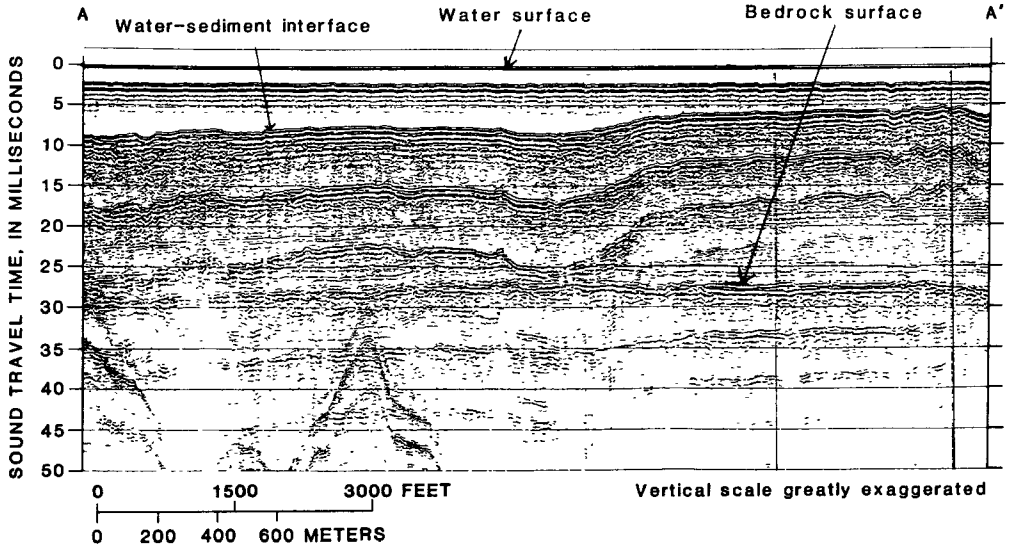


Figure 31.--USGS line 12 A-A', St. Clair River.



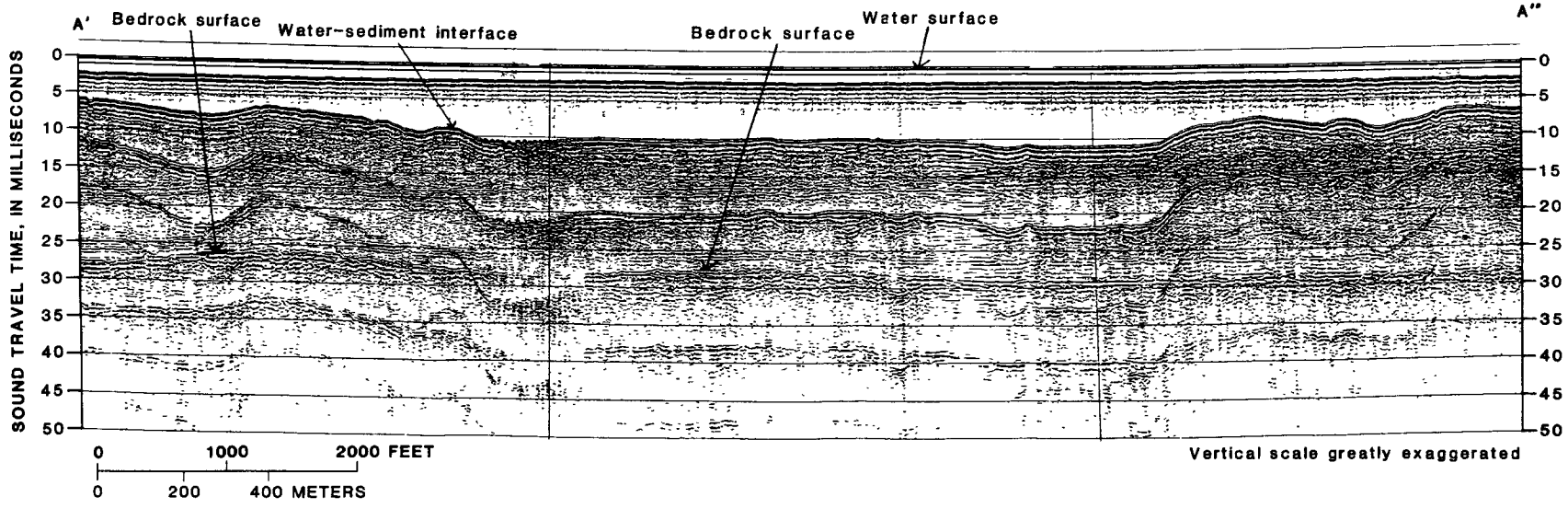


Figure 32.--USGS line 20 A-A'-A'', St. Clair River.

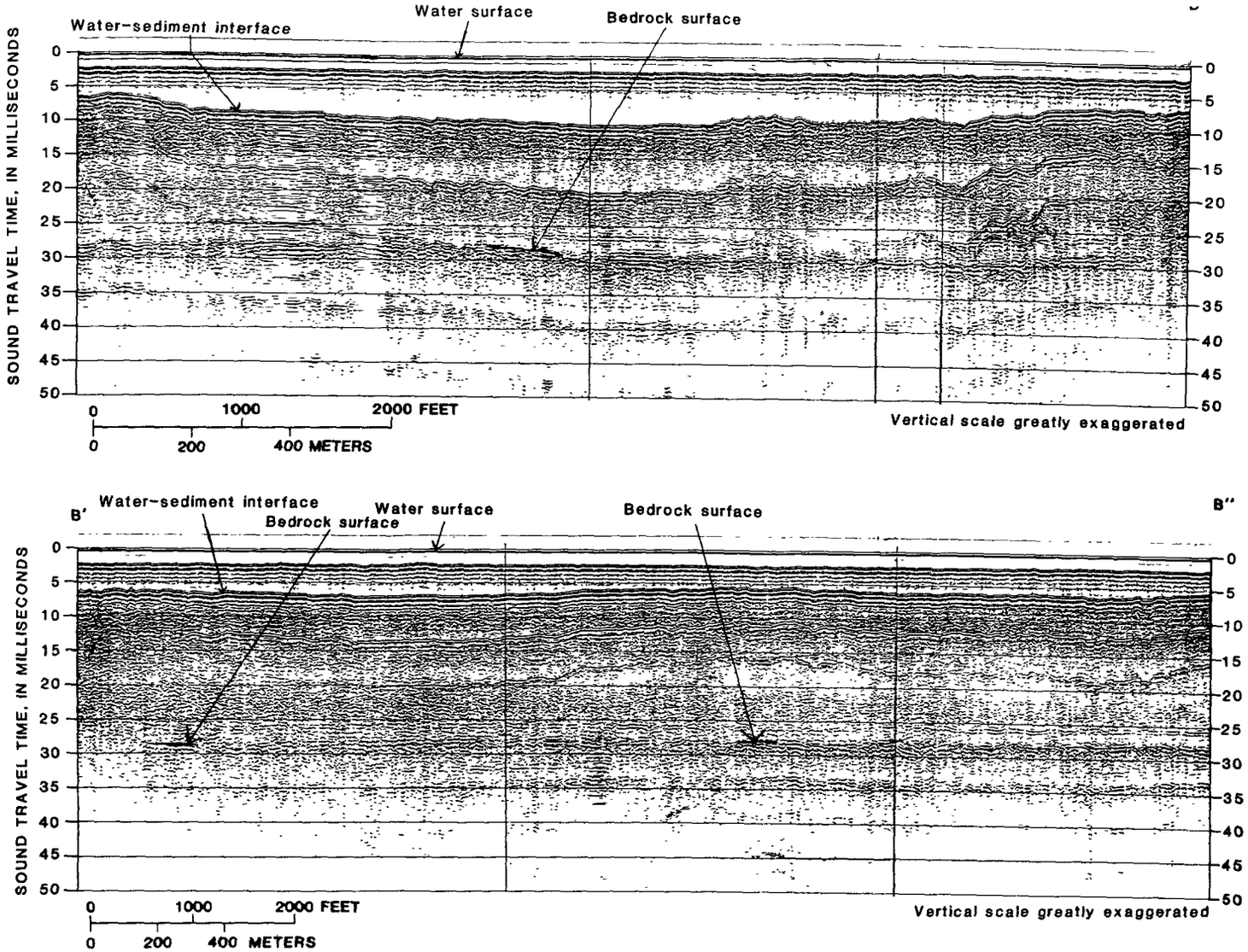
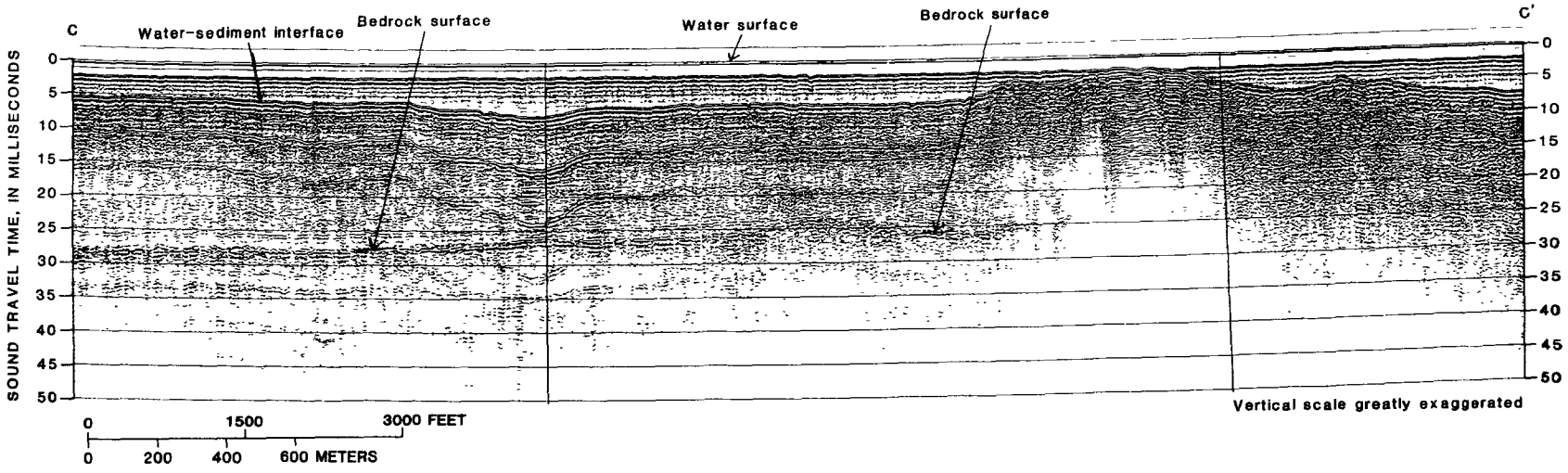


Figure 33.--USGS line 20 B-B'-B'', St. Clair River.



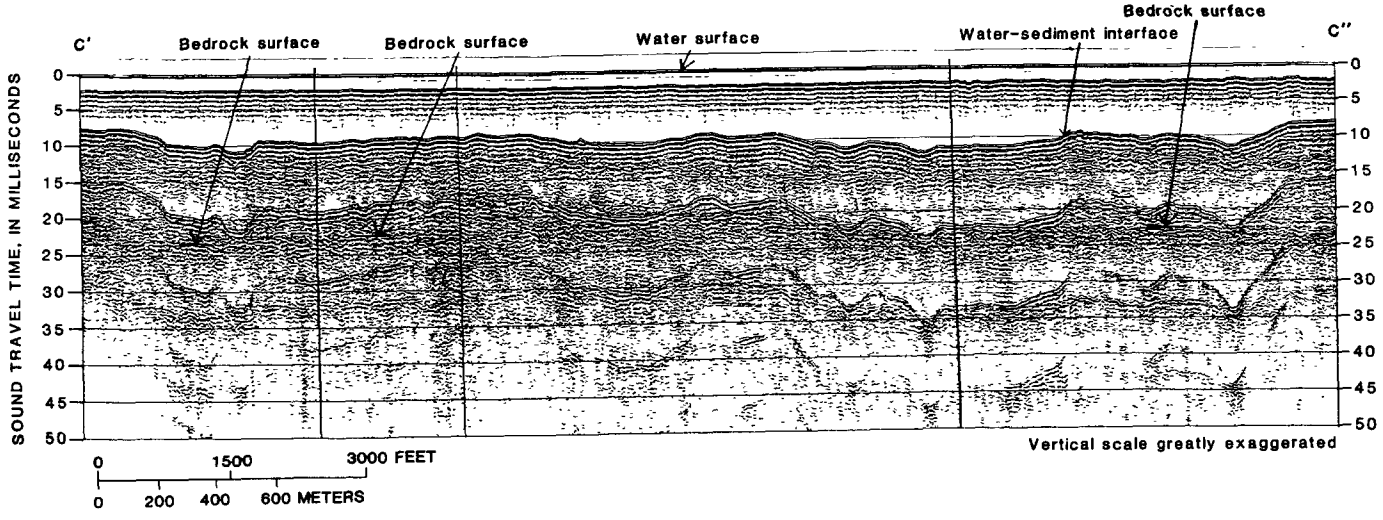


Figure 34.--USGS line 20 C-C'-C'', St. Clair River.

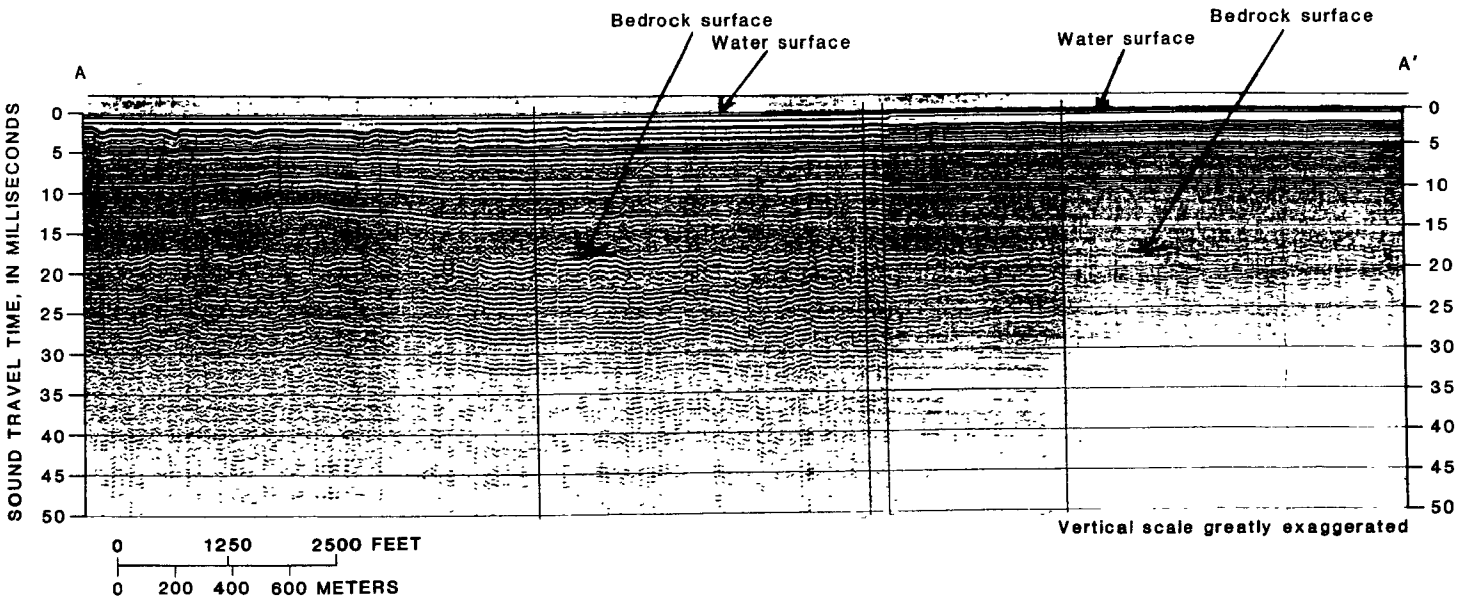


Figure 35.--USGS line 14 A-A', Lake St. Clair.

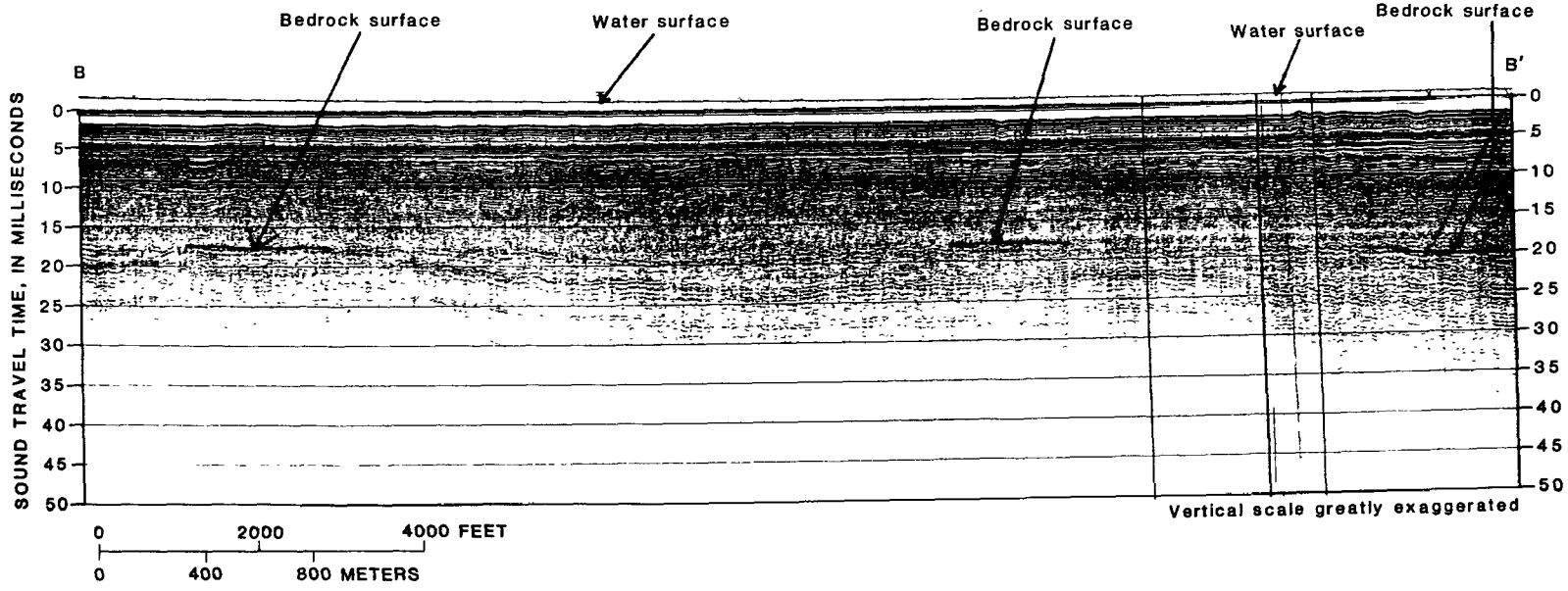


Figure 36.--USGS line 14 B-B', Lake St. Clair.

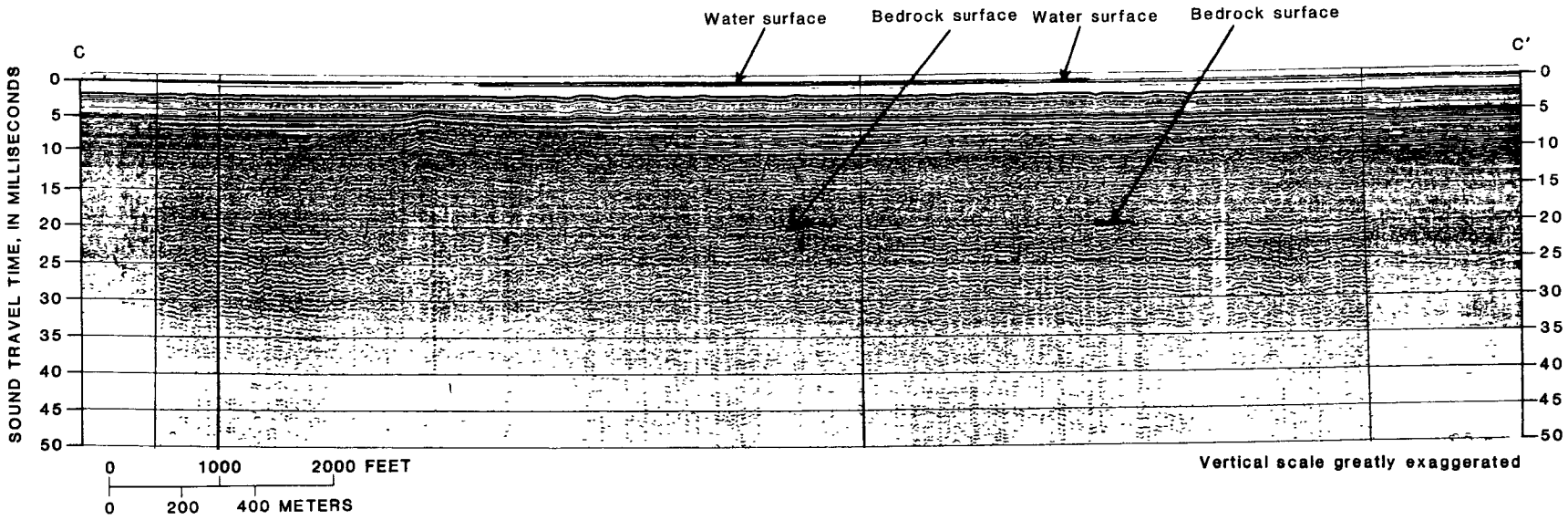


Figure 37.--USGS line 14 C-C', Lake St. Clair.

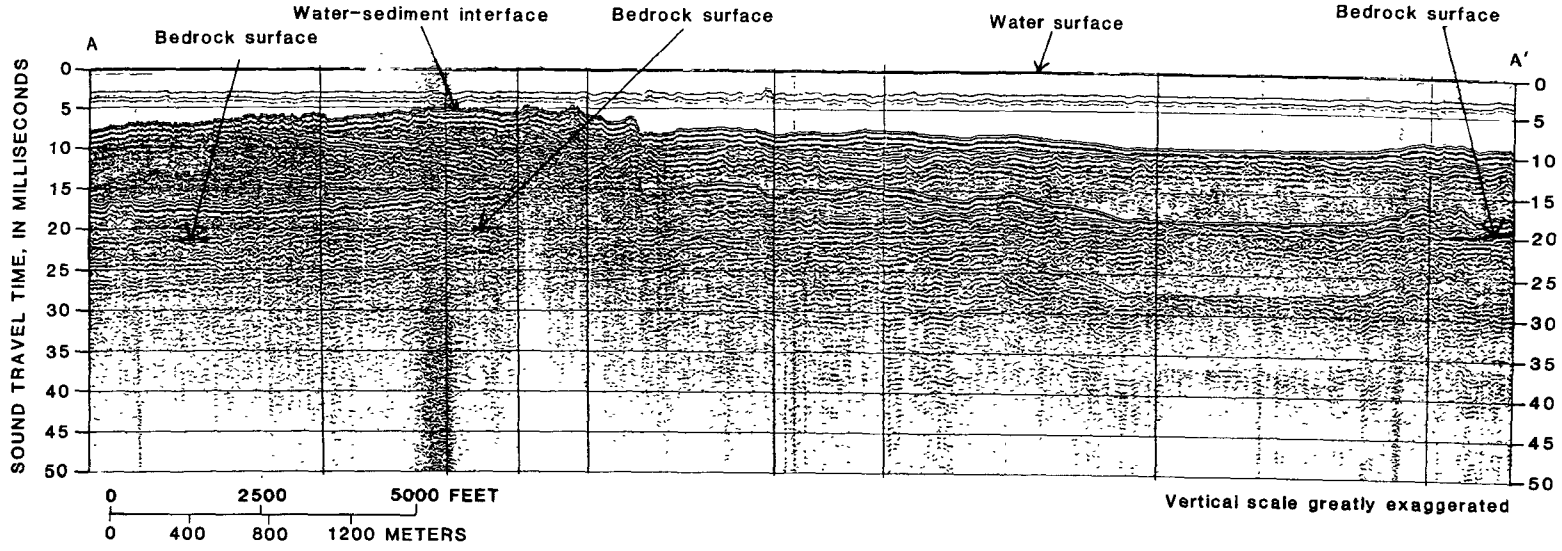


Figure 38.--USGS line 22 A-A', Detroit River.

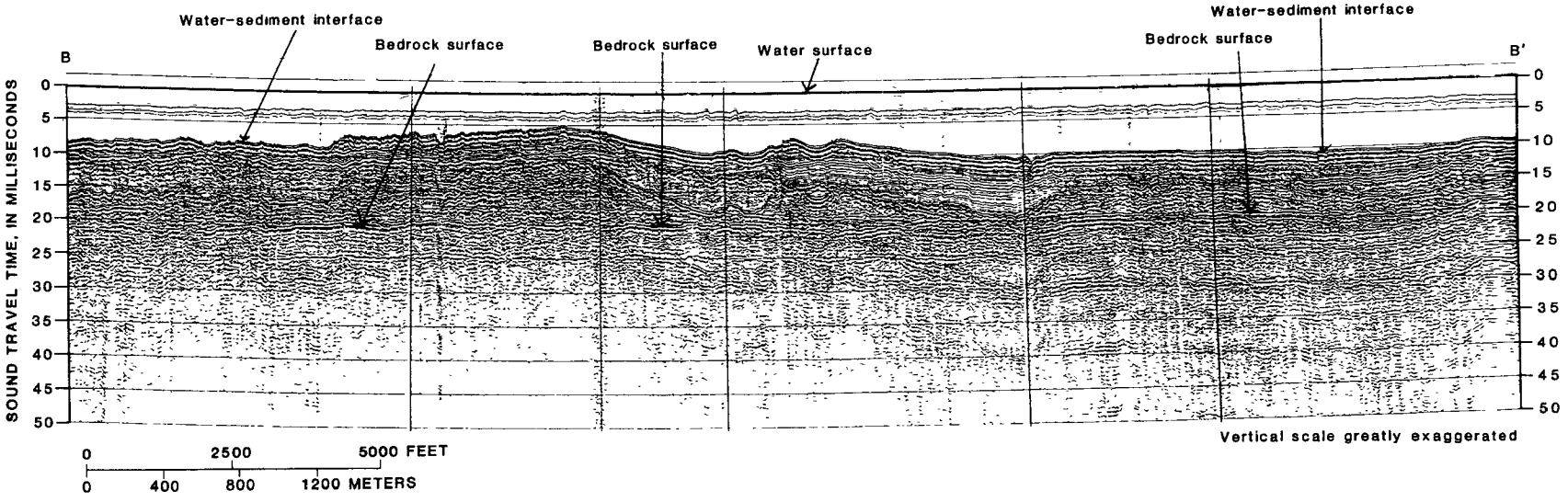


Figure 39.--USGS line 22 B-B', Detroit River.

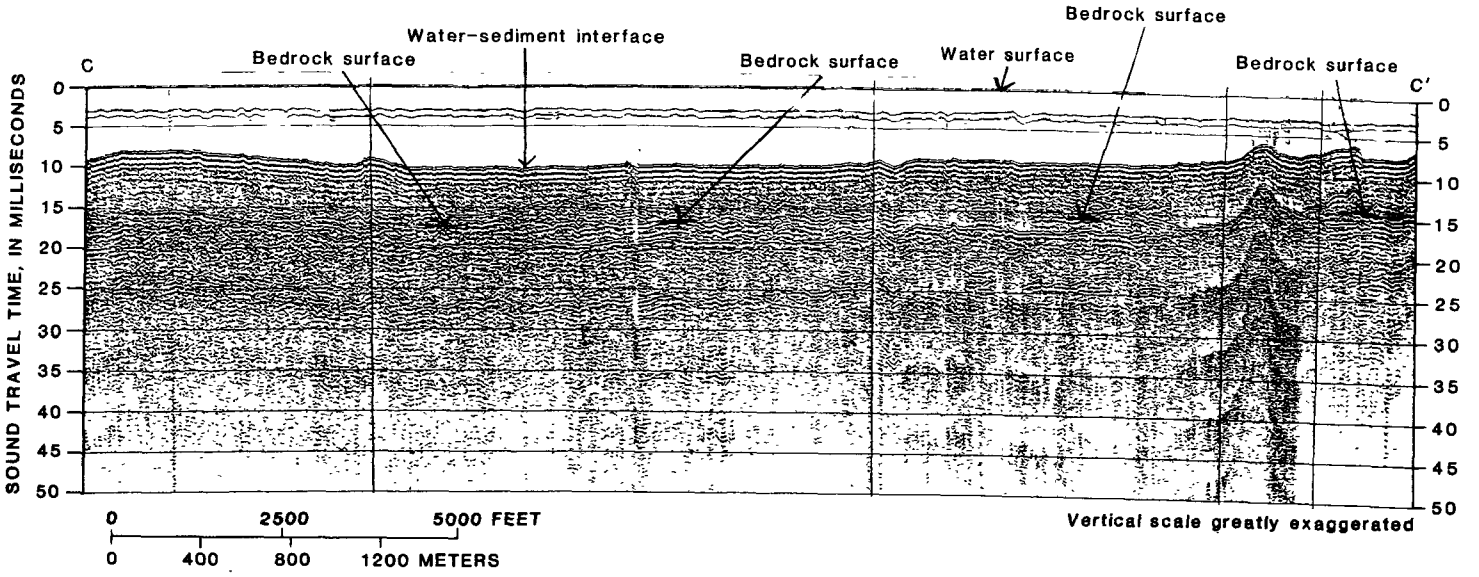


Figure 40.--USGS line 22 C-C', Detroit River.

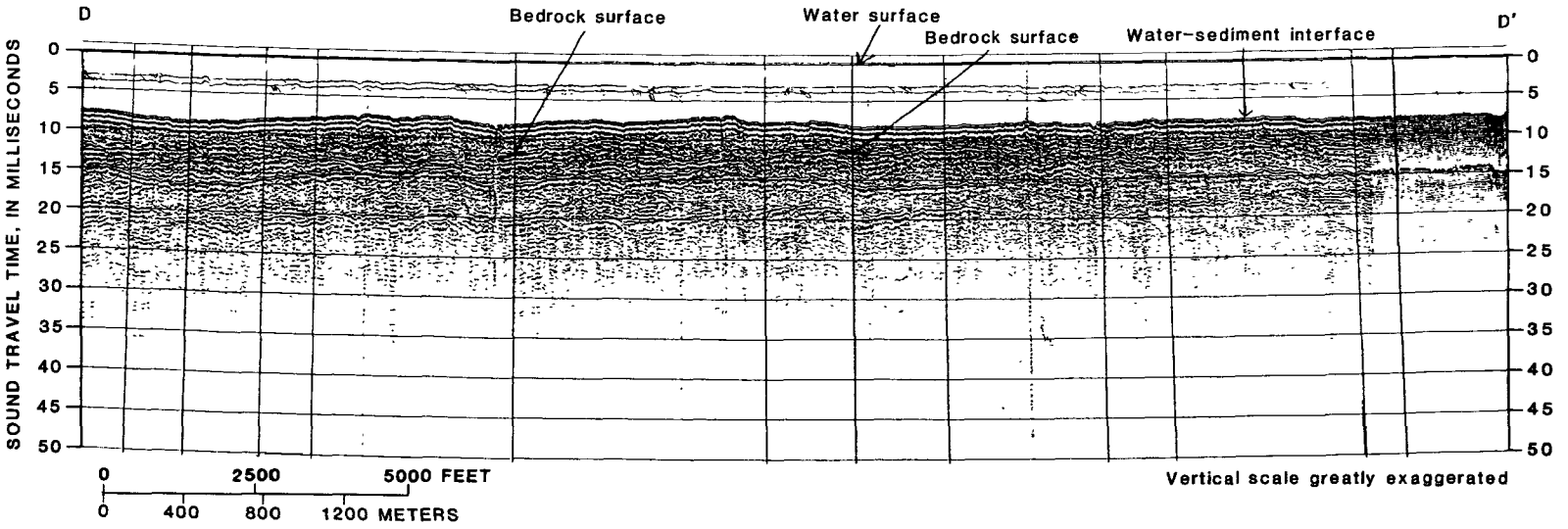


Figure 41.--USGS line 22 D-D', Detroit River.

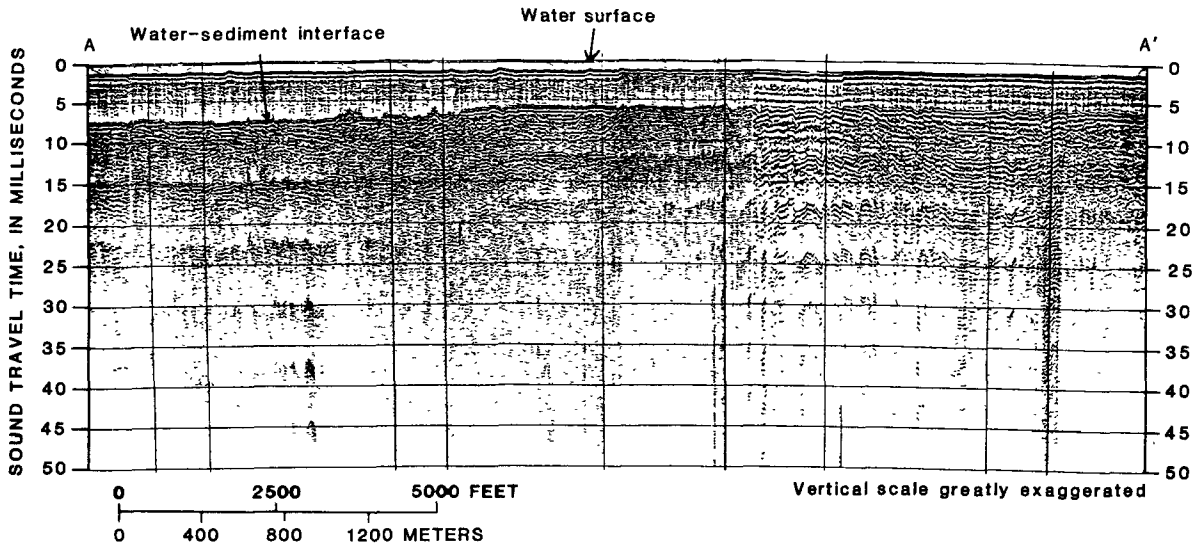


Figure 42.--USGS line 23 A-A', Detroit River.

APPENDIX D: TABLES OF DATA

Table 7.--Selected data for wells installed by the U.S. Geological Survey

[in., inches; ft, feet]

Well number	Location	Ground water discharge area	Well diameter (in.)	Depth, total/screen (ft)	Geologic characterization: Depth (ft)	Geologic characterization: Description
G1	7N 17E 35BDD	1	2	34/27-31	0-6	Sand, gray, silty; damp
					6-27	Clay, gray, silty, includes black shale clast; damp
					27-30	Sand, gravel; wet
					30-34	Clay, gray, silty; damp
G2	6N 17E 15BDD	2	4	112/107-111	0-5	Fill
					5-35	Clay, brown, silty, trace sand; includes rock clast
					35-100	Clay, gray, silty; includes black shale clast; damp
					100-107	Clay, gray, silty; damp
					107-108	Round black shale fragments with coarse grain sand
					108-112	Black shale
G3	6N 17E 21CCB	2	2	50/41-45	0-12	Sand, brown-gray; dry
					12-21	Clay, gray, silty; damp
					21-22	Sand, gray, silty; damp
					22-41	Clay, gray, silty; damp
					41-44	Sand, gray, silty; damp
					45-50	Clay, gray, silty; damp
G4	5N 17E 7ADD	2	2	65/52-63	0-21	Clay, brown, silty, small shale clast; dry
					21-65	Clay, gray, silty; damp
G5	4N 17E 7DCD	3	2	48/44-48	0-10	Clay, brown, silty; dry
					0-48	Clay, gray, silty; damp
G6	4N 17E 30AAC	3	2	24/19-24	0-1	Clay, brown, silty; dry
					1-7	Clay, brown, silty; damp
					7-9	Organic material; clay; damp
					9-24	Sand, gray, fine; clay; wet

Table 7.--Selected data for wells installed by the U.S. Geological Survey--Continued

Well number	Location	Ground water discharge area	Well diameter (in.)	Depth, total/screen (ft)	Geologic characterization: Depth (ft)	Geologic characterization: Description
G7	3N 16E 14DDC	4a	2	52/43-52	0-2.5	Topsoil; gravel
					2.5-6	Sand, brown-tan; clay; dry
					6-16	Clay, brown-green, silty; trace gravel, fine; damp
					16-49	Clay, gray, silty; trace gravel, fine; damp
					49-52	No record
G8	3N 16E 9BCA	4a	2	28/21-28	0-2	Topsoil
					2-17	Clay, gray, silty; trace gravel, fine
					17-26	Clay, gray; trace gravel
					26-28	Clay, gray
G9	2N 16E 9BCA	4b	2	33/20-24	0-1	Topsoil
					1-5	Sand, yellow, fine
					5-26	Sand, gray, fine-medium; trace gravel
					26-28	Sand, gray, clayey
					28-33	Clay, gray
G10	3N 15E 23ADA	4b	2	52/43-52	0-.5	Topsoil
					.5-3.5	Fill, clay, rocks, brick
					3.5-9	Clay, brown-gray, silty; dry
					9-13	Clay, brown, silty; damp
					13-49	Clay, gray, silty; trace gravel, fine; damp
					49-52	No record
G11	3N 15E 17AAC	5	2	48/38-48	0-.5	Topsoil
					.5-9	Clay, brown; dry
					9-48	Clay, gray; wet
G12	3N 14E 23DA	5	2	42/35-42	0-1.5	Topsoil
					1.5-5	Clay, brown, sandy-silty; trace gravel; damp
					5-6	Clay, gray, sandy
					6-28	Clay, brown-gray, silty; damp
					28-39	Clay, gray; wet
					39-42	No record

Table 7.--Selected data for wells installed by the U.S. Geological Survey--Continued

Well number	Location	Ground water discharge area	Well diameter (in.)	Depth, total/screen (ft)	Geologic characterization: Depth (ft)	Geologic characterization: Description
G13	2N 14E 5DB	5	2	33/23-33	0-2.5	Topsoil
					2.5-6	Clay, brown; dry
					6-9	Clay, brown-gray; damp
					9-29.5	Clay, gray; wet
					29.5-33	Sand, tan-gray, fine, clayey; dry
G14	2N 14E 29AC	6	2	49/45-49	0-5	Sand
					5-49	Clay, gray, silty; trace gravel; wet
G15	1N 13E 14BAA	7a	2	49/45-49	0-4	Sand, tan, silty; fill; clay
					4-12	Clay, brown, silty; trace gravel
					12-22	Clay, gray, silty; damp
					22-49	Clay, gray; wet
G16	1S 13E 22DD	7a	2	48/44-48	0-2	Topsoil
					2-12	Clay, brown; trace gravel, fine; dry
					12-48	Clay, gray; trace gravel, fine; slightly damp
G17	2S 12E 1AAD	7b	2	30.5/15.5-	0-8.5	Fill, dirt, sand, clay, gravel, metal, bricks; damp
					8.5-12	Fill; wet
					12-30	Sand, clayey; gravel; wet
G18	3S 11E 5ADA	9	2	47/33-47	0-7	Topsoil, fill
					7-12	Clay, brown, silty; dry
					12-17	Clay, brown, silty; damp
					17-43	Clay, gray, silty; trace gravel, fine; damp
					43-47	No record
G19	3S 11E 9CDA	9	2	50/41-50	0-3	Fill, dirt, brick
					3-7	Clay, dark gray; dirt; dry
					7-14	Clay, brown-tan, silty; damp
					14-18	Clay, brown, silty; wet
					18-50	Clay, dull gray, silty; trace gravel; wet

Table 7.--Selected data for wells installed by the U.S. Geological Survey--Continued

Well number	Location	Ground water discharge area	Well diameter (in.)	Depth, total/screen (ft)	Geologic characterization: Depth (ft)	Geologic characterization: Description
G20	5S 10E 1A	11	2	27/ -- (open hole 19.5-27)	0-2	Topsoil
					2-4	Clay, brown, silty; dry
					4-11	Clay, brown, silty; gravel, fine; dry
					11-19.5	Clay, gray, silty; trace gravel; dry
					19.5-22	Clay, gravel, dry
					22-27	Limestone
G21	5S 10E 12DC	11	2	33.5/26-30 (open hole	0-13	Clay, brown, silty; dry
					13-15	Clay, light gray, silty; trace gravel, fine medium; dry
					15-25	Clay, dark gray, silty; trace gravel,small-medium; dry
					25-26	Clay, dark gray, silty; gravel, fine; wet
					26-28	Clay, gray; gravel; wet
					28-33.5	Limestone
G22	47N 1W 31BB	12	4	44/40-44	0-1	Topsoil
					1-2	Sand, tan
					2-36	Clay, red-brown
					36-40	Clay, red-brown; trace gravel
					40-44	Sand, tan, very fine; clay, red-brown
G23	47N 1W 11BA	13	4	21/17-21	0-3	Leather waste; dry
					3-7	Leather waste; wet
					7-11	Sand, red-brown, very fine, silty; wet
					11-15	Sand, gray-red, very fine, silty; clay, light brown, wet
					15-21	Sand, tan, very fine, silty; clay, light brown, wet

Table 7.--Selected data for wells installed by the U.S. Geological Survey--Continued

Well number	Location	Ground water discharge area	Well diameter (in.)	Depth, total/screen (ft)	Geologic characterization	
					Depth (ft)	Description
G24	47N 1E 5DD	13	4	53/49-53	0-1.5	Topsoil, trace gravel
					1.5-2.5	Topsoil; sand; gravel
					2.5-42	Clay, brown; trace sand, fine
					42-48	Clay, brown; sand, tan, fine; trace gravel
					48-53	Sand, tan, fine; clay, brown
G25	45N 2E 19AA	14	4	22/17-21	0-.5	Topsoil
					.5-2	Fill, dirt, clay, gravel
					2-17	Clay, gray, silty
					17-22	Sand, fine-coarse

Table 8.--Concentrations of volatile hydrocarbons in ground water discharging to the Upper Great Lakes connecting channels

[Analyses by the U.S. Geological Survey. Concentrations are in µg/L (micrograms per liter). Values underlined are greater than the detection limit. < means less than]

Compound	Location and well number							
	St. Clair River area							
	G1[1]	G2	G3	G4	G5	G6	G7	G8
Benzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Bromoform	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Carbon Tetrachloride	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chlorobenzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chlorodibromomethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
2-Chloroethylvinylether	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chloromethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chloroform	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
m-Dichlorobenzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
o-Dichlorobenzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
p-Dichlorobenzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Dichlorobromomethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Dichlorodifluoromethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1-Dichloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-Dichloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1-Dichloroethylene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-(trans)Dichloroethylene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-Dichloropropane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,3-Dichloropropene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Ethyl benzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-Dibromoethylene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Methylbromide	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Methylene chloride	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Styrene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1,2,2-Tetrachloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Tetrachloroethylene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Toluene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1,1-Trichloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1,2-Trichloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Trichloroethlyene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Trichlorofluoromethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Vinyl Chloride	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Xylenes	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

[1] Wells designated as "G" wells are those installed by the U.S. Geological Survey

Table 8.--Concentrations of volatile hydrocarbons in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. Concentrations are in µg/L (micrograms per liter). Values underlined are greater than the detection limit. < means less than]

Compound	Location and well number									
	Lake St. Clair area									
	G9	G10	G11	G11[1]	G12	G13	G14	G15	G15[1]	G16
Benzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	3.1	<3.0	<3.0	<3.0
Bromoform	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Carbon Tetrachloride	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chlorobenzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chlorodibromomethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
2-Chloroethylvinylether	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chloromethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chloroform	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
m-Dichlorobenzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
o-Dichlorobenzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
p-Dichlorobenzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Dichlorobromomethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Dichlorodifluoromethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1-Dichloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-Dichloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1-Dichloroethylene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-(trans)Dichloroethylene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-Dichloropropane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,3-Dichloropropene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Ethyl benzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-Dibromoethylene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Methylbromide	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Methylene chloride	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Styrene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1,2,2-Tetrachloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Tetrachloroethylene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Toluene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1,1-Trichloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1,2-Trichloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Trichloroethlyene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Trichlorofluoromethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Vinyl Chloride	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Xylenes	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

[1] Duplicate sample collected for quality assurance/quality control

Table 8.--Concentrations of volatile hydrocarbons in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. Concentrations are in µg/L (micrograms per liter). Values underlined are greater than the detection limit. < means less than]

Compound	Location and well number								
	Detroit River area								
	G17	P1[1]	G18	G19	P2	G20	P3	P3[2]	G21
Benzene	<3.0	270	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Bromoform	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Carbon Tetrachloride	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chlorobenzene	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chlorodibromomethane	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chloroethane	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
2-Chloroethylvinylether	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chloromethane	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chloroform	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
m-Dichlorobenzene	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
o-Dichlorobenzene	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
p-Dichlorobenzene	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Dichlorobromomethane	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Dichlorodifluoromethane	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1-Dichloroethane	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-Dichloroethane	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1-Dichloroethylene	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-(trans)Dichloroethylene	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-Dichloropropane	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,3-Dichloropropene	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Ethyl benzene	<3.0	410	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-Dibromoethylene	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Methylbromide	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Methylene chloride	<3.0	<20	<3.0	<3.0	5.9	<3.0	<3.0	<3.0	<3.0
Styrene	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1,2,2-Tetrachloroethane	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Tetrachloroethylene	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Toluene	<3.0	24	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1,1-Trichloroethane	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1,2-Trichloroethane	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Trichloroethlyene	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Trichlorofluoromethane	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Vinyl Chloride	<3.0	<20	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Xylenes	<3.0	740	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

[1] Wells designated as "P" wells are private wells

[2] Duplicate sample collected for quality assurance/quality control

Table 8.--Concentrations of volatile hydrocarbons in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. Concentrations are in µg/L (micrograms per liter). Values underlined are greater than the detection limit. < means less than]

Compound	Location and well number							
	St. Marys River area							
	G22	P4	G23	G24	P5	P6	G25	G25[1]
Benzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Bromoform	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Carbon Tetrachloride	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chlorobenzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chlorodibromomethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
2-Chloroethylvinylether	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chloromethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Chloroform	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
m-Dichlorobenzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
o-Dichlorobenzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
p-Dichlorobenzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Dichlorobromomethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Dichlorodifluoromethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1-Dichloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-Dichloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1-Dichloroethylene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-(trans)Dichloroethylene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-Dichloropropane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,3-Dichloropropene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Ethyl benzene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,2-Dibromoethylene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Methylbromide	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Methylene chloride	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Styrene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1,2,2-Tetrachloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Tetrachloroethylene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Toluene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1,1-Trichloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
1,1,2-Trichloroethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Trichloroethlyene	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Trichlorofluoromethane	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Vinyl Chloride	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Xylenes	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

[1] Duplicate sample collected for quality assurance/quality control

Table 9.--Concentrations of base neutral, acid extractable, and chlorinated neutral extractable compounds in ground water discharging to the Upper Great Lakes connecting channels

[Analyses by the U.S. Geological Survey. Concentrations are in µg/L (micrograms per liter). Values underlined are greater than the detection limit. < means less than]

Compound	Location and well number							
	St. Clair River area							
	G1[1]	G2	G3	G4	G5	G6	G7	G8
Acenaphthene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Acenaphthylene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Aldrin	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Anthracene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Benzo (a) anthracene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Benzo (b) fluoranthene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Benzo (k) fluoranthene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Benzo (g,h,i) perylene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Benzo (a) pyrene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Bis (2-chloroethoxy) methane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Bis (2-chloroethyl) ether	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Bis (2-chloroisopropyl) ether	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Bis (2-ethyl hexyl) phthalate	80.0	<5.0	1,500	<5.0	<5.0	<5.0	6.0	<5.0
4-Bromophenyl phenyl ether	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Butyl benzyl phthalate	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	6.0	6.0
Chlordane	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
2-Chlorophenol	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
2-Chloronapthalene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
4-Chlorophenyl phenyl ether	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
4-Chloro-3-methylphenol	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0
Chrysene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
DDD	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
DDE	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
DDT	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
Dibenzo (a,h) anthracene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
1,2-Dichlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,3-Dichlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
1,4-Dichlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
2,4-Dichlorophenol	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Dieldrin	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
Diethyl phthalate	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
2,4-Dimethylphenol	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Dimethyl phthalate	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Di-n-butyl phthalate	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
4,6-Dinitro-2-methylphenol	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0
2,4-Dinitrophenol	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0
2,4-Dinitrotoluene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0

[1] Wells designated as "G" wells are those installed by the U.S. Geological Survey

Table 9.--Concentrations of base neutral, acid extractable, and chlorinated neutral extractable compounds in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. Concentrations are in µg/L (micrograms per liter). Values underlined are greater than the detection limit. < means less than]

Compound	Location and well number							
	St. Clair River area							
	G1	G2	G3	G4	G5	G6	G7	G8
2,6-Dinitrotoluene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Di-n-octylphthalate	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Endosulfan	<.010	<.010	<.010	<.010	<.010	.080	<.010	<.010
Endrin	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
Fluoranthene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Fluorene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Gross polychlorinated biphenyls	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Gross polychlorinated naphthalenes	<.10	<.10	<.10	<.10	<.10	<.10	<.10	<.10
Heptachlor	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
Heptachlor epoxide	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
Hexachlorobenzene	0	0	0	0	0	0	0	0
Hexachlorobutadiene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Hexachlorocyclopentadiene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Hexachloroethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Indeno (1,2,3-cd) pyrene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Isophorone	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Lindane	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
Methoxychlor	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Mirex	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Naphthalene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Nitrobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
2-Nitrophenol	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
4-Nitrophenol	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0
n-Nitrosodimethylamine	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
n-Nitrosodi-n-propylamine	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
n-Nitrosodiphenylamine	<5.0	<5.0	10.0	<5.0	<5.0	<5.0	<5.0	<5.0
Octachlorostyrene	0	0	0	0	0	0	0	0
Pentachlorophenol	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0
Perthane	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Phenanthrene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Phenol	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Pyrene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Toxaphene	<1	<1	<1	<1	<1	<1	<1	<1
1,2,4-Trichlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
2,4,6-Trichlorophenol	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0

Table 9.--Concentrations of base neutral, acid extractable, and chlorinated neutral extractable compounds in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. Concentrations are in µg/L (micrograms per liter). Values underlined are greater than the detection limit. < means less than]

Compound	Location and well number							
	Lake St. Clair area							
	G9	G10	G11	G11[1]	G11[2] RPD	G12	G13	G14
Acenaphthene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Acenaphthylene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Aldrin	<.01	<.01	<.050	<.050	0	<.01	<.01	<.050
Anthracene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Benzo (a) anthracene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Benzo (b) fluoranthene	<10.0	<10.0	<10.0	<10.0	0	<10.0	<10.0	<10.0
Benzo (k) fluoranthene	<10.0	<10.0	<10.0	<10.0	0	<10.0	<10.0	<10.0
Benzo (g,h,i) perylene	<10.0	<10.0	<10.0	<10.0	0	<10.0	<10.0	<10.0
Benzo (a) pyrene	<10.0	<10.0	<10.0	<10.0	0	<10.0	<10.0	<10.0
Bis (2-chloroethoxy) methane	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Bis (2-chloroethyl) ether	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Bis (2-chloroisopropyl) ether	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Bis (2-ethyl hexyl) phthalate	100	<5.0	170	560	107	<5.0	51.0	38.0
4-Bromophenyl phenyl ether	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Butyl benzyl phthalate	9.0	<5.0	25.0	37	39	12.0	16.0	<5.0
Chlordane	<.1	<.1	<.5	<.5	0	<.1	<.1	<.5
2-Chlorophenol	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
2-Chloronapthalene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
4-Chlorophenyl phenyl ether	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
4-Chloro-3-methylphenol	<30.0	<30.0	<30.0	<30.0	0	<30.0	<30.0	<30.0
Chrysene	<10.0	<10.0	<10.0	<5.0	0	<10.0	<10.0	<10.0
DDD	<.010	<.010	<.050	<.050	0	<.010	<.010	<.050
DDE	<.010	<.010	<.050	<.050	0	<.010	<.010	<.050
DDT	.080	<.010	.41	<.050	--	<.010	<.010	<.050
Dibenzo (a,h) anthracene	<10.0	<10.0	<10.0	<10.0	0	<10.0	<10.0	<10.0
1,2-Dichlorobenzene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
1,3-Dichlorobenzene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
1,4-Dichlorobenzene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
2,4-Dichlorophenol	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Dieldrin	<.010	<.010	<.050	<.050	0	<.010	<.010	<.050
Diethyl phthalate	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
2,4-Dimethylphenol	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Dimethyl phthalate	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Di-n-butyl phthalate	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
4,6-Dinitro-2-methylphenol	<30.0	<30.0	<30.0	<30.0	0	<30.0	<30.0	<30.0
2,4-Dinitrophenol	<20.0	<20.0	<20.0	<20.0	0	<20.0	<20.0	<20.0
2,4-Dinitrotoluene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0

[1] Duplicate sample collected for quality assurance/quality control
[2] RPD (relative percent difference) is the difference between the two sample values, divided by the mean of the values, multiplied by 100. RPD is not calculated if one of the values is reported as less than (<).

Table 9.--Concentrations of base neutral, acid extractable, and chlorinated neutral extractable compounds in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. Concentrations are in µg/L (micrograms per liter). Values underlined are greater than the detection limit. < means less than]

Compound	Location and well number							
	Lake St. Clair area							
	G9	G10	G11	G11[1/]	G11[2/] RPD	G12	G13	G14
2,6-Dinitrotoluene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Di-n-octylphthalate	<10.0	<10.0	<10.0	<10.0	0	<10.0	<10.0	<10.0
Endosulfan	<.010	<.010	<.050	<.050	0	<.010	<.010	<.050
Endrin	<.010	<.010	<.050	<.050	0	<.010	<.010	<.050
Fluoranthene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Fluorene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Gross polychlorinated biphenyls	<.1	<.1	<.5	<.5	0	<.1	<.1	<.5
Gross polychlorinated naphthalenes	<.10	<.10	<.50	<.50	0	<.10	<.10	<.50
Heptachlor	<.010	<.010	<.050	.05	--	<.010	.14	<.050
Heptachlor epoxide	<.010	<.010	<.050	<.050	0	<.010	<.010	<.050
Hexachlorobenzene	0	0	0	0	0	0	0	0
Hexachlorobutadiene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Hexachlorocyclopentadiene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Hexachloroethane	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Indeno (1,2,3-cd) pyrene	<10.0	<10.0	<10.0	<10.0	0	<10.0	<10.0	<10.0
Isophorone	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Lindane	.030	<.01	<.050	<.050	0	<.010	<.010	<.050
Methoxychlor	<.01	<.01	<.05	<.05	0	<.01	<.01	<.05
Mirex	<.01	<.01	<.05	<.05	0	<.01	<.01	<.05
Naphthalene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Nitrobenzene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
2-Nitrophenol	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
4-Nitrophenol	<30.0	<30.0	<30.0	<30.0	0	<30.0	<30.0	<30.0
n-Nitrosodimethylamine	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
n-Nitrosodi-n-propylamine	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
n-Nitrosodiphenylamine	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Octachlorostyrene	0	0	0	0	0	0	0	0
Pentachlorophenol	<30.0	<30.0	<30.0	<30.0	0	<30.0	<30.0	<30.0
Perthane	<.1	<.1	<.5	<.5	0	<.1	<.1	<.5
Phenanthrene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Phenol	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Pyrene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Toxaphene	<1	<1	<5	<5	0	<1	<1	<5
1,2,4-Trichlorobenzene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
2,4,6-Trichlorophenol	<20.0	<20.0	<20.0	<20.0	0	<20.0	<20.0	<20.0

[1] Duplicate sample collected for quality assurance/quality control
[2] RPD (relative percent difference) is the difference between the two sample values, divided by the mean of the values, multiplied by 100. RPD is not calculated if one of the values is reported as less than (<).

Table 9.--Concentrations of base neutral, acid extractable, and chlorinated neutral extractable compounds in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. Concentrations are in µg/L (micrograms per liter). Values underlined are greater than the detection limit. < means less than]

Compound	Location and well number							
	Lake St. Clair area continued				Detroit River Area			
	G15	G15[1]	G15[2] RPD	G16	G17	P1[3]	G18	G19
Acenaphthene	<5.0	<5.0	0	<5.0	<5.0	15.0	<5.0	<5.0
Acenaphthylene	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Aldrin	<.050	<.050	0	<.050	<.01	<.01	<.01	<.01
Anthracene	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Benzo (a) anthracene	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Benzo (b) fluoranthene	<10.0	<10.0	0	<10.0	10.0	<10.0	<10.0	<10.0
Benzo (k) fluoranthene	<10.0	<10.0	0	<10.0	<10.0	<10.0	<10.0	<10.0
Benzo (g,h,i) perylene	<10.0	<10.0	0	<10.0	10.0	<10.0	<10.0	<10.0
Benzo (a) pyrene	<10.0	<10.0	0	<10.0	12.0	<10.0	<10.0	<10.0
Bis (2-chloroethoxy) methane	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Bis (2-chloroethyl) ether	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Bis (2-chloroisopropyl) ether	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Bis (2-ethyl hexyl) phthalate	75.0	46	48	13.0	350	<5.0	<5.0	<5.0
4-Bromophenyl phenyl ether	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Butyl benzyl phthalate	<5.0	<5.0	0	24.0	14.0	<5.0	27.0	8.0
Chlordane	<.5	<.5	0	<.5	<.1	<.1	<.1	<.1
2-Chlorophenol	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
2-Chloronapthalene	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
4-Chlorophenyl phenyl ether	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
4-Chloro-3-methylphenol	<30.0	<30.0	0	<30.0	<30.0	<30.0	<30.0	<30.0
Chrysene	<10.0	<10.0	0	<10.0	<10.0	<10.0	<10.0	<10.0
DDD	<.050	<.050	0	<.050	<.010	<.010	<.010	<.010
DDE	<.050	<.050	0	<.050	<.010	<.010	<.010	<.010
DDT	.20	.20	0	<.050	<.010	<.010	<.010	<.010
Dibenzo (a,h) anthracene	<10.0	<10.0	0	<10.0	<10.0	<10.0	<10.0	<10.0
1,2-Dichlorobenzene	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
1,3-Dichlorobenzene	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
1,4-Dichlorobenzene	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
2,4-Dichlorophenol	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Dieldrin	<.050	<.050	0	<.050	<.010	<.010	<.010	<.010
Diethyl phthalate	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
2,4-Dimethylphenol	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Dimethyl phthalate	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Di-n-butyl phthalate	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
4,6-Dinitro-2-methylphenol	<30.0	<30.0	0	<30.0	<30.0	<30.0	<30.0	<30.0
2,4-Dinitrophenol	<20.0	<20.0	0	<20.0	<20.0	<20.0	<20.0	<20.0
2,4-Dinitrotoluene	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0

[1] Duplicate sample collected for quality assurance/quality control
[2] RPD (relative percent difference) is the difference between the two sample values, divided by the mean of the values, multiplied by 100. RPD is not calculated if one of the values is reported as less than (<).
[3] Wells designated as "P" wells are private wells

Table 9.--Concentrations of base neutral, acid extractable, and chlorinated neutral extractable compounds in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. Concentrations are in µg/L (micrograms per liter). Values underlined are greater than the detection limit. < means less than]

Compound	Location and well number							
	Lake St. Clair area continued				Detroit River area			
	G15	G15[1]	G15[2] RPD	G16	G17	P1[3]	G18	G19
2,6-Dinitrotoluene	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Di-n-octylphthalate	<10.0	<10.0	0	<10.0	<10.0	<10.0	<10.0	<10.0
Endosulfan	<.050	<.050	0	<.050	<.010	<.010	<.010	<.010
Endrin	<.050	<.050	0	<.050	<.010	<.010	<.010	<.010
Fluoranthene	<5.0	<5.0	0	<5.0	6.0	<5.0	<5.0	<5.0
Fluorene	<5.0	<5.0	0	<5.0	<5.0	9.0	<5.0	<5.0
Gross polychlorinated biphenyls	<.5	<.5	0	<.5	<.1	<.1	<.1	<.1
Gross polychlorinated naphthalenes	<.50	<.50	0	<.50	<.10	<.10	<.10	<.10
Heptachlor	<.050	.07	--	<.050	<.010	.021	<.010	<.010
Heptachlor epoxide	<.050	<.050	0	<.050	<.010	<.010	<.010	<.010
Hexachlorobenzene	0	0	0	0	0	0	0	0
Hexachlorobutadiene	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Hexachlorocyclopentadiene	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Hexachloroethane	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Indeno (1,2,3-cd) pyrene	<10.0	<10.0	0	<10.0	<10.0	<10.0	<10.0	<10.0
Isophorone	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Lindane	<.050	<.050	0	<.050	<.010	<.010	<.010	<.010
Methoxychlor	<.05	<.05	0	<.05	<.01	<.01	<.01	<.01
Mirex	<.05	<.05	0	<.05	<.01	<.01	<.01	<.01
Naphthalene	<5.0	<5.0	0	<5.0	<5.0	250	<5.0	<5.0
Nitrobenzene	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
2-Nitrophenol	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
4-Nitrophenol	<30.0	<30.0	0	<30.0	<30.0	<30.0	<30.0	<30.0
n-Nitrosodimethylamine	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
n-Nitrosodi-n-propylamine	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
n-Nitrosodiphenylamine	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Octachlorostyrene	0	0	0	0	0	0	0	0
Pentachlorophenol	<30.0	<30.0	0	<30.0	<30.0	<30.0	<30.0	<30.0
Perthane	<.5	<.5	0	<.5	<.1	<.1	<.1	<.1
Phenanthrene	<5.0	<5.0	0	<5.0	11.0	13.0	<5.0	<5.0
Phenol	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
Pyrene	<5.0	<5.0	0	<5.0	9.0	<5.0	<5.0	<5.0
Toxaphene	<5	<5	0	<5	<1	<1	<2	<1
1,2,4-Trichlorobenzene	<5.0	<5.0	0	<5.0	<5.0	<5.0	<5.0	<5.0
2,4,6-Trichlorophenol	<20.0	<20.0	0	<20.0	<20.0	<20.0	<20.0	<20.0

[1] Duplicate sample collected for quality assurance/quality control
[2] RPD (relative percent difference) is the difference between the two sample values, divided by the mean of the values, multiplied by 100. RPD is not calculated if one of the values is reported as less than (<).
[3] Wells designated as "P" wells are private wells

Table 9.--Concentrations of base neutral, acid extractable, and chlorinated neutral extractable compounds in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. Concentrations are in µg/L (micrograms per liter). Values underlined are greater than the detection limit. < means less than]

Compound	Location and well number							
	Detroit River area continued						St. Marys River area	
	P2	G20	P3	P3[1]	P3[2] RPD	G21	G22	P4
Acenaphthene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Acenaphthylene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Aldrin	<1.0	<.010	<.010	<.010	0	<.010	<.010	<.010
Anthracene	11.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Benzo (a) anthracene	17.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Benzo (b) fluoranthene	26.0	<10.0	<10.0	<10.0	0	<10.0	<10.0	<10.0
Benzo (k) fluoranthene	20.0	<10.0	<10.0	<10.0	0	<10.0	<10.0	<10.0
Benzo (g,h,i) perylene	23.0	<10.0	<10.0	<10.0	0	<10.0	<10.0	<10.0
Benzo (a) pyrene	30.0	<10.0	<10.0	<10.0	0	<10.0	<10.0	<10.0
Bis (2-chloroethoxy) methane	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Bis (2-chloroethyl) ether	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Bis (2-chloroisopropyl) ether	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Bis (2-ethyl hexyl) phthalate	150	76.0	<5.0	<5.0	0	26.0	<5.0	<5.0
4-Bromophenyl phenyl ether	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Butyl benzyl phthalate	<5.0	20.0	<5.0	<5.0	0	8.0	<5.0	<5.0
Chlordane	<.1	<.1	<.1	<.1	0	<.1	<.1	<.1
2-Chlorophenol	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
2-Chloronapthalene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
4-Chlorophenyl phenyl ether	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
4-Chloro-3-methylphenol	<30.0	<30.0	<30.0	<30.0	0	<30.0	<30.0	<30.0
Chrysene	15.0	<10.0	<10.0	<5.0	--	<10.0	<10.0	<10.0
DDD	<.010	<.010	<.010	<.010	0	<.010	<.010	<.010
DDE	<.010	<.010	<.010	<.010	0	<.010	<.010	<.010
DDT	<.010	<.010	<.010	<.010	0	<.010	<.010	<.010
Dibenzo (a,h) anthracene	16.0	<10.0	<10.0	<10.0	0	<10.0	<10.0	<10.0
1,2-Dichlorobenzene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
1,3-Dichlorobenzene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
1,4-Dichlorobenzene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
2,4-Dichlorophenol	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Dieldrin	<.010	<.010	<.010	<.010	0	<.010	<.010	<.010
Diethyl phthalate	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
2,4-Dimethylphenol	48.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Dimethyl phthalate	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Di-n-butyl phthalate	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
4,6-Dinitro-2-methylphenol	<30.0	<30.0	<30.0	<30.0	0	<30.0	<30.0	<30.0
2,4-Dinitrophenol	<20.0	<20.0	<20.0	<20.0	0	<20.0	<20.0	<20.0
2,4-Dinitrotoluene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0

[1] Duplicate sample collected for quality assurance/quality control
[2] RPD (relative percent difference) is the difference between the two sample values, divided by the mean of the values, multiplied by 100. RPD is not calculated if one of the values is reported as less than (<).

Table 9.--Concentrations of base neutral, acid extractable, and chlorinated neutral extractable compounds in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. Concentrations are in µg/L (micrograms per liter). Values underlined are greater than the detection limit. < means less than]

Compound	Location and well number							
	Detroit River area continued						St. Marys River area	
	P2	G20	P3	P3[1]	P3[2] RPD	G21	G22	P4
2,6-Dinitrotoluene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Di-n-octylphthalate	<10.0	<10.0	<10.0	<10.0	0	<10.0	<10.0	<10.0
Endosulfan	<.010	<.010	<.010	<.010	0	<.010	<.010	<.010
Endrin	.021	<.010	<.010	<.010	0	<.010	<.010	<.010
Fluoranthene	21.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Fluorene	10.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Gross polychlorinated biphenyls	<.1	<.1	<.1	<.1	0	<.1	<.1	<.1
Gross polychlorinated naphthalenes	<.10	<.10	<.10	<.10	0	<.10	<.10	<.10
Heptachlor	<.010	<.010	<.010	<.010	0	<.010	<.010	<.010
Heptachlor epoxide	<.010	<.010	<.010	<.010	0	<.010	<.010	<.010
Hexachlorobenzene	0	0	0	0	0	0	0	0
Hexachlorobutadiene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Hexachlorocyclopentadiene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Hexachloroethane	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Indeno (1,2,3-cd) pyrene	21.0	<10.0	<10.0	<10.0	0	<10.0	<10.0	<10.0
Isophorone	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Lindane	<.010	<.010	<.010	<.010	0	<.010	<.010	<.010
Methoxychlor	<.01	<.01	<.01	<.01	0	<.01	<.01	<.01
Mirex	<.01	<.01	<.01	<.01	0	<.01	<.01	<.01
Naphthalene	5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Nitrobenzene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
2-Nitrophenol	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
4-Nitrophenol	<30.0	<30.0	<30.0	<30.0	0	<30.0	<30.0	<30.0
n-Nitrosodimethylamine	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
n-Nitrosodi-n-propylamine	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
n-Nitrosodiphenylamine	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Octachlorostyrene	<5.0	<5.0	0	0	0	<5.0	<5.0	<5.0
Pentachlorophenol	<30.0	<30.0	<30.0	<30.0	0	<30.0	<30.0	<30.0
Perthane	<5.0	<5.0	<.1	<.1	0	<5.0	<5.0	<5.0
Phenanthrene	35.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Phenol	47.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Pyrene	19.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
Toxaphene	0	0	<1	<1	0	0	0	0
1,2,4-Trichlorobenzene	<5.0	<5.0	<5.0	<5.0	0	<5.0	<5.0	<5.0
2,4,6-Trichlorophenol	<20.0	<20.0	<20.0	<20.0	0	<20.0	<20.0	<20.0

[1] Duplicate sample collected for quality assurance/quality control
[2] RPD (relative percent difference) is the difference between the two sample values, divided by the mean of the values, multiplied by 100. RPD is not calculated if one of the values is reported as less than (<).

Table 9.--Concentrations of base neutral, acid extractable, and chlorinated neutral extractable compounds in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. Concentrations are in µg/L (micrograms per liter). Values underlined are greater than the detection limit. < means less than]

Compound	Location and well number						
	St. Marys River area continued						
	G23	G24	P5	P6	G25	G25[1]	G25[2] RPD
Acenaphthene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Acenaphthylene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Aldrin	<.01	<.01	<.01	<.01	<.010	<.010	0
Anthracene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Benzo (a) anthracene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Benzo (b) fluoranthene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	0
Benzo (k) fluoranthene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	0
Benzo (g,h,i) perylene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	0
Benzo (a) pyrene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	0
Bis (2-chloroethoxy) methane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Bis (2-chloroethyl) ether	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Bis (2-chloroisopropyl) ether	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Bis (2-ethyl hexyl) phthalate	95.0	11.0	<5.0	<5.0	<5.0	<5.0	0
4-Bromophenyl phenyl ether	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Butyl benzyl phthalate	5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Chlordane	<.1	<.1	<.1	<.1	<.1	<.1	0
2-Chlorophenol	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
2-Chloronapthalene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
4-Chlorophenyl phenyl ether	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
4-Chloro-3-methylphenol	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0	0
Chrysene	<10.0	<10.0	<10.0	<10.0	<10.0	<5.0	--
DDD	<.010	<.010	<.010	<.010	<.010	<.010	0
DDE	<.010	<.010	<.010	<.010	<.010	<.010	0
DDT	<.010	<.010	<.010	<.010	<.010	<.010	0
Dibenzo (a,h) anthracene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	0
1,2-Dichlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
1,3-Dichlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
1,4-Dichlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
2,4-Dichlorophenol	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Dieldrin	<.010	<.010	<.010	<.010	<.010	<.010	0
Diethyl phthalate	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
2,4-Dimethylphenol	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Dimethyl phthalate	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Di-n-butyl phthalate	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
4,6-Dinitro-2-methylphenol	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0	0
2,4-Dinitrophenol	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	0
2,4-Dinitrotoluene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0

[1] Duplicate sample collected for quality assurance/quality control
[2] RPD (relative percent difference) is the difference between the two sample values, divided by the mean of the values, multiplied by 100. RPD is not calculated if one of the values is reported as less than (<).

Table 9.--Concentrations of base neutral, acid extractable, and chlorinated neutral extractable compounds in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. Concentrations are in µg/L (micrograms per liter). Values underlined are greater than the detection limit. < means less than]

Compound	Location and well number						
	St. Marys River area continued						
	G23	G24	P5	P6	G25	G25[1]	G25[2] RPD
2,6-Dinitrotoluene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Di-n-octylphthalate	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	0
Endosulfan	<.010	<.010	<.010	<.010	<.010	<.010	0
Endrin	<.010	<.010	<.010	<.010	<.010	<.010	0
Fluoranthene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Fluorene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Gross polychlorinated biphenyls	<.1	<.1	<.1	<.1	<.1	<.1	0
Gross polychlorinated naphthalenes	<.10	<.10	<.10	<.10	<.10	<.10	0
Heptachlor	<.010	<.010	<.010	<.010	<.010	<.010	0
Heptachlor epoxide	<.010	<.010	<.010	<.010	<.010	<.010	0
Hexachlorobenzene	0	0	0	0	0	0	0
Hexachlorobutadiene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Hexachlorocyclopentadiene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Hexachloroethane	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Indeno (1,2,3-cd) pyrene	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	0
Isophorone	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Lindane	<.010	<.010	<.010	<.010	<.010	<.010	0
Methoxychlor	<.01	<.01	<.01	<.01	<.01	<.01	0
Mirex	<.01	<.01	<.01	<.01	<.01	<.01	0
Naphthalene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Nitrobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
2-Nitrophenol	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
4-Nitrophenol	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0	0
n-Nitrosodimethylamine	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
n-Nitrosodi-n-propylamine	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
n-Nitrosodiphenylamine	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Octachlorostyrene	<5.0	<5.0	<5.0	<5.0	0	0	0
Pentachlorophenol	<30.0	<30.0	<30.0	<30.0	<30.0	<30.0	0
Perthane	<5.0	<5.0	<5.0	<5.0	<.1	<.1	0
Phenanthrene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Phenol	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Pyrene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
Toxaphene	0	0	0	0	<1	<1	0
1,2,4-Trichlorobenzene	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	0
2,4,6-Trichlorophenol	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	0

[1] Duplicate sample collected for quality assurance/quality control
[2] RPD (relative percent difference) is the difference between the two sample values, divided by the mean of the values, multiplied by 100. RPD is not calculated if one of the values is reported as less than (<).

Table 10.--Concentrations of trace metals and other dissolved substances in ground water discharging to the Upper Great Lakes connecting channels

[Analyses by the U.S. Geological Survey. -- means no analysis made. < means less than]

Compound	Location and well number					
	St. Clair River area					
	G1[1]	G2	G3	G4	G5	G6
Antimony, total (µg/L)	1	<1	<1	9	1	1
Arsenic, total (µg/L)	4	15	12	9	<1	2
Barium, dissolved (µg/L)	240	300	1,400	60	51	300
Beryllium, dissolved (µg/L)	<.5	<1	4	<1	<1	<1
Cadmium, total (µg/L)	<1	<1	<1	<1	<1	<1
Chromium, total (µg/L)	59	21	<1	18	17	26
Cobalt, total (µg/L)	20	10	200	2	<1	30
Copper, total (µg/L)	38	36	380	11	2	160
Iron, total (mg/L)	48	40	200	9.7	1.2	79
Lead, total (µg/L)	1,600	23	6,300	1,500	36	100
Mercury, total (µg/L)	.40	.50	<.10	.50	<.10	<.10
Nickel, total (µg/L)	52	56	400	6	<1	200
Selenium, total (µg/L)	<1	<1	<1	<1	<1	<1
Zinc, total (mg/L)	70	2.5	390	83	9.9	9.3
Carbon, total organic (mg/L)	28	16	17	30	3.6	18
Chloride (mg/L)	79	210	44	51	250	31
Cyanide, total (mg/L)	<.010	<.010	<.010	<.010	<.010	<.010
Dissolved solids (mg/L)	436	629	246	285	1,560	810
Oil-grease, total (mg/L)	6	5	3	7	4	5
Nitrogen, total (mg/L)	1.2	1.7	2.1	.20	1.8	2.3
pH (units)	10.1	8.4	10.9	11.2	11.0	8.1
Phenols, total (µg/L)	5	4	4	6	4	2
Phosphorus, total (mg/L)	.440	.570	.041	.070	.021	.120
Specific conductance (µS/cm)	[2]838	1,100	[2]427	720	2,380	1,190
Temperature (°C)	14.0	11.5	13.5	16.0	14.5	17.0

[1] Wells designated as "G" wells are those installed by the U.S. Geological Survey
[2] Laboratory value

Table 10.--Concentrations of trace metals and other dissolved substances in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. -- means no analysis made. < means less than]

Compound	Location and well number						
	St. Clair River area continued		Lake St. Clair area				
	G7	G8	G9	G10	G11	G12	G13
Antimony, total (µg/L)	13	1	3	2	5	1	5
Arsenic, total (µg/L)	13	4	2	2	8	<1	8
Barium, dissolved (µg/L)	96	2,100	78	110	79	4,000	1,000
Beryllium, dissolved (µg/L)	<1.0	21	<.5	<1	2	22	<.5
Cadmium, total (µg/L)	<1	<1	<1	<1	<1	<1	<1
Chromium, total (µg/L)	13	11	41	12	<1	<1	36
Cobalt, total (µg/L)	3	26	1	<1	<1	1	10
Copper, total (µg/L)	8	730	10	11	10	3	19
Iron, total (mg/L)	9.5	500	5.2	5.3	3.7	580	15
Lead, total (µg/L)	400	1,700	71	500	110	34	200
Mercury, total (µg/L)	.1	.3	.10	.20	.20	.30	.30
Nickel, total (µg/L)	11	1,300	11	6	2	<1	29
Selenium, total (µg/L)	<1	<1	<1	<1	<1	<1	<1
Zinc, total (mg/L)	26	78	9.6	21	21	74	16
Carbon, total organic (mg/L)	30	190	15	19	5.0	220	19
Chloride (mg/L)	56	11	14	280	530	5.6	32
Cyanide, total (mg/L)	<.010	<.010	<.010	<.010	<.010	<.010	<.010
Dissolved solids (mg/L)	218	145	230	1,020	1,530	144	3,920
Oil-grease, total (mg/L)	8	18	10	6	10	19	6
Nitrogen, total (mg/L)	2.5	--	1.3	3.0	.6	43	.20
pH (units)	10.9	10.3	8.5	11.4	7.5	10.7	[1]9.3
Phenols, total (µg/L)	4	4	5	4	3	7	8
Phosphorus, total (mg/L)	.16	.10	.008	.330	.090	.110	1.10
Specific conductance (µS/cm)	454	322	411	2,130	2,610	397	5,790
Temperature (°C)	12.5	12.5	14.5	14.0	12.0	18.5	14.0

[1] Laboratory value

Table 10.--Concentrations of trace metals and other dissolved substances in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. -- means no analysis made. < means less than]

Compound	Location and well number						
	Lake St. Clair area continued			Detroit River area			
	G14	G15	G16	G17	P1[1]	G18	G19
Antimony, total (µg/L)	5	1	5	--	--	<1	5
Arsenic, total (µg/L)	2	7	11	<1	58	3	13
Barium, dissolved (µg/L)	1,700	210	680	2,400	2,000	110	99
Beryllium, dissolved (µg/L)	260	14	4	13	<10	<1	<1
Cadmium, total (µg/L)	<1	1	4	<1	40	1	<1
Chromium, total (µg/L)	<1	25	12	<1	120	10	15
Cobalt, total (µg/L)	60	9	60	50	160	<1	<1
Copper, total (µg/L)	350	23	250	2,500	660	16	27
Iron, total (mg/L)	180	15	130	570	960	3.4	9.4
Lead, total (µg/L)	500	110	600	4,700	2,500	400	4,200
Mercury, total (µg/L)	.50	.20	.20	2.2	55	.40	.20
Nickel, total (µg/L)	500	19	400	900	880	7	2
Selenium, total (µg/L)	<1	<1	<1	<1	<1	<1	<1
Zinc, total (mg/L)	24	6.4	34	26	12	16	170
Carbon, total organic (mg/L)	68	7.5	14	330	1,000	9.3	29
Chloride (mg/L)	66	140	130	930	93	220	190
Cyanide, total (mg/L)	<.010	<.010	<.010	<.010	<.010	<.010	<.010
Dissolved solids (mg/L)	395	423	523	2,110	--	2,840	2,210
Oil-grease, total (mg/L)	3	3	2	4	--	4	13
Nitrogen, total (mg/L)	10	1.0	1.5	58	--	3.4	.90
pH (units)	8.8	8.6	10.6	7.0	6.6	9.0	10.1
Phenols, total (µg/L)	4	2	1	4	580	3	4
Phosphorus, total (mg/L)	1.10	.480	.710	3.80	2.2	.070	.830
Specific conductance (µS/cm)	686	776	942	3,620	3,110	3,070	[2]2,590
Temperature (°C)	13.0	10.5	13.0	13.5	14.0	15.0	14.5

[1] Wells designated as "P" wells are private wells
[2] Laboratory value

Table 10.--Concentrations of trace metals and other dissolved substances in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. -- means no analysis made. < means less than]

Compound	Location and well number					
	Detroit River area continued					
	P2	G20	P3	P3[1]	P3[2] RPD	G21
Antimony, total (µg/L)	4	1	<1	<1	0	1
Arsenic, total (µg/L)	84	2	<1	<1	0	4
Barium, dissolved (µg/L)	130	82	16	15	6	150
Beryllium, dissolved (µg/L)	1	<.5	<1	<1	0	3
Cadmium, total (µg/L)	<1	<1	5	<1	--	7
Chromium, total (µg/L)	3	30	30	26	14	29
Cobalt, total (µg/L)	6	<1	<1	<1	0	10
Copper, total (µg/L)	530	12	18	6	100	36
Iron, total (mg/L)	42	3	.12	.39	106	25
Lead, total (µg/L)	800	600	<5	8	--	300
Mercury, total (µg/L)	1.7	.70	.20	.30	40	<1.0
Nickel, total (µg/L)	1,500	6	4	3	29	42
Selenium, total (µg/L)	<1	<1	<1	<1	0	<1
Zinc, total (mg/L)	.39	12	.18	.63	192	9.6
Carbon, total organic (mg/L)	86	14	3.2	3.4	6	15
Chloride (mg/L)	64,000	32	18	23	24	27
Cyanide, total (mg/L)	<.010	<.010	<.010	<.010	0	<.010
Dissolved solids (mg/L)	114,000	1,390	2,380	2,240	6	2,420
Oil-grease, total (mg/L)	13	10	3	4	29	10
Nitrogen, total (mg/L)	.80	50	1.7	1.7	0	2.9
pH (units)	11.5	7.4	7.5	[3]7.9	52	7.4
Phenols, total (µg/L)	250	2	2	2	0	2
Phosphorus, total (mg/L)	.830	.600	.021	.041	65	.700
Specific conductance (µS/cm)	130,000	1,760	2,430	[3]2,400	1	2,440
Temperature (°C)	16.0	12.0	14.0	14.0	0	14.5

[1] Duplicate sample collected for quality assurance/quality control
[2] RPD (relative percent difference) is the difference between the two sample values, divided by the mean of the values, multiplied by 100. RPD is not calculated if one of the values is reported as less than (<).
[3] Laboratory value

Table 10.--Concentrations of trace metals and other dissolved substances in ground water discharging to the Upper Great Lakes connecting channels--Continued

[Analyses by the U.S. Geological Survey. -- means no analysis made. < means less than]

Compound	Location and well number						
	St. Marys River area						
	G22	P4	G23	G24	P5	P6	G25
Antimony, total (µg/L)	<1	--	1	<1	<1	<1	<1
Arsenic, total (µg/L)	1	2	1	2	1	1	1
Barium, dissolved (µg/L)	32	150	120	66	37	120	21
Beryllium, dissolved (µg/L)	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Cadmium, total (µg/L)	<1	<1	<1	<1	<1	<1	5
Chromium, total (µg/L)	23	<1	320	42	15	<1	25
Cobalt, total (µg/L)	<1	<1	4	70	<1	<1	70
Copper, total (µg/L)	<1	1	19	3	3	1	2
Iron, total (mg/L)	<.01	.04	6.6	.28	.16	.08	3.5
Lead, total (µg/L)	<5	<5	49	12	<5	12	<5
Mercury, total (µg/L)	.30	.10	.1	.30	.30	.30	.10
Nickel, total (µg/L)	<1	2	11	<1	<1	<1	<1
Selenium, total (µg/L)	<1	<1	<1	<1	<1	<1	<1
Zinc, total (mg/L)	.24	.081	8.4	2	.009	.099	.22
Carbon, total organic (mg/L)	.7	.6	56	4.6	2.4	2.2	1.3
Chloride (mg/L)	.70	160	.8	7.3	15	140	.70
Cyanide, total (mg/L)	<.010	<.010	<.010	<.010	<.010	<.010	<.010
Dissolved solids (mg/L)	101	443	385	290	263	487	156
Oil-grease, total (mg/L)	1	2	5	<1	<1	1	<1
Nitrogen, total (mg/L)	.20	.40	.4	1.0	.40	.40	1.2
pH (units)	8.3	8.3	8.2	8.4	7.9	8.2	7.5
Phenols, total (µg/L)	2	2	7	6	2	2	3
Phosphorus, total (mg/L)	.021	.100	.43	.070	.041	.120	.021
Specific conductance (µS/cm)	154	700	639	474	410	876	252
Temperature (°C)	8.0	11.0	9.5	9.0	12.0	12.5	8.0

APPENDIX E: IDENTIFICATION OF WASTE SITES

Information on the location and nature of active and inactive waste sites within 12 miles of the connecting channels was obtained from published reports, from the USEPA, and from the Michigan Department of Natural Resources. The majority of sites are landfills, hazardous-waste disposal sites, and regulated-storage sites. Other sites include transportation spills, leaking underground storage tanks, contaminated wells, and underground injection wells. The sites are listed by county in tables 11 to 17 and are shown on plates 6-10. Sixty-one sites listed on USEPA's CERCLIS (Comprehensive Environmental Response Compensation Liability Information System) list and 33 sites listed in a report by Gorman and Akeley (1978) have not been located or ranked because of insufficient information.

Underground injection wells are present in the St. Clair, Lake St. Clair, and Detroit River study areas. The wells are identified in table 11, but are not ranked because a suitable ranking system could not be developed. The USEPA is required by the Safe Drinking Water Act of 1974 to regulate injection-well activities to protect aquifers that are or may be used to supply public water systems. Injection wells are divided into the following five classes: (1) wells used to inject hazardous wastes or industrial and municipal waste waters below the lowest usable aquifer (Class I); (2) wells used to dispose of fluids associated with oil and gas production or to inject fluids for enhanced oil recovery or liquid hydrocarbon storage (Class II); (3) wells that inject fluids for mineral extraction, that is, solution mining (Class III); (4) hazardous waste wells used to inject wastes into or above usable aquifers (Class IV)[5]; and (5) wells not belonging in the other four classes, generally used to inject nonhazardous fluids into or above usable aquifers (Class V). All wells have been tested for mechanical integrity. Any well that failed the test was shut down.

There are seven Class I wells in the St. Clair, Lake St. Clair, and Detroit River study areas. Two of the wells were used to inject a nonhazardous mixed-brine solution to depths greater than 4,600 ft; they are temporarily abandoned. Three of the other five Class I wells dispose of hazardous wastes at depths greater than 3,700 ft. The wastes contain chloride, ammonia, and phenols. The remaining two Class I wells were used to dispose of hazardous wastes at depths greater than 3,800 ft; neither of the wells are currently operating.

Permits have been issued for more than 63 Class II wells, 7 of which are not currently in operation. Class II wells are divided into three types. Type D wells are saltwater disposal wells. The 29 type D wells inject saltwater at depths of 890 ft to greater than 4,000 ft. Type H wells are hydrocarbon storage wells. These wells provide access to rock formations that are used to store natural gas, refined petroleum products, or liquified petroleum gas. At least 28 type H wells use storage areas usually 2,500 ft or more deep. Type R wells, which are enhanced-oil-recovery wells, are all within the St. Clair River study area. Of the six type R wells with permits,

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5 Use of Class IV wells was banned in 1985.

five are currently operating. These wells are finished in the Detroit River Group and Niagaran Dolomite.

Thirteen wells have Class III permits for solution mining. Water is pumped into a salt bed, the salt dissolves, and the water is pumped out. Eight of the wells, which produce salt from Salina Group evaporites, operate in the St. Clair River area. The other five wells are not in operation.

There are no Class IV wells in the UGLCC study area. Of the 200 Class V wells, 103 are in Chippewa County, 17 are in the St. Clair Area, 14 are in the Lake St. Clair area and 66 are in the Detroit River area. None are considered potential contamination sources by the USEPA.

Table 11.--Underground injection sites in Macomb, Monroe, Oakland, St. Clair, and Wayne Counties

[Source: Christiane Saada and Art Moretta, U.S. Environmental Protection Agency, written commun., 1988. Site numbers indicate county; MA is Macomb County, MO is Monroe County, OA is Oakland County, SC is St. Clair County and WA is Wayne County.]

Site number	Site name	Well name	Well[1] permit number	Well[2] class	Well[3] type	Well[4] status
MA-U1	Consumers Power Company	Dean Kaster '1-1	MIS24061	II	D	AC
MA-U2	Consumers Power Company	Lenox	MIS2H19	II	H	AC
MA-U3	Consumers Power Company	Ray	MIS2H27	II	H	AC
MA-U4	Tenexco Incorporated	Inwood 1-10	MIS36401	II	D	TA
MA-U5	Preston Oil Company	Marcereau Etal '6-36	MIS0992D0001	II	D	TA
MO-U1	Sun Exploration and Production Co.	F Roe 3	MIS4225	II	D	AC
MO-U2	Freedom Oil Company	H Montry 4	MIS8569	II	D	PA
MO-U3	Grey Petroleum Incorporated	Halberstadt A1	MISBD69	II	D	AC
MO-U4	Dixon Exploration Incorporated	Woodbury 1-19	MIS37598	II	D	AC
OA-U1	Energy Acquisition Corporation	Peters 1-21	MIS1252D0001	II	D	UC
OA-U2	Lakeville Gas Association	Leonard BDW-1	MIS30697	II	D	AC
SC-U1	Consumers Power Company	FB-7005 ('2-CC)	MIS28537	II	H	AC
SC-U2	Consumers Power Company	FB-7007 ('10C5)	MIS28550	II	H	AC
SC-U3	Consumers Power Company	FB-7008 ('2-C5)	MIS28588	II	H	AC
SC-U4	Consumers Power Company	FB-7012 ('2-C3)	MIS28598	II	H	AC
SC-U5	Consumers Power Company	FB-7010 ('2-C4)	MIS28599	II	H	AC
SC-U6	Consumers Power Company	FB-7006 ('3-CC)	MIS28600	II	H	AC
SC-U7	Consumers Power Company	FB-7004 ('1-CC)	MIS28601	II	H	AC
SC-U8	Consumers Power Company	FB-7009 ('1-C4)	MIS28549	II	H	AC
SC-U9	Consumers Power Company	FB-7011 ('1-C3)	MIS28538	II	H	AC
SC-U10	Sappington Crude Oil	Ferdinand Fordt 1	MIS23720	II	D	AC
SC-U11	Sappington Crude Oil	Brown 3	MIS25704	II	D	AC
SC-U12	Consumers Power Company	Four Corners	MIS2H9	II	H	AC
SC-U13	Sun Exploration and Production Co.	Melvin Thueme '2	MIS23388	II	D	AC
SC-U14	Sun Exploration and Production Co.	Columbus 3 Unit 9-2	MIS27655	II	R	AC
SC-U15	Sun Exploration and Production Co.	Waltos and St Clair Rd	MIS1472D0008	II	D	AC
SC-U16	Sun Exploration and Production Co.	Columbus 3 Unit	MIS2R20	II	D	AC
SC-U17	Vans Tank Truck Service	Marian and Aileen Stov	MIS25311	II	R	AC
SC-U18	Vans Tank Truck Service	Arthur Fordt '1	MIS24868	II	R	TA
SC-U19	Wiser Oil Company	Harvey Schultz 3	MIS1472D0004	II	D	AC
SC-U20	Consumers Power Company	Consumers Power CO-M	MIS2H43	II	H	AC
SC-U21	Consumers Power Company	BD-139	MISBD139	II	D	AC
SC-U22	Consumers Power Company	Smith "E" 01	MIS1472D0005	II	D	AC
SC-U23	Consumers Power Company	2-7 BDW	MIS1471I0002	I	I	TA
SC-U24	Consumers Power Company	1-7 BDW	MIS1471I0001	I	I	TA
SC-U25	Eastside Producing Company	Mullins and Gaedcke 2	MIS24190	II	D	TA
SC-U26	Diamond Crystal	1	-----	III	G	AC

[1]Well permit number is the number of the approved permit issued by U.S. Environmental Protection Agency.

[2]Class I wells are industrial and municipal wells; Class II wells are associated with oil and gas production and liquid hydrocarbon storage; Class III wells are process wells used in solution mining.

[3]Type H (Class I) wells are industrial hazardous waste disposal wells; Type I (Class I) wells are nonhazardous waste disposal wells; Type D (Class II) wells are salt water disposal wells; Type H (Class II) wells are hydrocarbon storage wells; Type R (Class II) wells are enhanced oil recovery wells; Type G (Class III) wells are solution mining wells.

[4]Well status AC refers to an active well; TA is a temporarily abandoned well; UC is a well under construction; and PA is a plugged and abandoned well.

Table 11.--Underground injection sites in Macomb, Monroe, Oakland, St. Clair, and Wayne Counties--Continued

Site number	Site name	Well name	Well permit number	Well Class	Well type	Well status
SC-U27	Diamond Crystal	2	-----	III	G	AC
SC-U28	Diamond Crystal	3	-----	III	G	AC
SC-U29	Diamond Crystal	4	-----	III	G	AC
SC-U30	Diamond Crystal	5	-----	III	G	AC
SC-U31	Diamond Crystal	6	-----	III	G	AC
SC-U32	Diamond Crystal	7	-----	III	G	AC
SC-U33	Diamond Crystal	8	-----	III	G	AC
SC-U34	Lanphars Incorporated	Broadbridge-Meli 1	MIS25729	II	R	AC
SC-U35	Leob Oil Company	Belin	MIS2R22	II	R	AC
SC-U36	Leob, Herman L.	Berk Henderson 2	MIS22406	II	D	PA
SC-U37	McClure Oil Company	Naeyaert 1	MIS27703	II	R	AC
SC-U38	Michigan Consolidated Gas Company	Belle River Mills	MIS2H6	II	H	AC
SC-U39	Michigan Consolidated Gas Company	Columbus West	MIS2H2	II	H	AC
SC-U40	Michigan Consolidated Gas Company	Columbus	MIS2H3	II	H	AC
SC-U41	Morton Salt Company	Morton Salt Manistee	MIS024737851	III	G	PA
SC-U42	Consumers Power Company	Hessen	MIS2H13	II	H	AC
SC-U43	Consumers Power Company	Ira	MIS2H15	II	H	AC
SC-U44	Consumers Power Company	Puttygut	MIS2H26	II	H	AC
SC-U45	Consumers Power Company	Swan Creek	MIS2H33	II	H	AC
SC-U46	Consumers Power Company	Lyszczyk 01	MIS21530	II	D	PA
SC-U47	American Oil Company	American Oil Co-St C	MIS2H44	II	H	AC
SC-U48	Amoco Production Company	St. Clair LPG Termina	MIS2H37	II	H	AC
SC-U49	Sun Exploration and Production Co.	Kaufman 1	MIS23412	II	D	AC
SC-U50	ANR Pipeline Company	Harry and J. Tosch etal #1	MIS24646	II	D	AC
SC-U51	ANR Pipeline Company	Beebe #1	MIS24876	II	D	AC
WA-U1	BASF Wyandotte	BASF Wyandotte Corp.	MIS2H36	II	H	AC
WA-U2	Consumers Power Company	Northville	MIS2H22	II	H	AC
WA-U3	Marathon/Buckeye Petro Company	Brine Disp Well #1	MISBD146	II	D	AC
WA-U4	Mobil Oil Corporation	Mobile Trenton LPG St	MIS2H40	II	H	AC
WA-U5	Phillips Petroleum Company	Phillips-Wyandotte L	MIS2H38	II	H	AC
WA-U6	Sun Exploration and Production Co.	Sun Inkster 4	MISBD124	II	D	AC
WA-U7	Sun Exploration and Production Co.	Sun Inkster 3	MISBD96	II	D	AC
WA-U8	Sun Exploration and Production Co.	Sun Inkster 2	MISBD95	II	D	AC
WA-U9	Sun Exploration and Production Co.	Sun Inkster Junction	MIS2H45	II	H	AC
WA-U10	Detroit Coke Corporation	WDW-1	MIS1631H0003	I	H	AC
WA-U11	Detroit Coke Corporation	WDW-2	MIS1631H0004	I	H	AC
WA-U12	Detroit Coke Corporation	WDW-3	MIS1631H0005	I	H	AC
WA-U13	Rouge Steel Company	Ford Disposal Well #1	MIS1631HP&AL	I	H	PA
WA-U14	Rouge Steel Company	Ford Disposal Well #2	MIS1631H0002	I	H	TA
WA-U15	Pennwalt Chemical Co.-Wyandotte	Wyandotte 15	MIS47736882	III	G	PA
WA-U16	Marathon Oil Company	Woodhaven (LPG site)	MIS2H41	II	H	AC
WA-U17	Pennwalt Corporation	Pennwalt 4	MIS049736882	III	G	PA
WA-U18	Bell and Gault Drilling	Sun Inkster 5	MISBD155	II	D	AC
WA-U19	Marathon Oil Company	Woodhaven #1	MIS27160	II	D	AC
WA-U20	Pennwalt Corporation	Wyandotte #6	MIS48736882	III	G	PA
WA-U21	Pennwalt Corporation	Wyandotte #4	MIS49736882	III	G	PA

Table 12.--Confirmed or possible ground-water-contamination sites in Macomb County

[The use of industry or firm names in this report is for identification or location purposes only and does not impute responsibility for any present or potential effects on the natural resources. The first two segments of the site location designate township and range, the third segment designates section, and the letters A through D designate successively smaller 1/4 subdivision of the section; see Site-Location System. Dash indicates data not presently available. References to footnotes are numbered and are given in parenthesis following each site name.]

Site number	Site name	Site location	Nature of site
MA1	Malow Landfill (1,2,3)	3N 12E 30AB, 30AC, 30BA, and 30BD	Landfill. Demolition debris
MA2	Carolee Street area (1,2,4)	3N 12E 22CB	Residential water wells having high chloride levels
MA3	Ramona Park Landfill (1,2,3,4)	3N 12E 33CA	Landfill. Mixed industrial and municipal waste. Phenols
MA4	Residential wells Foss Road (1,2,4)	3N 13E 10ACC	Tetrachloroethylene
MA5	Residential wells Cedargrove Road (1,2,4)	3N 12E 20ABB	Dichloroethane

[1] Frank Belobraidich, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987.

[2] Steve Cunningham, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987.

[3] Tom Work, Michigan Department of Natural Resources, written comm., 1986

[4] Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987.

Table 12.--Confirmed or possible ground-water-contamination sites in Macomb County--Continued

Site number	Site name	Site location	Nature of site
MA6	New Haven Foundary (1,2,4)	4N 14E 33BDCA	Steel foundry
MA7	Tuff Kote Dinol Inc. (1,2,4)	1N 12E 12CC	Light industry
MA8	Clinton River Road Disposal area (1,2,3,4)	2N 13E 19AD	Landfill. Mixed industrial and municipal waste. Phenols
MA9	Hamlin Road Landfill (1,2,3,4,5)	3N 12E 19CDA, 19CDD, 19DC, 19DDC, and 30AB	Landfill. Mixed industrial and municipal waste. Methylene chloride, dichloropropane, chlorobenzene
MA10	Koch Road Dump (1,2,4)	2N 12E 32BDD	Landfill.
MA11	Utica Site Cardinal Land Corp. (1,2,3,4)	3N 12E 33DC	Landfill. Light industrial waste
MA12	G and H Landfill (1,2,3,4,5,6,7)	3N 12E 19AA	Landfill. Phenols, phthalates, benzene, chromium, cyanide
MA13	Red Run Drain Landfill (1,2,3,4,5)	2N 12E 25A	Landfill. Heavy metals, toluene, benzene

[5] Gorman and Akeley, 1978

[6] U.S. Environmental Protection Agency, 1986a.

[7] Ken Westlake, U.S. Environmental Protection Agency, written commun., 1987.

Table 12.--Confirmed or possible ground-water-contamination sites in Macomb County--Continued

Site number	Site name	Site location	Nature of site
MA14	Ryan and 23 Mile Road (1,2,4)	3N 12E 19AA	Residential water wells. Toluene, xylene, vinylidene chloride chlorinated hydrocarbons
MA15	South Macomb Disposal Authority 9 and 9A (1,2,3,4,5,6,7)	3N 13E 15BD	Landfill. Household and commercial waste. Methylethyl ketone, ethyl ether, styrene
MA16	St. Lawrence Cemetery--sawmill (1,2,3,5)	3N 12E 33CBD	Landfill. Household and commercial waste
MA17	Metro Beach Incinerator (1)	2N 14E 22	Incinerator. General refuse
MA18	American Legion (1,2,3,5)	3N 12E 33DA	Landfill. Household and commercial waste, demolition debris
MA19	Dean Bros. 27 Mile Lenox Township (1,2,3)	4N 14E 35BDAB	Landfill. Mixed industrial and municipal waste
MA20	Dean Bros. 25 Mile Chesterfield Township (1,2,3,5)	3N 14E 10AD	Landfill. Mixed industrial and municipal waste
MA21	A and A Lenox Township (1)	4N 14E 24	Landfill (under construction)
MA22	Detroit Sportsman Congress (A and A Landfill) (1,2,3,5)	3N 12E 19CA	Landfill. Commercial and demolition debris. Possible liquid waste disposal

Table 12.--Confirmed or possible ground-water-contamination sites in Macomb County--Continued

Site number	Site name	Site location	Nature of site
MA23	Sugarbush (1,2,4)	3N 14E 21DCCD	Landfill. Chromium lead, nickel, copper, zinc
MA24	South Macomb Disposal Authority Transfer Station (1)	1N 13E 18BA	General refuse
MA25	New Baltimore Sanitary Landfill (1)	3N 14E 13BBBD	Landfill. General refuse
MA26-27	Ray Township Transfer and Disposal Station (1,3)	4N 13E 17A and 17D	Landfill. Household and commercial waste
MA28	Richmond Township Landfill (1,3,5)	5N 14E 33ADA	Landfill. Demolition debris
MA29	Mt. Clemens Coatings and Plastics (Ford Vinyl and Paint, Mt. Clemens) (2,4)	2N 13E 2DC	Automobile manufacturing, PCB, phthalates, methyl ethyl ketone, tetra-hydrofuran
MA30	City of Warren, Refuse Transfer Station (1)	1N 12E 24CAB	--
MA31	Rosso Highway SAFB - Avis Ford (1,3)	3N 14E 32	Landfill. Foundry sand
MA32	Grosse Points Clinton Waste Reduction Plant (old Dean site) (1)	2N 13E 34DA and 34DB	Incinerator
MA33	Liquid Disposal (1,2,4,6,7)	3N 12E 30AAA	Liquid waste incinerator. Phenols, PCB, trichloroethylene, perchlorethylene, phthalates, chloroform
MA34	Standard Oil Gas Station (1,2,4)	2N 13E 27AA	Gas Station. Benzene, toluene, xylene

Table 12.--Confirmed or possible ground-water-contamination sites in Macomb County--Continued

Site number	Site name	Site location	Nature of site
MA35	Achem Products Inc. (8)	1N 12E 28CDA	Industrial plant
MA36	General Electric Co. (8)	1N 12E 34DB and 34DC	Wastes stored in containers; spent halogenated and nonhalogenated solvents, electroplating sludges, solutions with cyanide
MA37	GMC Technical Center (8)	1N 12E 8A, 8D, and 9	Wastes stored or treated on site; spent halogenated and nonhalogenated solvents, lead, acetone, toluene diisocyante
MA38	OMI International Corp Udylite Sel-Rex (8)	1N 12E 34DBA	Wastes stored in containers or tanks; spent halogenated and nonhalogenated solvents, chromium, cyanide, lead
MA39	U.S. Army Tank Automotive Command (8)	1N 12E 16ACC and 16BDD	Wastes stored in containers or tanks; spent halogenated and nonhalogenated solvents, electroplating sludges, cyanide,
MA40	U.S .Chemical Company Inc. (8)	1N 13E 7CCA	Wastes stored in containers or tanks; spent halogenated and nonhalogenated solvents

[8] Richard Traub, U.S. Environmental Protection Agency, written comm., 1986.

Table 12.--Confirmed or possible ground-water-contamination sites in Macomb County--Continued

Site number	Site name	Site location	Nature of site
MA41	Selfridge ANG Base (8)	2N 14E 18BCA	Wastes stored in containers or tanks; spent halogenated and nonhalogenated solvents, formic acid, 1,1,1-trichloroethane,
MA41a	Selfridge ANG Base (2,4)	2N 14E	Landfills (3), solvents, paint wastes, petroleum products. Fuel spills (2), JP-4. Fire training areas (2), solvents, paint wastes, petroleum products
MA42	Safety Kleen Corporation (8)	2N 13E 2ADB	Wastes stored in containers or tanks; spent halogenated and nonhalogenated solvents, lead
MA43	M-97 Landfill (3)	2N 13E 10DAC	Landfill. Demolition debris, and stumps
MA44	Weil Sanitary Landfill (3)	3N 14E 2	Proposed landfill never developed. Removed from map and ranking
MA45	Hayes Road Site No. 8 (3,5)	2N 12E 36A	Landfill. General refuse
MA46	Marsack and Son (3)	1N 13E 3BB and 3BC	Landfill
MA47	Fourteen Mile Road Site (3)	2N 13E 33D	Landfill. General refuse, industrial waste
MA48	Macomb Township Dump (2)	3N 13E 14CD	Landfill

Table 12.--Confirmed or possible ground-water-contamination sites in Macomb County--Continued

Site number	Site name	Site location	Nature of site
MA49	Mt. Clemens (2)	2N 13E 12D	Landfill
MA50	South Macomb Disposal (2)	2N 13E 34CA	Landfill
MA51	Cardinal (Reitzloff) (2)	1N 13E 34CDB	Landfill
MA52	South Macomb Disposal (2)	1N 13E 3BA	Landfill
MA53	Detroit Fill (2)	1N 12E 4AC	Landfill. Incinerator ash
MA54	Blundt Dump - Hamtramck or Highland Park (2)	1N 12E 6BD	Landfill
MA55	Detroit Fill (2)	2N 12E 33CCC	Landfill. Incinerator ash
MA56	South Macomb Disposal (2)	2N 12E 32DB and 32DC	Landfills (2)
MA57	Detroit fill (2)	2N 12E 32BBA	Landfill. Incinerator ash
MA58	South Macomb Disposal No. 5 (2)	2N 12E 23AAA	Landfill
MA59	Detroit Fill (2)	3N 12E 33D	Landfill. Incinerator ash
MA60	Detroit Fill (2)	3N 12E 30ADA	Landfill. Incinerator ash
MA61	Residential wells Card Road (2)	3N 13E 15DA	Residential water well having low concentration of benzene
MA62	Henning Road Landfill (2)	3N 14E 29CB	Landfill
MA63	Shores Oil Co. (2)	1N 13E 28CD	Oil storage. Fuel oil

Table 12.--Confirmed or possible ground-water-contamination sites in Macomb County--Continued

Site number	Site name	Site location	Nature of site
MA64	Fini Finish Products (2)	1N 12E 29AA	Plating, polishing. Chrome, cyanide
MA65	GE Carboloy (2)	1N 12E 34DC	Underground storage tank. Acetone
MA66	G and L Industries (2)	3N 14E 30BD	Fiberboard manufacture. Phthalates, lead
MA67	Clark Gas Station (2)	1N 12E 5DA	Gas station
MA68	NI Industries/Mirrex (2)	2N 13E 14AA	Drum storage. Paint products
MA69	Clinton River (2)	Mt. Clemens to mouth (2N 13E and 2N 14E)	River sediments. Chrome, lead, oil, grease

Table 13.--Confirmed or possible ground-water-contamination sites in Monroe County

[The use of industry or firm names in this report is for identification or location purposes only and does not impute responsibility for any present or potential effects on the natural resources. The first two segments of the site location designate township and range, the third segment designates section, and the letters A through D designate successively smaller 1/4 subdivisions of the section; see Site-Location System. References to footnotes are numbered and are given in parameters following each site name.]

Site number	Site name	Site location	Nature of site
MO1	Ash Township (1,2,3)	5S 9E 8DAB	Landfill. Mixed industrial and municipal waste
MO2	Burt's Landfill (1,2)	5S 10E 6AA	Landfill. Foundry sand
MO3	Edward C. Levy Co. (1,2,3,4)	5S 9E 5AB and 5AC	Landfill. Solid industrial waste from steel mill
MO4	Matlin Road (Carleton) (1,2)	5S 9E 8DBA and 8DBC	Landfill. Demolition debris
MO5	Wayne Disposal (Rockwood) (1,2)	5S 10E 34AD	Landfill. Inert wastes; demolition debris, foundry sand

[1] Frank Belobraidich, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987.

[2] Tom Work, Michigan Department of Natural Resources, written comm., 1986.

[3] Gorman and Akeley, 1978

[4] Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987.

Table 13.--Confirmed or possible ground-water-contamination sites in Monroe County--Continued

Site number	Site name	Site location	Nature of site
MO6	Brandon Road Land Reclamation (Proposed site only) (1,2)		Proposed landfill, never developed. Removed from map and ranking
MO7	Moo-Lee Co. (1,2,4,5)	5S 10E 35BCAB	Landfill. Inert wastes; demolition debris, foundry sand and fly ash

[5] Steve Cunningham, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987.

Table 14.--Confirmed or possible ground-water-contamination sites in Oakland County

[The use of industry or firm names in this report is for identification or location purposes only and does not impute responsibility for any present or potential effects on the natural resources. The first two segments of the site location designate township and range, the third segment designates section, and the letters A through D designate successively smaller 1/4 subdivision of the section; see Site-Location System. References to footnotes are numbered and are given in parameters following each site name.]

Site number	Site name	Site location	Nature of site
OA1	Parker Chemical Company (1)	1N 11E 2BD	Wastes stored in containers or tanks; spent halogenated and nonhalogenated solvents, chromium, corrosive wastes
OA2	Reichhold Chemicals Inc. (1)	1N 11E 27AC	Wastes stored in containers or tanks; spent halogenated and nonhalogenated solvents, lead, hydroxybenzene, formaldehyde
OA3	Safety Kleen Corp. (1)	1N 11E 36BB	Wastes stored in containers; spent halogenated and nonhalogenated solvents
OA4	Operator unknown (2)	1N 11E 12A	Landfill
OA5	Southeast Oakland County Incinerator Authority (2)	1N 11E 12CB	Landfill

[1] Richard Traub, U.S. Environmental Protection Agency, written comm., 1986.

[2] Steve Cunningham, Michigan Department of Natural Resources, written comm., 1985, 1986, 1987.

Table 14.--Confirmed or possible ground-water-contamination sites in Oakland County--Continued

Site number	Site name	Site location	Nature of site
OA6	Operator unknown (2)	1N 11E 11DA	Landfill
OA7	City of Detroit (2)	1N 11E 13DB	Landfill
OA8	Operator unknown (2)	1N 11E 13ACCC	Landfill
OA9	City of Detroit (2)	1N 11E 25AAA	Landfill
OA10	City of Detroit (2)	1N 11E 32CA	Landfill
OA11	Southeast Oakland County Incinerator Authority (2)	1N 11E 12CCC	Landfill
OA12	Howard Plating (2)	1N 11E 1AA	Plating, polishing. Cyanide, heavy metals
OA13	Ethyl Corporation (2)	1N 11E 33CD	Petroleum refining

Table 15.--Confirmed or possible ground-water-contamination sites in St. Clair County

[The use of industry or firm names in this report is for identification or location purposes only and does not impute responsibility for any present or potential effects on the natural resources. The first two segments of the site location designate township and range, the third segment designates section, and the letters A through D designate successively smaller 1/4 subdivision of the section; see Site-Location System. References to footnotes are numbered and are given in parameters following each site name.]

Site number	Site name	Site location	Nature of site
SC1	Belle River Berm Project (Range Road Property) (1,2,3)	4N 16E 12	Landfills. Fly ash disposal
SC2	Howard Disposal (1,2,3)	7N 17E 16CCD	Landfill. Demolition debris
SC3	Huron Development (Marine City Sanitary Landfill) (1,2,3)	4N 16E 28DDA, 28DCA, 28DDB, 28DCB	Landfill. Household waste, demolition debris, foundry sand
SC4	Whitcomb Barrel Dump (4,5)	6N 16E 5DB	Heavy manufacturing wastes
SC5	Vlasic Foods Inc. Sanitary Landfill (1,2,3)	5N 16E 6ABC	Landfill. Pickling process waste
SC6	Blue Water Construction (1,2,3)	7N 17E 16BBA	Landfill. Demolition debris

[1] Frank Belobraidich, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987.

[2] Tom Work, Michigan Department of Natural Resources, written comm., 1986.

[3] Gorman and Akeley, 1978.

[4] Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987.

[5] Steve Cunningham, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987.

Table 15.--Confirmed or possible ground-water-contamination sites in St. Clair County--Continued

Site number	Site name	Site location	Nature of site
SC7	Clay Township Sanitary Landfill (1,2,3)	2N 16E 4CCA	Landfill. Household and commercial waste
SC8	Norman Markel (1,2,3)	3N 16E 2DABC	Industrial waste, demolition debris
SC9	B.F.I. Landfill (1,2)	5N 15E 27A	Proposed landfill, never developed. Removed from map & ranking
SC10	County Line Landfill (1,2)	4N 15E 18DC	Landfill. Mixed industrial and municipal waste
SC11	Winchester Disposal area (1,4,5)	6N 17E 17AC	Household and heavy industrial waste
SC12	Hwy M-29 and Michigan St. (1,4,5)	2N 16E 10CA	Service station. gasoline
SC13	Grand Trunk Railroad (1,4,5)	6N 17E 17AB	Railroad pipeline. Oil
SC14	Sanitary Landfill Area No. 1 (Smith Creek Landfill) (1,2,3,4,5)	6N 16E 32CAD	Landfill. Mixed industrial and municipal waste. Phenols
SC15	Wills Street Dump site (1,4,5)	5N 17E 7AC	Landfill. Heavy manufacturing wastes
SC16	A and B Waste Disposal (1,4,5)	6N 17E 20DDDD	Landfill. Toluene, xylene, trichloroethane, ethyl benzene, tetrachloroethylene
SC17	John A. Biewer Company (1,4,5)	4N 16E 1DA	Wood preserving. Chromium

Table 15.--Confirmed or possible ground-water-contamination sites in St. Clair County--Continued

Site number	Site name	Site location	Nature of site
SC18	Hoover Chemical Reeves Products (1,4,5)	6N 17E 20DD	Paint products. Methylene, chloride, solvents
SC19	Akzo Chemie America (6)	5N 17E	Wastes stored in containers; methyl hydrazine, methyl isocyanate, 2-propanone, toluene
SC20	Eltra Corp. Prestolite Wiring (6)	6N 17E 21CAAA	Wastes stored in containers; halogenated and nonhalogenated solvents, wastewater, lead, chloroethene, methyl ethyl ketone
SC21	Mueller Brass Co. (6)	6N 17E 9AB	Waste stored in pile; lead. Wastes treated in tanks; cadmium, cyanide solutions, chromium, halogenated solvents
SC22	St. Clair Rubber Co. Marysville (1,4,5)	5N 17E 6AA	Plastic, rubber manufacturing.
SC23	Fort Gratiot Sanitary Landfill (2)	7N 17E 16CDC	Landfill. Household wastes, demolition debris, foundry sand, fly ash
SC24	Total Oil Storage (4)	6N 17E 8CC	Oil storage

[6] Richard Traub, U.S. Environmental Protection Agency, written comm., 1986.

Table 15.--Confirmed or possible ground-water-contamination sites in St. Clair County--Continued

Site number	Site name	Site location	Nature of site
SC25	General Technical Coatings (4)	3N 16E 12CA	Paint products
SC26	Harsens Island Barrel Dump (4)	2N 16E 20BCC	Landfill. Paint products

Table 16.--Confirmed or possible ground-water-contamination sites in Wayne County

The use of industry or firm names in this report is for identification or location purposes only and does not impute responsibility for any present or potential effects on the natural resources. The first two segments of the site location designate township and range, the third segment designates section, and the letters A through D designate successively smaller 1/4 subdivisions of the section; see Site-Location System. Dash indicates data not presently available. References to footnotes are numbered are are given in parameters following each site name.]

Site number	Site name	Site location	Nature of site
WA1	Ford Motor Company Allen Park Clay Mine (1,2,3,4)	2S 10E 25CD and 36BA 36BA	Landfill. Fly ash, foundry sand. Barium, lead, tar sludge from coking operations, emission control sludge from steel production
WA2	Huron Quarry Sanitary Landfill (1,2,5,6)	4S 9E 36DB	Landfill. Domestic waste incinerator ash
WA3	Pennfill (1,2,5,6)	3S 10E 34CD	Industrial landfill containing foundry sand, brick, calcium carbonate sludge, concrete slag
WA4	M and P Development Co. (1,2,5,6)	4S 10E 30DBDB	Landfill. Municipal and light industrial waste

[1] Frank Belobraidich, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987.

[2] Tom Work, Michigan Department of Natural Resources, written comm., 1986.

[3] Richard Traub, U.S. Environmental Protection Agency, written comm., 1986.

[4] David Slayton, Michigan Department of Natural Resources, written comm., 1986 and 1987.

Table 16.--Confirmed or possible ground-water-contamination sites in Wayne County--Continued

Site number	Site name	Site location	Nature of site
WA5	Mclouth Steel Corp. (1,2)	4S 10E 36	Slag disposal
WA6	Michigan Casting Center (1,2)	4S 10E 33BC	Landfill. Foundry sand
WA7	Monsanto Co. (1,3,4)	4S 11E 30C	Wastes stored in containers or surface ponds; corrosive and reactive wastes, arsenic
WA8	Riverview Land (1,2) Preserve	4S 10E 11A, 11B, 12B, and 12C	Landfill. Mixed industrial and commercial waste, demolition debris, fly ash, foundry sand
WA9	Sibley Quarry (1,2)	4S 11E 7BB	Landfill. Inert waste, fly-ash disposal
WA10	Thorton Landfill (1,2,5,6)	4S 10E 4CB	Landfill. Industrial waste. Chromium, nickel
WA11	Vulcan Mold and Iron Co. (1,2,5,6)	4S 11E 7CC	Landfill. Foundry sand, benzene, phenols, toluene, and xylene
WA12	Ottawa Silica Co. (1,2)	5S 10E 15BD and 15AC	Landfill. Household and commercial waste

[5] Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987.

[6] Steve Cunningham, Michigan Department of Natural Resources, written comm., 1985, 1986, and 1987.

Table 16.--Confirmed or possible ground-water-contamination sites in Wayne County--Continued

Site number	Site name	Site location	Nature of site
WA13	Lyon Development Co. (1)	4S 9E 5C	Proposed landfill never developed. Removed from map and ranking
WA14	Detroit River Sediments (1,5,6)	Detroit River	Mercury, lead, PCB, arsenic, zinc, nickel
WA15	Federal Marine Terminal Properties (1,5,6)	4S 11E 5C	Landfill. Mercury, chlorinated hydrocarbons, phenols, organics
WA16	Dump near Wicks Elementary School (1,5,6)	3S 9E 8CA and 8BD	Landfill. Phenol, cyanide, zinc, iron, xylene, cadmium
WA17	Peloquin Enterprises Detroit (1,5,6)	1S 12E 9CC	Oil storage and waste processing
WA18	Peloquin Enterprises St. Aubin (1,5,6)	1S 12E 29CA	Waste hauling. Heavy manufacturing oils
WA19	Chem-Met Services (1,3,4,5,6)	4S 10E 3DDDA	Waste-treatment facility. Xylene, toluene, asbestos, chloride
WA20	Zug Island Great Lake Steel (1,5,6)	2S 11E 35	Steel foundry. Asbestos, oil
WA21	Norfolk and Western Railroad (1,5,6)	2S 11E 32BD	Wastes stored in tanks; fuel oil
WA22	Industrial Landfill (Firestone) (1,5,6)	4S 11E 5B	Landfill. PCB, phenol
WA23	Mich. Con. Riverside Park (1,5,6)	2S 12E 19BB	Coal gasification. Petroleum and coal products, benzene, copper, xylene, pyrene, zinc

Table 16.--Confirmed or possible ground-water-contamination sites in Wayne County--Continued

Site number	Site name	Site location	Nature of site
WA24	National Airport Site (1,5,6)	2S 9E 18CB	Landfill
WA25	Cooper School Site (1,5,6)	2S 9E 1CB	Landfill
WA26	Erving and Vivian Brown Landfill (1,5,6)	5S 10E 6AA	Landfill
WA27	Dynamite Park (1)	2S 9E 28DC	Possible release of waste water from a now closed automobile dealership
WA28	B.A.S.F. Wyandotte North works (1,3,5,6)	3S 10E 21B	Chemical company. Styrene, phenols, dichloroethane, benzene, chloroform Wastes stored in containers; spent halogenated and nonhalogenated solvents
WA29	B.A.S.F. Wyandotte South works (1,5,6)	3S 11E 32C	Chemical company. Chloroform, phenols dichloroethane, trichloroethane
WA30	Allied Chemical Corp. Detroit Tar Plant (3)	2S 11E 26CDC	Wastes stored in containers (drums etc); creosote-production sludges, creosole, naphthalene
WA31	Ashland Chemical Co. (3)	1S 12E 21CADD	Wastes stored in containers; spent halogenated and nonhalogenated solvents

Table 16.--Confirmed or possible ground-water-contamination sites in Wayne County--Continued

Site number	Site name	Site location	Nature of site
WA32	Chemical Recovery Systems (3,4,5,6)	3S 9E 5ABB	Wastes stored in containers or tanks; spent halogenated and nonhalogenated solvents, acetone, trichloroethylene, 1,1,1-trichloroethane. Lagoon, leaking organic chemicals, priority pollutants
WA33	Commercial Steel Treating Corp. (3)	2S 11E 3BDD	Wastes treated on site; metal-heat-treating operation sludges, cyanides
WA34	Dearborn Refining Co. (3,5,6)	2S 11E 17DDDD	Wastes stored in tanks; Electroplating and heat-treating sludges, cyanides, barium, cadmium, chromium, lead, silver
WA35	Detrex Chemical Industries, Inc. (3)	1S 11E 20ADA and 20ADB	Wastes stored in containers or tanks; spent halogenated solvents
WA36	Diversey Corp. (3)	3S 11E 21CBB	Wastes stored in containers; chromium, dichloromethane, methyl alcohol. Wastes treated in tanks; chromium

Table 16.--Confirmed or possible ground-water-contamination sites in Wayne County--Continued

Site number	Site name	Site location	Nature of site
WA37	Edwards Oil Service Inc. (3,4)	2S 11E 28CA	Stored or treated in tanks; arsenic, barium, cadmium, chromium, lead, mercury, selenium, spent pickle liquor from steel-finishing operation
WA38	Environmental Waste Control Inc. (3,4)	2S 9E 25ACCB	Wastes stored in tanks or treated in ponds or tanks: spent pickle liquor from steel-finishing operation, electroplating sludges, chromium, selenium, arsenic, barium, cadmium, mercury, silver
WA39	General Electric Co. (3)	4S 11E 6DAA	Wastes stored in containers or tanks; spent halogenated and nonhalogenated solvents, xylene, 1,1,1-trichloroethane
WA40	General Oil Company Inc. (3,5,6)	1S 10E 30ADD	Wastes stored or treated in tanks; spent halogenated and nonhalogenated solvents, spent cyanide solutions, petroleum refining waste
WA41	GMC Cadillac Clark Plant (3)	2S 11E 14AAD	Wastes stored in containers; chromium, lead spent halogenated and nonhalogenated solvents

Table 16.--Confirmed or possible ground-water-contamination sites in Wayne County--Continued

Site number	Site name	Site location	Nature of site
WA42	GMC Chevrolet Detroit Assembly (3)	1S 12E 31DB	Wastes stored in containers or treated in tanks; electroplating sludges, cyanides
WA43	GMC Chevrolet Detroit Forge (3)	1S 12E 29BCB	Wastes stored in containers; electroplating sludges, cyanides, spent halogenated solvents
WA44	GMC Chevrolet Detroit Gear and Axle (3)	1S 12E 30AAA	Wastes stored in containers or treated and stored in tanks; spent halogenated solvents, electroplating sludges, cyanides
WA45	GMC Detroit Diesel Allison Division Redford (3)	2S 10E 28CA, 28CB, and 28DB	Wastes stored in containers or treated and stored in tanks; spent halogenated and nonhalogenated solvents, spent cyanide, plating bath solutions,
WA46	Huron Valley Steel Corp. (3)	2S 11E 34DBD	Wastes stored in tanks; emission control sludge from steel production
WA47	Inmont Corp. (3)	2S 11E 3DC	Wastes stored in containers or tanks; spent nonhalogenated solvents, lead, ignitable waste

Table 16.--Confirmed or possible ground-water-contamination sites in Wayne County--Continued

Site number	Site name	Site location	Nature of site
WA48	Jones Chemicals Inc. (3)	4S 11E 5BD	Wastes stored or treated in tanks; corrosive wastes
WA49	Edward C. Levy Co. Plant No. 3 (3,4)	3S 11E 10C	Wastes stored in surface pond; spent pickle liquor from steel-finishing operation
WA50	Edward C. Levy Co. Plant No. 6 (3,5)	2S 11E 29DBD	Wastes stored in surface pond; spent pickle liquor from steel-finishing operation
WA51	Edward C. Levy Co. Trenton Plant (3,5)	4S 11E 5CCC	Wastes stored in surface pond; spent pickle liquor from steel-finishing operation
WA52	Master Alloys Inc. (3)	1S 12E 29ABCC	Wastes stored in containers; emission control sludge from secondary lead melting
WA53	McKesson Chemical Co. (3)	3S 10E 7CBB	Wastes stored in containers; spent halogenated and nonhalogenated solvents
WA54	Mclouth Steel (3,4)	4S 11E 8BBC and 7DDA	Wastes stored in tanks; spent pickle liquor from steel-finishing operations. Wastes stored in pile; emission control sludge from steel production

Table 16.--Confirmed or possible ground-water-contamination sites in Wayne County--Continued

Site number	Site name	Site location	Nature of site
WA55	Michigan Chrome and Chemical Co. (3)	1S 12E 22BDB	Wastes stored in containers; spent halogenated and nonhalogenated solvents. Wastes stored or treated in tanks; electroplating sludges and bath solutions, cyanides
WA56	Nelson Industrial Services (3,4,5,6)	1S 11E 30DAA	Hazardous waste facility. Wastes stored and treated on site; electroplating sludges and bath solutions, cyanides, ink solvents, chromium, lead
WA57	Pennwalt Corporation (3,5,6)	3S 11E 32CCC	Wastes stored in containers or tanks; dipropylamine, 1-propanamine, phenol
WA58	Rouge Steel Co. (3)	2S 11E 28BBB	Injection well disposal
WA59	Safety Kleen Corp. (3)	3S 9E 21CBD	Wastes stored in containers; spent halogenated and nonhalogenated solvents

Table 16.--Confirmed or possible ground-water-contamination sites in Wayne County--Continued

Site number	Site name	Site location	Nature of site
WA60	Waste Acid Service Inc. (3,4)	1S 12E 21DB	Wastes stored or treated in tanks; spent pickle liquor from steel-finishing operations, arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver
WA61	MI Environmental Services Co. (5,6)	4S 10E 31DB	Oil solvent recycle. PCB
WA62	Inkster Gasoline Leak (5,6)	2S 9E 30BB	Gas station. Toluene, xylene
WA63	Intervale Lyndon LC (5,6)	1S 11E 21DB	Heavy manufacturing
WA64	Plating Equipment Used, Inc. (5,6)	1S 11E 16BB	Plating, polishing. Cyanide
WA65	Van Dusen Airport Service (5,6)	3S 9E 13CD	Aircraft manufacturing. Cyanide, jet fuel
WA66	Celanese Plastics Specialities Co. (5,6)	1S 12E 19DB	Paint products, xylene, toluene, benzene
WA67	Carters Waste Oil Reclamation Inc. (3)	1S 11E 12BCA	Recycled waste oils petro chemicals
WA68	GMC Detroit Diesel Allison Romulus Plant (3)	3S 9E 5C	Wastes stored in containers or tanks; spent halogenated and nonhalogenated solvents, dimethyl sulfate

Table 16.--Confirmed or possible ground-water-contamination sites in Wayne County--Continued

Site number	Site name	Site location	Nature of site
WA69	GMC Fisher Body Fort Street (3)	2S 11E 22DAC	Wastes stored in surface impoundments or tanks, or treated in tanks; spent halogenated and nonhalogenated solvents
WA70	Petro-Chem Processing Inc. (3,4)	1S 12E 36DD	Wastes stored in containers or tanks, or treated in tanks; spent halo genated or nonhalogenated solvents, 2-butanone, toluene
WA71	Chem-Central Romulus (5,6)	3S 9E 29BB	Spills; organic chemicals, priority pollutants
WA72	Carters Industrials (5,6)	2S 11E 12BA	Polychlorinated biphenols (PCB's)
WA73	Levy Co. King Road Site (1,2)	4S 11E 7DC	Landfill
WA74	Young Patriots Park (1,2)	4S 10E 1DC	Landfill. Inorganic industrial waste
WA75	Berger-Gordon (6) (Berger Corp.)	1S 12E 33AA	Polychlorinated biphenols (PCB's)
WA76	Huber Foundry (4)	1S 12E 21	Polychlorinated biphenols (PCB's)
WA77	M and H Service (6) Station	2S 11E 8BA	Gas station
WA78	Palmer and Brush Streets (6)	1S 12E 31DA	Barrels. Possibly containing solvents
WA79	Tronex Chemical Corporation (6)	1S 11E 22AB	Chemical product manufacturing

Table 16.--Confirmed or possible ground-water-contamination sites in Wayne County--Continued

Site number	Site name	Site location	Nature of site
WA80	Palmer Street at Railroad (3)	1S 12E 32AC	Oil storage
WA81	Unistrut Corporation (3)	2S 9E 28CC	Metal processing. Oil, xylene
WA82	Troy Auto Parts (3)	1S 12E 10BA	Automobile junkyard
WA83	Inkster Rd. Oil Contamination (Dimattia Enterprises) (3)	2S 9E 24DDA	--
WA84	Mich. Con Station B (3)	2S 12E 10AAC	Coal gasification
WA85	Central Ave Wyandotte (3)	3S 11E 32CDB	Phenols, toluene vinyl chloride, mercury, lead, cyanide
WA86	Mich. Con Station J (3)	2S 11E 3CBA	Coal gasification
WA87	Mich. Con Melvindale Plant (3)	2S 11E 30ADC	Coal gasification

Table 17.--Confirmed or possible ground-water-contamination sites in Chippewa County

[The use of industry or firm names in this report is for identification or location purposes only and does not impute responsibility for any present or potential effects on the natural resources. The first two segments of the site location designate township and range, the third segment designates section, and the letters A through D designate successively smaller 1/4 subdivisions of the section; see Site-Location System. References to footnotes are numbered and are given in parenthesis following each site name.]

Site number	Site name	Site location	Nature of site
CH1	Bay Mills Township Sanitary Landfill (1,2)	47N 3W 35AC	Landfill. Household waste
CH2	Montero Excavation Inc. (1,2)	47N 1W 24AA	Landfill. Demolition debris
CH3	Dafter Sanitary Landfill (Ed Reid Landfill) (1,2)	46N 1W 33C	Household and light industrial waste
CH4	Sault Ste. Marie Disposal (Union Carbide) (2,3)	47N 1E 8BA	Lime-waste pile; contains calcium oxide, carbon, cyanide, ferric oxide, silica alumina
CH5	Cannelton Industries Tannery Disposal (2,3)	47N 1W 11AB	Leather tanning; soils and river sediments contain high levels of chromium, lead, copper, cyanide

[1] Tom Work, Michigan Department of Natural Resources, written comm., 1986.

[2] Mark Petrie, Michigan Department of Natural Resources, written comm., 1986.

[3] Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources, 1986 and 1987.

Table 17.--Confirmed or possible ground-water-contamination sites in Chippewa County--Continued

Site number	Site name	Site location	Nature of site
CH6	Superior Sanitation Landfill (3 Mile Rd.) (1,2,3)	47N 1W 14CD	Landfill. Mixed municipal and industrial waste, no known hazardous waste
CH7	Transportation spill, Soo Township (2,3)	47N 1W 12C	Truck transport; methylene chloride, 1,1,1-trichloroethane
CH8	Old Kincheloe Air Force Base (3)	45N 1W 31	Trichloroethylene
CH9	Veldt Farm (3)	46N 1W 7AD	PBB
CH10	Mac's Service (1)	47N 1W 13CC	Landfill
CH11	Soo Line Railroad Solid Waste Site (1)	47N 1W 11A	Landfill. Construction and demolition debris, trees, inert waste
CH12	Soo Township Peterman Site (3)	47N 1E 19ACC	Automobile junkyard. Fuel oil, lead and zinc

Table 18.--Nature of contamination at waste sites in each ground-water-discharge area

[The use of industry or firm names in this report is for identification or location purposes only and does not impute responsibility for any present or potential effects on the natural resources. Analyses included in the table were made by private laboratories. Results in some instances are reported in ppb (parts per billion) and in ppm (parts per million). Ppm and ppb are essentially equivalent to mg/L (milligrams per liter) and µg/L (micrograms per liter), respectively, used at other places in this report. References to footnotes are numbered and are given in parameters following each site name.]

Area	Nature of contamination
1	No waste sites are in Area 1.
2	Eight waste sites are in Area 2. Two sites, SC15 and SC16 have analyses. Site SC15: On site soil samples indicate low levels of 1,1-dichloroethane, 1,1,1-trichloroethane and toluene. The samples also revealed up to 1,587 ppb of phenol and up to 3,400 ppb of aroclor 1260. There are no analyses of ground water from or downgradient of the site. Site SC16: Analyses of ground water indicate that toluene, xylene, TCE, and PCE are present. Concentrations, however, are unknown. No analyses of water downgradient from the site have been made.
3	One waste site is in Area 3. There are no chemical analyses of ground water from the site or downgradient.
4a	One waste site is in Area 4a. There are no chemical analysis of ground water available from the site or downgradient.
4b	Two waste sites are in Area 4b. There are no chemical analyses of ground water available from the site or downgradient.
5	Eleven waste sites are in Area 5. Three sites MA6, MA41a, and MA66 have analyses. Site MA6: A nearby stream is contaminated with phenols. No analyses of ground water from the site or downgradient have been made.

Table 18.--Nature of contamination at waste sites in each ground-water-discharge area--Continued

Area	Nature of contamination
5 (continued)	Site MA41a: There are seven locations at which contamination is known; the maximum concentrations of contaminants revealed in analyses of water from monitoring wells are listed below. (1) Southwest Sanitary Landfill Phenols - 435 µg/L Soluble copper - 1.1mg/L Cadmium - 0.019 mg/L Methylene chloride - 84 µg/L 1,2 trans-dichloroethylene - 71 µg/L Toluene - 52 µg/L Vinyl chloride - 45 µg/L Ethyl benzene - 44 µg/L Trichloroethylene - 6.7 µg/L Benzene - 51 µg/L (2) Fire Training area 2 Phenols - 17 µg/L Petroleum hydrocarbons - 2.4 mg/L Trichloroethylene - 2.4 µg/L Methylene chloride - 6.6 µg/L (3) Fire Training area 1 Petroleum hydrocarbons - 1.0 mg/L Phenols - 7 µg/L (4) West Ramp Petroleum hydrocarbons - 2.4 mg/L Trichloroethylene - 2.5 µg/L Methylene chloride - 4.7 µg/L (5) Tucker Creek Landfill Phenols 40 µg/L (upgradient well) Soluble cadmium - 0.014 mg/L Copper - 1.9 mg/L Lead - 0.044 mg/L Oil and grease - 1.17 mg/L Trichloroethylene - 3.1 µg/L

Table 18.--Nature of contamination at waste sites in each ground-water-discharge area--Continued

Area	Nature of contamination
5 (continued)	(6) Northwest Sanitary Landfill Phenols - 15 µg/L Soluble copper - 1.6 mg/L Lead - 0.024 mg/L Oil and grease - 3.7 mg/L (upgradient well) Trichloroethylene - 2.2 µg/L (7) East Ramp Petroleum hydrocarbons - 9.2 mg/L Trichloroethylene - 9.0 µg/L Site MA66: Exact location of wells sampled is unknown; maximum concentrations in water were: 0.118 mg/L barium, 0.036 mg/L lead, 2 mg/L oil and grease, 410 µg/L bis (2-ethyl hexyl) phthalate, 190 µg/L butyl benzl phthalates; 650 µg/L dioctylphthalate, and 1 µg/L methylene chloride.
6	One waste site is in Area 6. There are no chemical analyses of ground water available from this site or downgradient.
7a	Twenty-one waste sites are in Area 7a. Analyses of ground water from one site MA65 revealed the presence of acetone. Concentrations are unknown. There are no chemical analyses of ground water available downgradient.
7b	Twenty-eight waste sites are in Area 7b. Seven sites OA13, WA23, WA66, WA70, WA72 and WA84 have analyses. Site OA13: Analyses of water from monitoring wells around the disposal area indicate toluene and chloroform (1-5 µg/L for both) to be present. Tetrahydrofuran was also detected from 40-400 µg/L. No analyses of ground water downgradient from the site have been made.

Table 18.--Nature of contamination at waste sites in each ground-water-discharge area--Continued

Area	Nature of contamination
7b (continued)	Site WA23: The Detroit River borders the site. Analyses of ground water from on site monitoring wells have revealed the following maximum concentrations: Arsenic, total - 0.61 mg/L Chromium, total - 0.69 mg/L Copper - 9.7 mg/L Cyanide - 28 mg/L Lead - 30 mg/L Mercury, total - 120 µg/L Nickel - 0.82 mg/L Phenol, total - 0.77 mg/L Selenium - 0.04 mg/L Zinc - 9.8 mg/L Acenaphthene - 0.039 mg/L Acenaphthylene - 0.052 mg/L Anthracene - 0.051 mg/L Benzene - 3.5 mg/L Benzo (a) anthracene - 0.083 mg/L Benzo (a) pyrene - 0.018 mg/L Benzo (g,h,i) perylene - 0.016 mg/L Benzo (k) fluoranthene - 0.07 mg/L Bis (2-ethyl hexyl) phthalate - 0.021 mg/L Chrysene - 0.13 mg/L Dibenzo (a,h) anthracene - 0.004 mg/L Ethyl benzene - 2.6 mg/L Fluoranthene - 0.48 mg/L Fluorene - 0.39 mg/L Indeno (1,2,3-cd) pyrene - 0.009 mg/L Methylene chloride - 2.5 mg/L Naphthalene - 2.2 mg/L Phenanthrene - 0.68 mg/L Pyrene - 0.61 mg/L Toluene - 0.21 mg/L Trichloroethylene - 0.024 mg/L Site WA66: Analyses of ground water from on site monitoring wells have been made. The maximum concentrations of benzene, toluene and xylene are 2.07 ppm, 3.39 ppm and 42.34 ppm respectively. The maximum pH was 11.4. There are no analyses of ground water downgradient.

Table 18.--Nature of contamination at waste sites in each ground-water-discharge area--Continued

Area	Nature of contamination
7b (continued)	Site WA70: Analyses of ground water from monitoring wells located around the perimeter of the site have been made. One well had a high chloride level, 730 ppm and a high pH, 9.6. Another well had 560 ppm of sulfate. Chloroform (0.014-.61 ppb) and benzene (0.01-.07 ppb) were also detected. There are also low levels of organics (concentrations unknown). There are no analyses of ground water downgradient. Site WA72: Analyses of the contents of waste drums located on the site revealed up to 500,000 ppm of PCB's. Soil samples from near the site had concentrations of PCB's up to 96,000 ppm. Analyses of ground water from monitoring wells revealed elevated levels of arsenic (0.57 mg/L), cadmium (0.03 mg/L), chromium (0.15 mg/L), lead (0.43 mg/L), iron (170 mg/L) and manganese (4.8 mg/L). Site WA84: The Detroit River borders the site. Analyses of ground water from on site monitoring wells have revealed the following maximum concentrations: Antimony - 2.3 µg/L Arsenic - 35 µg/L Chromium, total - 0.25 mg/L Cyanide, total - 6.8 mg/L Mercury, total - 4.2 µg/L Phenol, total - 0.92 mg/L Selenium, total - 7.0 µg/L Xylene - 3.9 mg/L Zinc, total - 39 mg/L Acenaphthene - 91 mg/L Acenaphthylene - 360 mg/L Anthracene - 150 mg/L Benzene - 23 mg/L Benzo (a) anthracene - 230 mg/L Benzo (a) pyrene - 820 mg/L Benzo (g,h,i) perylene - 460 mg/L Benzo (k) fluoranthene - 500 mg/L Bis (2-ethyl hexyl) phthalate - 1 mg/L Chrysene - 250 mg/L Dibenzo (a,h) anthracene - 99 mg/L Di-n-butyl phthalate - 0.001 mg/L Ethyl benzene - 6.7 mg/L Fluoranthene - 200 mg/L Fluorene - 170 mg/L

Table 18.--Nature of contamination at waste sites in each ground-water-discharge area--Continued

Area	Nature of contamination
7b (continued)	Site WA84: (continued) Indeno (1,2,3-cd) pyrene - 320 mg/L Naphthalene - 810 mg/L Phenanthrene - 280 mg/L Pyrene - 170 mg/L 1,1,1-Trichloroethane - 0.002 mg/L Toluene - 2.8 mg/L Site WA86: Subsurface soil samples revealed the following maximum concentrations: Benzo (a) anthracene - 610 ppm Benzene - 9.4 ppm Bis (2-ethyl hexyl) phthalate - 86 ppm Chromium - 12 ppm Lead - 500 ppm Mercury - 2 ppm Phenanthrene - 700 ppm Various PNA's - 30-250 ppm Pyrene - 780 ppm Toluene - 32 ppm Xylene - 33 ppm There are no analyses of ground water from or downgradient of the site.
8	The site WA20 is Area 8. There are no chemical analyses available on site.
9	Two waste sites are in Area 9. Analyses of ground water from one site WA49 revealed up to 80 µg/L of cadmium and chromium, .82 mg/L of lead, 420 µg/L of chloride, 17 mg/L of iron, 1,500 mg/L of sulfate, 31 mg/L of iron, .96 mg/L of manganese, 3.8 mg/L of barium, 2.8 mg/L of fluoride, .012 mg/L of selenium, 250 mg/L of sodium, .03 µg/L of 2,4-D and 0.15 mg/L of phenols. Exact locations of the four monitoring wells are unknown (1 upgradient, 3 downgradient).
10	Ten waste sites are in Area 10. Six sites, WA28, WA29, WA15, WA51, WA57 and WA85 have analyses.

Table 18.--Nature of contamination at waste sites in each ground-water-discharge area--Continued

Area	Nature of contamination
10 (continued)	Site WA28: There are five smaller sites on this property. Analyses were performed in 1981 by the property owners. There are more recent samples; however, changes in well names, additional drilling, destroyed wells, etc., have made determining the sample locations difficult. The following maximum concentrations are from wells near the smaller sites. Site 1: Copper - 0.12 ppm Zinc - 9.7 ppm Benzene - 1,006 ppb Toluene - 1,382 ppb Ethyl benzene - 61 ppb Naphthalene - 12 ppb Bis (2-ethyl hexyl) phthalate - 12 ppb Phenol - 25 ppb 2,4-Dimethylphenol - 68 ppb Xylene - 137 ppb Methyl phenyl acetylene - 12 ppb Benzofuran - 112 ppb Thiophene - 68 ppb 2-Methyl thiophene - 53 ppb Aniline - 27 ppb Methylaniline - 44 ppb Dimethyl phenols - 173 ppb Cresols - 92 ppb Phenyl acetic acid - 125 ppb 1,2-Dichloropropane - 28 ppb Methylene chloride - 50 ppb Styrene - 537 ppb Toluene diamine - 42 ppb Indene - 158 ppb Chloroform - 18 ppb Site 2: Chromium - 0.27 ppm Copper - 0.05 ppm Lead - 0.46 ppm Zinc - 10.4 ppm Benzene - 19 ppb Naphthalene - 131 ppb Phenol - 0.41 ppb Methylene chloride - 42 ppb Styrene - 20 ppb Indene - 160 ppb Trimethylbenzene - 200 ppb Acenaphthene - 22 ppb

Table 18.--Nature of contamination at waste sites in each ground-water-discharge area--Continued

Area		Nature of contamination
10 (continued)	Site 2:	(continued)
		Fluorene - 23 ppb
		Phenanthrene - 20 ppb
		Anthracene - 75 ppb
		Pyrene - 93 ppb
	Site 3:	Cadmium - 0.12 ppm
		Chromium - 0.2 ppm
		Copper - 0.34 ppm
		Lead - 0.7 ppm
		Zinc - 13.3 ppm
		Benzene - 10 ppb
		Toluene - 271 ppb
		Phenol - 88 ppb
		2,4-Dimethylphenol - 153 ppb
		Aniline - 142 ppb
		1,2-Dichloropropane - 301 ppb
		Methylene chloride - 39 ppb
		Chloroform - 54 ppb
		Bis (2-chloroisopropyl) ether - 324 ppb
		Naphthalene - 105 ppb
		Pyrene - 927 ppb
		p-Chloro-m-cresol - 18 ppb
		2,4-Dichlorophenol - 24 ppb
		Benzoic acid - 126 ppb
		1,3-Dichloropropane - 38 ppb
	Sites 4 and 5:	Chromium - 0.03 ppm
		Copper - 0.34 ppm
		Lead - 0.3 ppm
		Zinc - 14.7 ppm
		Benzene - 1,143 ppb
		Toluene - 530 ppb
		Ethyl benzene - 35 ppb
		Naphthalene - 2,170 ppb
		Bis (2-ethyl hexyl) phthalate - 459 ppb
		Phenol - 39 ppb
		Xylene - 1,838 ppb
		Benzofuran - 343 ppb
		Thiophene - 64 ppb
		Aniline - 16 ppb
		Dimethyl phenols - 71 ppb
		p-Cresol - 259 ppb
		Phenyl acetic acid - 555 ppb
		Indene - 1,305 ppb

Table 18.--Nature of contamination at waste sites in each ground-water-discharge area--Continued

Area	Nature of contamination
10 (continued)	Sites 4 and 5: (continued) Indane - 124 ppb Dimethyl benzene - 40 ppb Isopropyl benzene - 328 ppb Fluorene - 31 ppb Pyridine - 1,328 ppb Ethyl pyridine - 811 ppb Benzoic acid - 238 ppb Di (2-ethyl hexyl) adipate - 624 ppb Site WA29: There are three smaller sites on this property. Analyses were performed in 1981 by the property owners. There are more recent samples; however, changes in well names and locations have made determining the sample locations difficult. The following maximum concentrations are from wells near these smaller sites. Site 6: Cadmium - 0.18 ppm Chromium - 26.6 ppm Copper - 17.7 ppm Lead - 62.4 ppm Mercury, total - 1.96 ppm Zinc - 67.5 ppm Toluene - 11 ppb Bis (2-ethyl hexyl) phthalate - 35 ppb Phenyl acetic acid - 114 ppb 1,2-Dichloropropane - 1,447 ppb Methylene chloride - 50 ppb Chloroform - 26 ppb 1,2-Dichloroethane - 83 ppb Bis (2-chloroisopropyl) ether - 223 ppb Di-n-butylphthalate - 20 ppb Benzoic acid - 267 ppb Site 7: Cadmium - 0.19 ppm Chromium - 0.03 ppm Copper - 0.46 ppm Lead - 2.9 ppm Zinc - 17 ppm Thiophene - 3,850 ppb Phenyl acetic acid - 117 ppb 1,2-Dichloropropane - 75 ppb Dichlorobutadiene - 2,395 ppb Trichlorobutadiene - 1,800 ppb Tetrachlorobutadiene - 2,900 ppb

Table 18.--Nature of contamination at waste sites in each ground-water-discharge area--Continued

Area	Nature of contamination
10 (continued)	Site 7: (continued) 1,2-Dichloroethylene - 1,510 ppb Vinyl chloride - 545 ppb Trichloroethylene - 2,785 ppb t-1,2-Dichloroethylene - 1,098 ppb Site 8: Copper - 0.18 ppm Mercury, total - 0.0008 ppm Zinc - 2.1 ppm 1,3-Dichloropropane - 107 ppb Bis (2 chloroisopropyl) ether - 12 ppb

Site WA15: Results of the analyses of water samples from hand-dug holes are listed below. Locations of the holes is unknown.

	Range	Mean
pH (units)	7.4 - 12.4	10.8
COD (mg/L)	335 - 11,800	3,990
BOD (mg/L)	300 - 4,900	3,030
TOC (mg/L)	66 - 7,000	2,100
Grease and Oil (mg/L)	40 - 11,600	3,480
MBAS (mg/L)	1 - 4,000	385
Total Solids (mg/L)	4,900 - 197,000	52,300
Suspended Solids (mg/L)	10 - 3,810	1,340
Volatile Solids (mg/L)	560 - 101,000	19,200
Total Phosphorus (as P)	<0.03 - 84.8	18.8
Total Kjeldahl N (mg/L)	4 - 300	82
Ammonia (mg/L)	<0.1 - 97.2	24.2
Sulfate (mg/L)	240 - 4,300	1,600
Sulfide (mg/L)	<1.0 -	<1.0
Cyanide (mg/L)	<0.1 - 58.8	14.7
Arsenic (mg/L)	<0.05 - 0.30	0.10
Cadmium (mg/L)	<0.1 - 0.6	0.14
Total Chromium (mg/L)	<0.1 - 0.9	0.34
Chromium, hexavalent (mg/L)	<0.1 - 0.4	0.17
Aluminum (mg/L)	0.4 - 76	16.0
Antimony (mg/L)	<0.1 - 9.0	2.3
Beryllium (mg/L)	<0.05	<0.05
Cobalt (mg/L)	<0.01 - 2.4	0.73
Copper (mg/L)	<0.01 - 2.4	0.66
Lead (mg/L)	0.3 - 6.8	2.7

Table 18.--Nature of contamination at waste sites in each ground-water-discharge area--Continued

Area	Nature of contamination		
10 (continued)	Site WA15: (continued)		
	Mercury (mg/L)	0.01 - 2.5	0.870
	Nickel (mg/L)	<0.01 - 5.3	1.8
	Selenium (mg/L)	0.06 - 0.55	0.27
	Silver (mg/L)	<0.1 - 0.8	0.27
	Zinc (mg/L)	<0.1 - 2.9	0.94
	Chloroform (µg/L)	5 - 44	16
	1,2-Dichloroethane (µg/L)	50 - 340	175
	1,2-Dichloropropane (µg/L)	86 - 195	135
	1,1,1-Trichloro-ethane (µg/L)	9 - 104	30
	Tetrachloroethylene (µg/L)	11 - 62	25
	Benzene (µg/L)	1 - 840	157
	Toluene (µg/L)	550 - 2,480	1,515
	Ethylbenzene (µg/L)	44 - 275	117
	Chlorobenzene (µg/L)	13 - 1100	557
	2-Chlorophenol (µg/L)	8 - 615	168
	2-Nitrophenol (µg/L)	70 - 115	93
	Phenol (µg/L)	15 - 3,000	534
	2,4-Dimethylphenol (µg/L)	5 - 465	109
	2,4-Dichlorophenol (µg/L)	10 - 660	335
	Trichlorophenol (µg/L)	5 - 1,010	270
	p-Chloro-m-cresol (µg/L)	15 - 145	75
	4-6-Dinitro-o-cresol (µg/L)	--	35
	Pentachlorophenol (µg/L)	80 - 1,300	458
	4-Nitrophenol (µg/L)	25 - 145	70
	Naptholene (µg/L)	40 - 27,000	3,723
	Anthracene (µg/L)	90 - 13,300	2,869
	Pyrene (µg/L)	230 - 10,500	3,942
	Acenaphthylene (µg/L)	170 - 4,200	1,071
	Fluorene (µg/L)	75 - 2,550	758
	Chrysene (µg/L)	--	150
	Acenaphthene (µg/L)	125 - 1,450	579
	Fluoranthene (µg/L)	1,115 - 2,445	1,780
	Dichlorobenzene (µg/L)	--	125
	Di-n-octyl phthalate (µg/L)	100 - 300	200
	Dibutyl phthalate (µg/L)	--	160

The maximum concentrations from 1985-86 quarterly monitoring well samples are as follows:

Benzo (a) pyrene - 337 ppb
Napthalene - 5,428 ppb
PCB's - 0.14 ppb

Table 18.--Nature of contamination at waste sites in each ground-water-discharge area--Continued

Area	Nature of contamination
10 (continued)	Site WA15: (continued) Pentachlorophenol - 69 ppb Mercury - 4,900 ppb Arsenic - 36,000 ppb Site WA22: Analyses from one of five monitoring wells revealed the following concentrations: Chloride - 14,350 mg/L Manganese - 3.21 mg/L Sodium - 7,752 mg/L Sulfate - 1,251 mg/L Nickel - 0.51 mg/L PCB 1260 - 0.019 mg/L This well is located across a stream and downgradient from the site. Site WA51: Analyses of water from wells at the site showed the following maximum concentrations: Barium - 3.9 mg/L Cadmium - 0.05 mg/L Chromium - 0.05 mg/L Fluoride - 4.1 mg/L Lead - 1.2 mg/L Mercury - 0.0088 mg/L Chloride - 820 mg/L Iron - 31 mg/L Manganese - 3.3 mg/L Phenols - 71 mg/L The samples were collected from four wells (one upgradient, three downgradient); however, which analyses belongs to which well cannot be determined with current data.
10	Site WA57: The site borders on the Detroit River. Analyses from on site monitoring wells revealed the following maximum concentrations: Aluminum - 22.5 mg/L Ammonia - 24.3 mg/L Calcium - 1,130 mg/L Chloride - 54,400 mg/L

Table 18.--Nature of contamination at waste sites in each ground-water-discharge area--Continued

Area	Nature of contamination
10 (continued)	Site WA57: (continued) Iron - 182 mg/L Magnesium - 104 mg/L Manganese - 3.8 mg/L Potassium - 128 mg/L Selenium - 0.02 mg/L Sodium - 36,900 mg/L Vanadium - 0.35 mg/L Aroclor 1254 - 32 µg/L Aroclor 1260 - 2.0 µg/L Benzo (a) anthracene - 550 µg/L Benzo (b) fluoranthene - 500 µg/L Chlorobenzene - 1000 µg/L Chloroform - 8,500 µg/L 2-chloronaphthalene - >1700 µg/L 2-chlorophenol - 200 µg/L Dichlorobenzene, total - 1,266 µg/L Fluoranthene - 24 µg/L Methylene chloride - 1,700 µg/L 2-Methylnaphthalene - 150 µg/L Naphthalene - 3,400 µg/L Pyrene - 700 µg/L
10 (continued)	Site WA85: Analyses of ground water from the site indicated the presence of phenols, sodium, chloride, sulfate, 1,2-dichloroethane, 1,2-dichloropropane, methylene chloride, toluene, vinyl chloride, phthalate esters, mercury, lead and cyanide. The location of sampling points and contaminant concentrations are unknown. The site is approximately one half mile from the Trenton channel, WA57 Pennwalt Corporation is downgradient from the site.
11	Three waste sites are in Area 11. Two sites WA5, and WA7 have analyses. Site WA5: Analyses of ground water wells located on site revealed the following maximum concentrations: Calcium - 1,400 mg/L Chloride - 370 mg/L Chromium - 0.14 mg/L Iron - 2.6 mg/L Lead - .3 mg/L

Table 18.--Nature of contamination at waste sites in each ground-water-discharge area--Continued

Area	Nature of contamination
11 (continued)	Site WA5: (continued) Magnesium - 350 mg/L Manganese - 270 µg/L Potassium - 3.5 mg/L Sodium - 85 mg/L Zinc - 120 µg/L Site WA7: Analyses of ground water from wells on site revealed elevated levels of sodium (max. conc. 17,500 mg/L), sulfate (max. conc. 7,410 mg/L), conductivity (max. 27,800), total phosphorus (7,300 mg/L) and arsenic (max. conc. 60 mg/L).
12	One waste site is in Area 12. There are no chemical analyses of ground water available from the site or downgradient.
13	Eight waste sites are located in Area 13. Three sites, CH4, CH5 and CH7 have analyses. Site CH4: Analyses of one ground water sample next to the waste pile revealed that chromium and lead exceed the standards; concentrations were 1,200 µg/L and 370 µg/L, respectively. Aluminum and nickel also had high concentrations at 410,000 µg/L and 570 µg/L, respectively. There are no chemical analyses available downgradient. Site CH5: Analyses of ground water collected at the site in 1979 and 1986 are listed below (only maximum concentrations are shown).

1979	1986
Total lead - 2.4 ppm	Lead - 0.08 ppm
Total chromium - 440 ppm	Manganese, dissolved - 0.34 ppm
Total copper - 1.1 ppm	Iron, dissolved - 0.35 ppm
Total manganese - 2.14 ppm	
Total arsenic - 0.3 ppm	
Total iron - 19 ppm	

Samples of St. Marys River sediment collected in 1976 had chromium concentrations ranging from 8 to 2,200 mg/kg.

Table 18.--Nature of contamination at waste sites in each ground-water-discharge area--Continued

Area	Nature of contamination
	Site CH7: A tanker truck spilled trichloroethane and methylene chloride. Neither of the chemicals has been detected in nearby residential wells; however, trichloroethane has been found in a stream at 1.4 ppb.
14	No waste sites are in Area 14.
15	No waste sites are in Area 15 (Sugar Island).
16	No waste sites are in Area 16 (Neebish Island).

Waste-Site Ranking System

As part of this investigation, it was necessary to evaluate the potential effect of waste sites on the quality of ground water in the connecting channels. Sites were ranked[6] using USEPA's DRASTIC[7] system (Aller and others, 1985) with modifications and additions.

System Design

The DRASTIC system uses seven features to determine contamination potential: depth to water, net recharge, aquifer media, soil media, topography, vadose media, and hydraulic conductivity. Each feature is assigned a weight factor, ranging from 1 to 5, on the basis of the effect of that feature relative to the effects of other features. Features with the most adverse effect were assigned a value of 5; those with the least adverse effect were assigned a value of 1.

The features are divided into units referred to as ranges (table 19); each range is assigned a numerical rating value. The rating value, ranging from 1 to 10, is assigned to each range based on the effect of that range relative to the effect of other ranges in that feature. Ranges with the most adverse effect were assigned a value of 10, those with the least adverse effect were assigned a value of 1.

Minor modifications were made to the definitions of the DRASTIC features "depth to water" and "aquifer media" and to the weight factor for "net recharge". Modifications are as follows:

(1) "Depth to water" was modified to include all saturated zones below the water table, including those zones that have insufficient permeability to yield significant quantities of water to wells. In addition, the potentiometric surface, rather than the top of the confined aquifer, was used because, at many places, it was not possible to characterize the aquifer. As modified, "depth to water" is defined by the depth to water in wells.

(2) "Net recharge" was assigned a weight factor of 1, three points less than that used in DRASTIC. This modification was made because throughout the study area, the geology does not differ appreciably and variation in precipitation is minor. A net-recharge weight

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6 Ranking of sites is based solely on the potential for affecting the water of the channels. The rankings may or may not correspond to the results of other procedures designed to evaluate localized ground-water contamination or its potential impact on human health.

7 DRASTIC is an acronym for a rating system designed to help prioritize the vulnerabilty of areas to ground-water contamination. The acronymon stands for the rating factors used in the system: Depth to water, net Recharge, Aquifer media, Soil media, Topography, Impact of the vadose zone, and hydraulic Conductivity of the aquifer.

Table 19.--Rating features, ranges, and rating values of waste-site ranking system

[ft, feet; in., inches; (gal/d)/ft^2, gallons per day per square foot]

Feature	Range	Rating value[1]
Depth to water (ft)	0-5	10
	5-10	9
	15-30	7
	30-50	5
	50-75	3
	75-100	2
	>100	1
Net recharge (in.)	>10	9
	7-10	8
	4-7	6
	2-4	3
	0-2	1
Aquifer media	Karst limestone	9-10 (10)
	Sand and gravel[2]	9-10 (10)
	Sand, medium to coarse[2]	7-10 (8)
	Till, weathered[2]	5-7 (6)
	Massive limestone	4-9 (6)
	Massive sandstone	4-9 (6)
	Thin-bedded sandstone, limestone, shale sequence	5-9 (6)
	Sand, fine grained, and silt[2]	5-9 (5)
	Till, unweathered[2]	3-5 (4)
	Clay, lacustrine[2]	1-3 (2)
	Massive shale	1-3 (2)

[1] Values in parenthesis are typical rating values.

[2] The DRASTIC system does not have these ranges, instead the system has the ranges: Basalt 2-10 (9)
Sand and gravel 6-9 (8)
Weathered metamorphic/igneous 3-5 (4)
Metamorphic/igneous 2-5 (3)

Table 19.--Rating features, ranges, and rating values of waste-site ranking system--Continued

Feature	Range	Rating value
Soil media	Thin or absent	10
	Gravel	10
	Sand	9
	Shrinking and aggregated clay	7
	Sandy loam	6
	Loam	5
	Silty loam	4
	Clay loam	3
	Nonshrinking and nonaggregated clay	1
Topography (percent slope)	0-2	10
	2-6	9
	6-12	5
	12-18	3
	18+	1
Impact of vadose zone media	Karst limestone[3]	8-10 (10)
	Sand and gravel	6-9 (8)
	Sand and gravel with significant silt and clay	4-8 (6)
	Bedded limestone, sandstone, shale	4-8 (6)
	Sandstone	4-8 (6)
	Limestone	2-7 (6)
	Shale	2-5 (3)
	Silt and clay	1-2 (1)
Hydraulic conductivity [(gal/d)/ft^2]	2000+	10
	1000-2000	8
	700-1000	6
	300-700	4
	100-300	2
	1-100	1

[3] The DRASTIC system includes two other ranges that were not used in this study: Basalt 2-10 (9)
Metamorphic/igneous 2-8 (4)

factor of 4, combined with the features aquifer media, soil media, impact of the vadose zone, and hydraulic conductivity of the aquifer--which already incorporate recharge characteristics--results in disproportionately high DRASTIC scores.

(3) "Aquifer media" was modified to include all unconsolidated rock and bedrock that transmits water, whether or not the rocks yield water in significant quantities. This broader definition of the term was used because fine sand, silt, and sandy and silty clay, although too impermeable to yield sufficient water for domestic supplies, allow for the movement of water and, thus, contaminants.

The ranges within the aquifer and vadose media features (table 19) have been modified to reflect the broader definition. DRASTIC has ranges for basalt and metamorphic/igneous rocks; however, these rocks are not found in the connecting-channels study area; thus, these ranges were not used. Till and additional sand and silt ranges were included in each feature as part of the modified definition.

The assessment of the potential for a site to have an adverse affect on the connecting channels was improved by including the distance of the site from the channels, the distance from major tributaries to the channels, and the types of pollutants at the site in the ranking procedure. Four rating features were added to DRASTIC: (1) occurrence of priority pollutants, (2) occurrence of primary and secondary inorganic contaminants, (3) site proximity to connecting channels, and (4) site proximity to major tributaries of connecting channels. Distances from sites to connecting channels and major tributaries were determined along the paths of ground-water flow. Table 20 shows the range and rating values for each feature; table 21 defines the ranges used to assess substantially different conditions with respect to contaminants.

Ranking of sites by use of the modified DRASTIC system is based on the DRASTIC score that was obtained by multiplying the rating value by the appropriate weight factor (table 22). The maximum score possible for a site is 350.

Table 20.--Rating features and ranges and rating values added to DRASTIC

[mi, mile]

Feature	Range	Rating value
Occurrence of priority pollutants	Presence confirmed; migration confirmed	10
	Presence confirmed; migration unconfirmed	8
	Presence unconfirmed	6
	Presence confirmed; migration undetected	4
	Not present	0
Occurrence of primary and secondary inorganic contaminants	Presence of primary contaminant confirmed; migration confirmed	10
	Presence of secondary contaminant confirmed; migration confirmed	8
	Presence of primary contaminant confirmed; migration unconfirmed	7
	Presence unconfirmed	6
	Presence of secondary contaminant confirmed; migration unconfirmed	5
	Presence of primary contaminant confirmed; migration undetected	4
	Presence of secondary contaminant confirmed; migration undetected	2
	Not present	0
Site proximity to connecting channels (mi)	0-1/2	10
	1/2-1	8
	1-2	6
	2-5	4
	5-10	2
	10+	0
Site proximity to major tributaries of connecting channels (mi)	0-1/4	10
	1/4-1/2	8
	1/2-1	6
	1-2	4
	2-3	2
	3+	1

Table 21.--Definition of ranges for priority-pollutant and inorganic-contaminant features of waste-site ranking system

Contaminants	Range	Definition
Priority pollutants[1]	Presence confirmed; migration confirmed	Priority pollutants known to be at site; detected in ground water at or near site.
	Presence confirmed; migration unconfirmed	Priority pollutants known to be at site, but no monitoring wells installed or no data obtained on migration.
	Presence confirmed; migration undetected	Priority pollutants known to be at site, but not detected in water from monitoring wells.
	Not present	Evidence indicates priority pollutants not at site.
Primary and secondary inorganic contaminants[2]	Presence of primary contaminant confirmed; migration confirmed.	A contaminant is known to be at site; detected in ground water at or near site.
	Presence of secondary contaminant confirmed; migration confirmed.	A contaminant is known to be at site; detected in ground water at or near site.

[1] Priority pollutants are substances selected for regulation under the Clean Water Act because of their toxicity, persistence, degradability, and the affect of the pollutant on organisms living in water.

[2] A primary inorganic chemical is one for which USEPA has established Primary Maximum Contaminant Levels for drinking water (U.S. Environmental Protection Agency, 1986b); a secondary inorganic chemical is one for which USEPA has established Secondary Maximum Contaminant Levels for drinking water (U.S. Environmental Protection Agency, 1986c). Brine is included in the secondary catetory.

Table 21.--Definition of ranges for priority-pollutant and inorganic-contaminant features of waste-site ranking system--Continued

Contaminants	Range	Definition
Primary and secondary inorganic contaminants--Continued	Presence of primary contaminant confirmed; migration unconfirmed.	A contaminant is known to be at site but no monitoring wells installed or no data obtained on migration.
	Presence unconfirmed.	No information available.
	Presence of secondary contaminant confirmed; migration unconfirmed.	A contaminant is known to be at site; but no monitoring wells installed or no data obtained on migration.
	Presence of primary contaminant confirmed; migration undetected.	A contaminant is known to be at site, but not detected in water from monitoring wells.
	Presence of secondary contaminant confirmed; migration undetected.	A contaminant is known to be at site, but not detected in water from monitoring wells.
	Not present	Evidence indicates primary and secondary contaminants not at site.

Table 22.--Summary of waste-site ranking system and modified DRASTIC scores

Rating feature	Rating value	Weight factor	Modified DRASTIC score
Depth to water table	1-10	5	5-50
Net recharge	1-10	1	1-10
Aquifer media	1-10	3	3-30
Soil media	1-10	2	2-20
Topography	1-10	1	1-10
Impact of vadose zone	1-10	5	5-50
Hydraulic conductivity of the aquifer	1-10	3	3-30
Occurrence of priority pollutants	0-10	5	0-50
Occurrence of primary and secondary inorganic contaminants	0-10	4	0-40
Site proximity to connecting channels	0-10	5	0-50
Site proximity to major tributaries of connecting channels	1-10	1	1-10
Total score (range)			21-350

Ranks and Site Scores

Table 23 gives the rank and site score for 208 sites for which data were sufficient for use of the modified DRASTIC system.

In general, sites having scores greater than 200 are in areas of sandy unconsolidated surficial materials and are near connecting channels. The water table generally is less than 15 ft below land surface, and priority pollutants and/or inorganic contaminants are on site or in the ground water.

Most sites having scores of 160 to 200 are in areas of fine-grained surficial materials and are one-half mile to 5 mi from the channel. At many sites, the water table is 10 to 30 ft below land surface, and priority pollutants and/or inorganic contaminants are not known to be on site or information concerning them is not available.

Most sites having scores less than 160 are in areas of clayey surficial materials and are more than 5 mi from connecting channels. The water table is 15 to 75 ft below land surface, and priority pollutants and/or inorganic contaminants are not known to be on site or information concerning them is not available.

Table 23.--Ranks and scores for confirmed or possible ground-water-contamination sites

[Ranks and scores were computed using the U.S. Environmental Protection Agency's DRASTIC[1] system (Aller and others, 1985). Information in this table was provided by or compiled from the following: Michigan Sites of Environmental Contamination-Priority List, Act 307, Michigan Department of Natural Resources 1986 and 1987; Frank Belobraidich, Michigan Department of Natural Resources, written commun., 1985, 1986, and 1987; Steve Cunningham, Michigan Department of Natural Resources, written commun., 1985, 1986, and 1987; Gorman and Akeley, 1978; David Slayton, Michigan Department of Natural Resources, written commun., 1986 and 1987; Richard Traub, U.S. Environmental Protection Agency, written commun., 1986; U.S. Environmental Protection Agency, 1986a; Ken Westlake, U.S. Environmental Protection Agency, written commun., 1987; and Tom Work, Michigan Department of Natural Resources, written commun., 1986]

Rank	Site number	Site name[2]	Score
1	WA20	Zug Island Great Lake Steel	290
2	WA15	Federal Marine Terminal Properties	274
3	WA9	Sibley Quarry	268
4	WA11	Vulcan Mold and Iron Co.	268
5	SC12	Hwy M-29 and Michigan St.	262
6	SC7	Clay Township Sanitary Landfill	258
7	WA22	Industrial Landfill (Firestone)	253
8	WA85	Central Ave Wyandotte	251
9	MA41a	Selfridge ANG Base	250
10	WA23	Mich. Con. Riverside Park	250
11	WA29	B.A.S.F. Wyandotte South works	249
12	MA15	South Macomb Disposal Authority 9 and 9A	248
13	WA28	B.A.S.F. Wyandotte North works	248
14	CH5	Cannelton Industries Tannery Disposal	246
15	MA33	Liquid Disposal	244

[1]DRASTIC is an acronym for a rating system designed to help prioritize the vulnerability of areas to ground-water contamination. The acronym stands for the rating factors used in the system: Depth to water, net Recharge, Aquifer media, Soil media, Topography, Impact of the vadose zone, and hydraulic Conductivity.

[2]The use of industry or firm names in this report is for identification or location purposes only and does not impute responsibility for any present or potential effects on the natural resources.

Table 23.--Ranks and scores for confirmed or possible ground-water-contamination sites--Continued

Rank	Site number	Site name	Score
16	MA14	Ryan and 23 Mile Road	242
17	WA46	Huron Valley Steel Corp.	242
18	WA37	Edwards Oil Service, Inc.	240
19	WA49	Edward C. Levy Co. Plant No. 3	239
20	WA51	Edward C. Levy Co. Trenton Plant	239
21	WA57	Pennwalt Corporation	239
22	SC26	Harsens Island Barrel Dump	237
23	WA30	Allied Chemical Corp. Detroit Tar Plant	236
24	MA17	Metro Beach Incinerator	235
25	WA36	Diversey Corp.	233
26	MA66	G and L Industries	231
27	CH11	Soo Line Railroad Solid Waste Site	230
28	MA5	Residential wells Cedargrove Road	230
29	MA41	Selfridge ANG Base	230
30	MA12	G and H Landfill	229
31	WA54	McLouth Steel	229
32	MA9	Hamlin Road Landfill	227
33	CH1	Bay Mills Township Sanitary Landfill	226
34	CH7	Transportation spill Soo Township	226
35	SC14	Sanitary Landfill Area No.1 (Smith Creek Landfill)	225
36	CH8	Old Kincheloe Air Force Base	224
37	MA34	Standard Oil Gas Station	224
38	WA7	Monsanto Co.	223
39	WA50	Edward C. Levy Co. Plant No. 6	220
40	MA16	St. Lawrence Cemetery-sawmill	219
41	SC21	Mueller Brass Co.	219
42	WA48	Jones Chemicals Inc.	219
43	CH4	Sault Ste. Marie Disposal (Union Carbide)	218
44	MA68	NI Industries/Mirrex	217
45	MA29	Mt. Clemens Coatings and Plastics (Ford Vinyl and Paint, Mt. Clemens)	216
46	MA11	Utica Site Cardinal Land Corp.	211
47	SC13	Grand Trunk Railroad	209
48	SC16	A and B Waste Disposal	209
49	SC18	Hoover Chemical Reeves Products	209
50	WA58	Rouge Steel Co.	208

Table 23.--Ranks and scores for confirmed or possible ground-water-contamination sites--Continued

Rank	Site number	Site name	Score
51	WA84	Mich. Con. Station B	207
52	CH6	Superior Sanitation Landfill (3 Mile Road)	206
53	SC20	Eltra Corp. Prestolite Wiring	206
54	MA3	Ramona Park Landfill	205
55	MA13	Red Run Drain Landfill	203
56	SC15	Wills Street Dump site	203
57	WA65	Van Dusen Airport Service	203
58	MA42	Safety Kleen Corporation	202
59	SC10	County Line Landfill	202
60	MA18	American Legion	201
61	WA2	Huron Quarry Sanitary Landfill	201
62	SC25	General Technical Coatings	200
63	WA45	GMC Detroit Diesel Allison Division Redford	200
64	MA62	Henning Road Landfill	199
65	SC11	Winchester Disposal area	199
66	WA53	McKesson Chemical Co.	199
67	MO7	Moo-Lee Co.	198
68	WA32	Chemical Recovery Systems	198
69	WA59	Safety Kleen Corp.	198
70	MA23	Sugarbush	197
71	WA10	Thorton Landfill	197
72	SC17	John A. Biewer Company	196
73	MA58	South Macomb Disposal No. 5	193
74	WA70	Petro-Chem Processing Inc.	193
75	WA83	Inkster Rd Oil Contamination (Dimattia Enterprises)	193
76	MA31	Rosso Highway SAFB-Avis Ford	192
77	MA48	Macomb Township Dump	191
78	MA61	Residential wells Card Road	191
79	MO5	Wayne Disposal (Rockwood)	191
80	MO2	Burt's Landfill	189
81	WA73	Levy Co. King Road Site	189
82	MA43	M-97 Landfill	188
83	SC8	Norman Markel	187
84	WA39	General Electric Co.	187
85	MA2	Carolee Street area	186

Table 23.--Ranks and scores for confirmed or possible ground-water-contamination sites--Continued

Rank	Site number	Site name	Score
86	MA49	Mt. Clemens	186
87	WA41	GMC Cadillac Clark Plant	186
88	WA40	General Oil Company, Inc.	185
89	WA71	Chem-Central Romulus	185
90	MA4	Residential wells Foss Rd.	184
91	MA22	Detroit Sportsman Congress (A and A Landfill)	184
92	SC19	Akzo Chemie America	183
93	WA62	Inkster Gasoline Leak	183
94	WA3	Pennfill	182
95	WA21	Norfolk and Western Railroad	182
96	MA60	Detroit Fill	181
97	WA25	Cooper School Site	181
98	MA47	Fourteen Mile Road Site	180
99	WA24	National Airport Site	180
100	WA34	Dearborn Refining Co.	180
101	WA87	Mich. Con. Melvindale Plant	180
102	MA8	Clinton River Road Disposal area	179
103	MA25	New Baltimore Sanitary Landfill	179
104	MA45	Hayes Road Site No. 8	179
105	OA12	Howard Plating	179
106	SC1	Belle River Berm Project (Range Road Property)	179
107	SC23	Fort Gratiot Sanitary Landfill	179
108	WA16	Dump near Wicks Elementary School	178
109	WA69	GMC Fisher Body Fort Street	178
110	MA63	Shores Oil Co.	177
111	MA59	Detroit Fill	176
112	WA19	Chem-Met Services	176
113	WA38	Environmental Waste Control Inc.	176
114	SC22	St. Clair Rubber Co. Marysville	175
115	MA1	Malow Landfill	173
116	MA51	Cardinal (Reitzloff)	173
117	WA12	Ottawa Silica Co.	173
118	SC4	Whitcomb Barrel Dump	172
119	SC24	Total Oil Storage	172
120	WA27	Dynamite Park	172

Table 23.--Ranks and scores for confirmed or possible ground-water-contamination sites--Continued

Rank	Site number	Site name	Score
121	WA67	Carters Waste Oil Reclamation Inc.	170
122	WA82	Troy Auto Parts	170
123	MA6	New Haven Foundary	169
124	CH10	Mac's Service	168
125	MA32	Grosse Points Clinton Waste Reduction Plant (old Dean site)	168
126	WA5	McLouth Steel Corp.	168
127	MA46	Marsack and Son	167
128	MA50	South Macomb Disposal	166
129	WA6	Michigan Casting Center	166
130	WA60	Waste Acid Service Inc.	166
131	WA68	GMC Detroit Diesel Alllison Romulus Plant	166
132	MO1	Ash Township	165
133	MO4	Matlin Road (Carleton)	165
134	OA2	Reichhold Chemicals Inc.	165
135	WA1	Ford Motor Company Allen Park Clay Mine	165
136	WA61	MI Environmental Services Co.	165
137	MA67	Clark Gas Station	164
138	WA18	Peloquin Enterprises St. Aubin	164
139	WA33	Commercial Steel Treating Corp.	164
140	WA77	M and H Service Station	164
141	MA26-27	Ray Township Transfer Station and Disposal Station	163
142	MO3	Edward C. Levy Co.	163
143	WA74	Young Patriots Park	163
144	WA86	Mich. Con. Station J	163
145	WA42	GMC Chevrolet Detroit Assembly	162
146	WA43	GMC Chevrolet Detroit Forge	162
147	WA44	GMC Chevolet Detroit Gear and Axle	162
148	WA47	Inmont Corp.	162
149	MA37	GMC Technical Center	161
150	WA56	Nelson Industrial Services	161
151	MA20	Dean Bros. 25 Mile Chesterfield Township	159
152	MA40	U.S. Chemical Company Inc.	159
153	MA39	U.S. Army Tank Automotive Command	158
154	MA52	South Macomb Disposal	158
155	WA26	Erving and Vivian Brown Landfill	158

Table 23.--Ranks and scores for confirmed or possible ground-water-contamination sites--Continued

Rank	Site number	Site name	Score
156	WA81	Unistrut Corporation	158
157	CH9	Veldt Farm	157
158	WA4	M and P Development Co.	157
159	WA31	Ashland Chemical Co.	155
160	WA55	Michigan Chrome and Chemical Co.	155
161	WA66	Celanese Plastics Specialities Co.	155
162	WA76	Huber Foundry	155
163	OA1	Parker Chemical Company	153
164	WA52	Master Alloys Inc.	153
165	SC3	Huron Development (Marine City Sanitary Landfill)	152
166	WA8	Riverview Land Preserve	151
167	WA75	Berger-Gordon (Berger Corp.)	151
168	MA28	Richmond Township Landfill	150
169	OA3	Safety Kleen Corp.	150
170	CH12	Soo Township Peterman Site	149
171	SC2	Howard Disposal	149
172	MA19	Dean Bros. 27 Mile Lenox Township	148
173	SC6	Blue Water Construction	148
174	CH3	Dafter Sanitary Landfill (Ed Reid Landfill)	147
175	MA30	City of Warren, Refuse Transfer Station	145
176	OA13	Ethyl Corporation	145
177	WA17	Peloquin Enterprises Detroit	145
178	MA24	South Macomb Disposal Authority Transfer Station	144
179	WA78	Palmer and Brush Streets	143
180	WA79	Tronex Chemical Corporation	143
181	WA80	Palmer Street at Railroad	143
182	WA35	Detrex Chemical Industries Inc.	142
183	MA10	Koch Road Dump	141
184	SC5	Vlasic Foods Inc. Sanitary Landfill	141
185	OA4	Operator unknown	140
186	MA7	Tuff Kote Dinol Inc.	139
187	MA36	General Electric Co.	139
188	MA38	OMI International Corp. Udylite Sel-Rex	139
189	WA72	Carters Industrials	139
190	OA5	Southeast Oakland County Incinerator Authority	138

Table 23.--Ranks and scores for confirmed or possible ground-water-contamination sites--Continued

Rank	Site number	Site name	Score
191	OA11	Southeast Oakland County Incinerator Authority	138
192	MA64	Fini Finish Products	137
193	MA54	Blundt Dump-Hamtramck or Highland Park	136
194	MA56	South Macomb Disposal	135
195	OA6	Operator unknown	135
196	OA7	City of Detroit	135
197	OA8	Operator unknown	135
198	OA9	City of Detroit	135
199	OA10	City of Detroit	135
200	WA63	Intervale Lyndon LC	133
201	WA64	Plating Equipment Used Inc.	133
202	MA21	A and A Lenox Township	129
203	MA35	Achem Products Inc.	129
204	CH2	Montero Excavation Inc.	117
205	MA65	GE Carboloy	113
206	MA53	Detroit Fill	111
207	MA55	Detroit Fill	108
208	MA57	Detroit Fill	108