Chapter 9

Ground Water Resources

Early in the 1970s, the ODNR Division of Water realized the need to distribute basic ground water availability information to the general public in an easy-to-use, semi-technical format. To meet this need, the Division began producing a series of maps that describe Ohio's ground water resources on a county-by-county basis. Generally referred to as "Ground Water Resource Maps," these maps are intended to aid homeowners, industries, municipalities and regional water systems in developing reliable ground water supplies.

Ground water is water that is found underground in the cracks and spaces in soil, sand and rock. When rain falls to the ground, the water does not stop moving. Some of it flows along the surface to streams or lakes, some of it is used by plants, some evaporates and returns to the atmosphere, and some sinks into the ground.

Ground water is stored in and moves slowly through layers of soil, sand and rocks called aquifers—water-bearing formations that readily transmit water to wells and springs. The U.S. Geological Survey defines an aquifer as 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.

Aquifers typically consist of gravel, sand, sandstone or fractured rock, like limestone. Most of the void spaces in the rock or unconsolidated formations (i.e. sand and gravel) below the water table are filled with water. But formations have different porosity and permeability characteristics, which means that water does not move around the same way.

The ground water resources table in this section describes the different bedrock aquifers found in the Lake Erie Basin. The unconsolidated aquifers are described more on the Primary Lithology and Aquifer Settings map pages.

Water in aquifers is brought to the surface naturally through a spring or can be discharged into lakes and streams. Wells can also be drilled into the aquifers and water can be pumped out. Precipitation eventually adds water (recharge) into the pores of the aquifer. The rate of recharge is not the same for all aquifers, though, and that must be considered when pumping water from a well. Pumping too much water too fast draws down the water in the aquifer and can eventually cause a well to yield less and less water and even run dry.

In areas where material above the aquifer is permeable, pollutants can readily sink into ground water supplies. Ground water can be polluted by landfills, septic tanks, leaky underground gas tanks, and from overuse of fertilizers and pesticides. If ground water becomes polluted, it will no longer be safe to drink.

While more than three million Ohioans use Lake Erie as their source of potable water, ground water is used for drinking water by more than 50 percent of the people in the United States, including most people who live in rural areas.

The following series of maps shows the ground water availability in the counties within Ohio's coastal region. The Glacial (unconsolidated) State Aquifer Map, in conjunction with the Bedrock State Aquifer Map, was part of a major effort undertaken by the ODNR Division of Water from 1996-2000. Prior to the initiation of this project, Ohio did not have a statewide aquifer map for unconsolidated (glacial) or bedrock aquifers, and had no formal identification system for aquifer boundaries, types or names. The goal of the project was to delineate aquifer boundaries, quantify yields, develop a standardized naming system and define aquifer thickness for all of the significant aquifers in the state.

The following is a short description of each of the maps in this section.

Ground Water Resources Map

The Ground Water Resources Map shows the expected yield to a drilled well at any location in a county. This map uses a consistent color-coding system to represent well yields. For example, properly constructed wells drilled in areas colored blue on the map can be expected to yield 100 to 500 gallons per minute (gpm). Areas colored yellow would yield 25 to 100 gpm. In all, there are eight colors used to identify well yield categories ranging from blue (100 to 500 gpm) to orange (less than 3 gpm).

Ground water resources maps were constructed using well log and drilling reports on file at the ODNR Division of Water, bedrock and glacial information published by the ODNR Division of Geological Survey, and unpublished geologic and hydrogeologic data including consultants' reports, test borings, sieve analyses and pumping tests.

Ground water resources information is available for all 88 counties in Ohio. Information on viewing, downloading or ordering a county map can be found at www.ohiodnr.com/water/gwrmaps/.

Glacial State Aquifer Maps

The Glacial State Aquifer Map is composed of five distinct, relatable layers or coverages. The coverages are primary lithology (composition), aquifer yield, drift thickness, aquifer setting and local aquifer names. Three of these coverages – primary lithology, aquifer settings and local aquifer names – are presented in the following pages. Information from the aquifer yields coverages is incorporated under the map for Ground Water Resources. A reason for this is that many of the glacial aquifers are lower yielding than the underlying bedrock aquifers within the Lake Erie Basin. Drift thickness is addressed by a similar, more up-to-date publication by the ODNR Division of Geological Survey found in next chapter (Chapter 10: Geology).

Four coverage layers are separately available on the ODNR Division of Water "Map Gallery" web page as PDF downloads from www.ohiodnr.com/water/samp/mapgalry.htm. The local aquifer names coverage is not available as a PDF but is available as an ArcView coverage. The entire package of coverages is available as a GIS ArcView download from the ODNR website www.ohiodnr.com/water/samp/uncon_coverages.htm. GIS coverages are also available on CD (please contact Jim Raab at jim.raab@dnr.state.oh.us or 614-265-6747).

Local Glacial Aquifer Names Map

In conjunction with the Ohio EPA, the ODNR Division of Water developed a naming system to help identify glacial aquifers. A set of local names was derived. These names are based upon geographic features including classic geomorphic and physiographic features, rivers and major nearby cities.

In the GIS coverages, the local aquifer names are used in tandem with the aquifer setting. For example, areas may be identified as the

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Cuyahoga buried valley aquifer, the Cuyahoga alluvial aquifer, etc.

Primary Lithology Map

The Primary Lithology Map shows the composition of glacial deposits in Ohio. It also includes related deposits such as lacustrine (lakebed) deposits associated with the ancestral stages of Lake Erie and alluvial (stream and river) deposits. These deposits are also referred to as unconsolidated deposits in order to differentiate them from the underlying consolidated deposits or bedrock. An older, commonly used term for unconsolidated deposits is glacial drift.

The purpose of the Primary Lithology map is to summarize the predominant composition or lithology of the entire sequence of glacial drift in any given area. There are three primary lithologies: fines (silt and clay), sand and gravel, and till. Till is an unsorted, non-layered mix of silt, clay and sand, and smaller proportions of gravel, cobbles and even boulders. Till was directly deposited by the ice sheet.

Where possible, one of these three primary lithologies is mapped. In many areas, the lithologies may combine or closely overlap each other either vertically or horizontally. In such cases, the first listed lithology is predominant and the next listed is secondary. For example, in areas mapped as till with sand and gravel, till is the most common lithology, however relatively thin layers or lenses of sand and gravel found with the till are common and important.

Glacial Aquifer Settings Map

Aquifer settings have been delineated as a part of the Glacial (Unconsolidated) State Aquifer Map for Ohio. Aquifer settings relate hydrogeologic properties of glacial aquifers to common geomorphic features. This combination helps to attach aquifer characteristics to easily recognizable surficial features and processes.

Data sources include "Quaternary Geology of Ohio" (Pavey et. al., 1999), the "Glacial Map of Ohio" (Goldthwait et. al., 1961), "Physiographic Regions of Ohio" (Brockman, 2002) and numerous county specific reports and manuscripts from the ODNR Division of Geological Survey. The Division of Geological Survey's series of 1:24,000 Reconnaissance Bedrock Topography Maps proved invaluable. These maps were used to construct a drift thickness map or coverage for the Glacial State Aquifer Map for Ohio that was crucial in helping to delineate the aquifer settings. Numerous county-specific and regional reports, bulletins and maps were utilized from the ODNR Division of Water, including both Ground Water Resources maps and Ground Water Pollution Potential (DRASTIC) Maps. Water well log record data on file at the ODNR Division of Water constituted a major source of data. Maps from National Resource Conservation Service (NRCS) County Soil Surveys also proved helpful.

Ten aquifer settings were established for the Glacial (Unconsolidated) State Aquifer Map; nine of these are present in the Lake Erie Basin. One 'new' setting, termed "complex" was created specifically for this project.

All of the map digitization for Glacial State Aquifer Maps was done at a 1:24,000 scale using USGS 7.5 Minute Topographic Quadrangle Maps as a base. Hand-drawn boundaries were digitized and converted into GIS coverages using ESRI Arc Info and Arc View. The mapping was funded through US EPA Clean Water Act Section 319 Nonpoint Source monies that were provided by the Ohio EPA.

For more information

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Background Photo: Chagrin River, Cuyahoga County

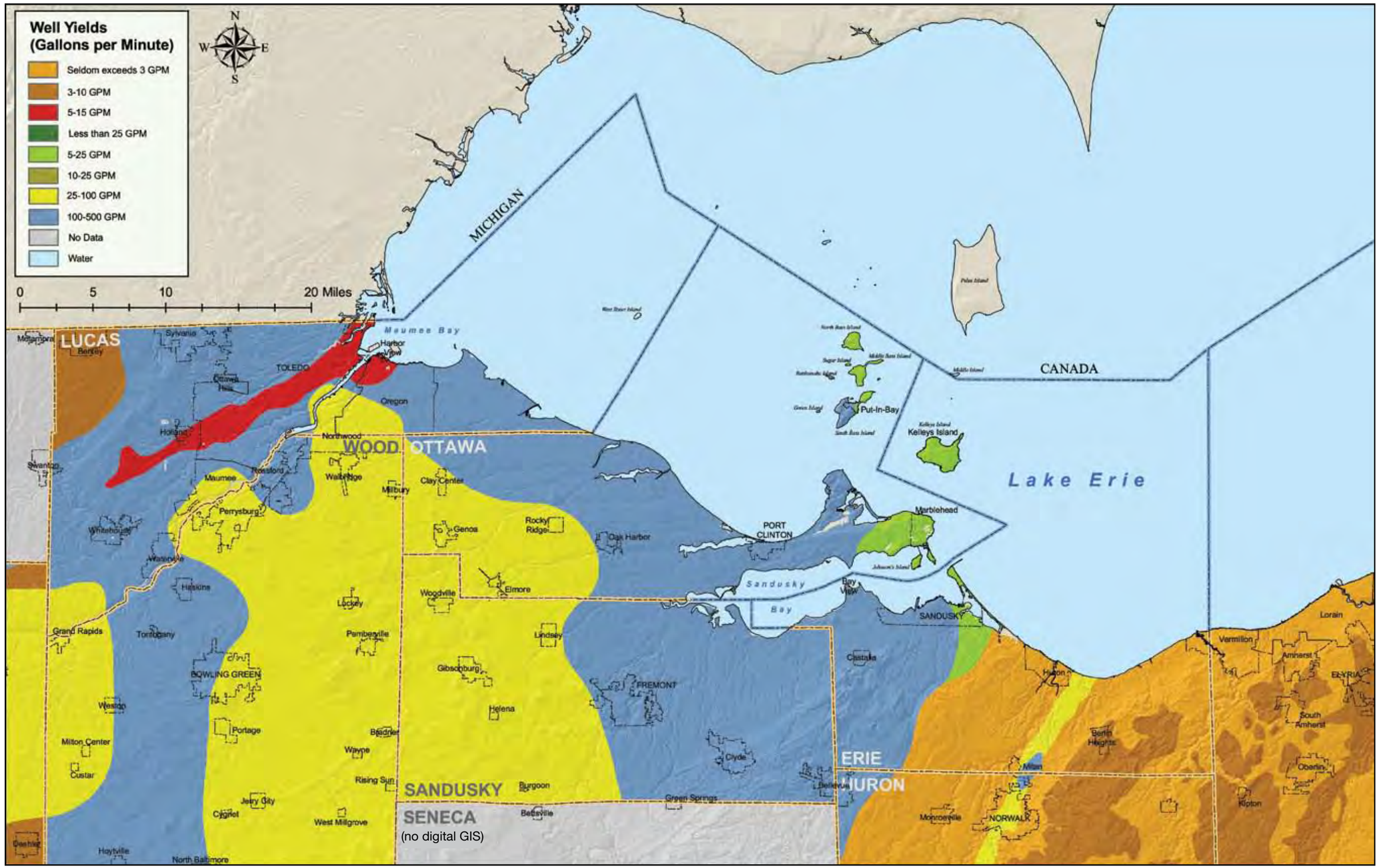
Ground Water Resources

Crane Creek, Lucas County

Cuyahoga State Scenic River

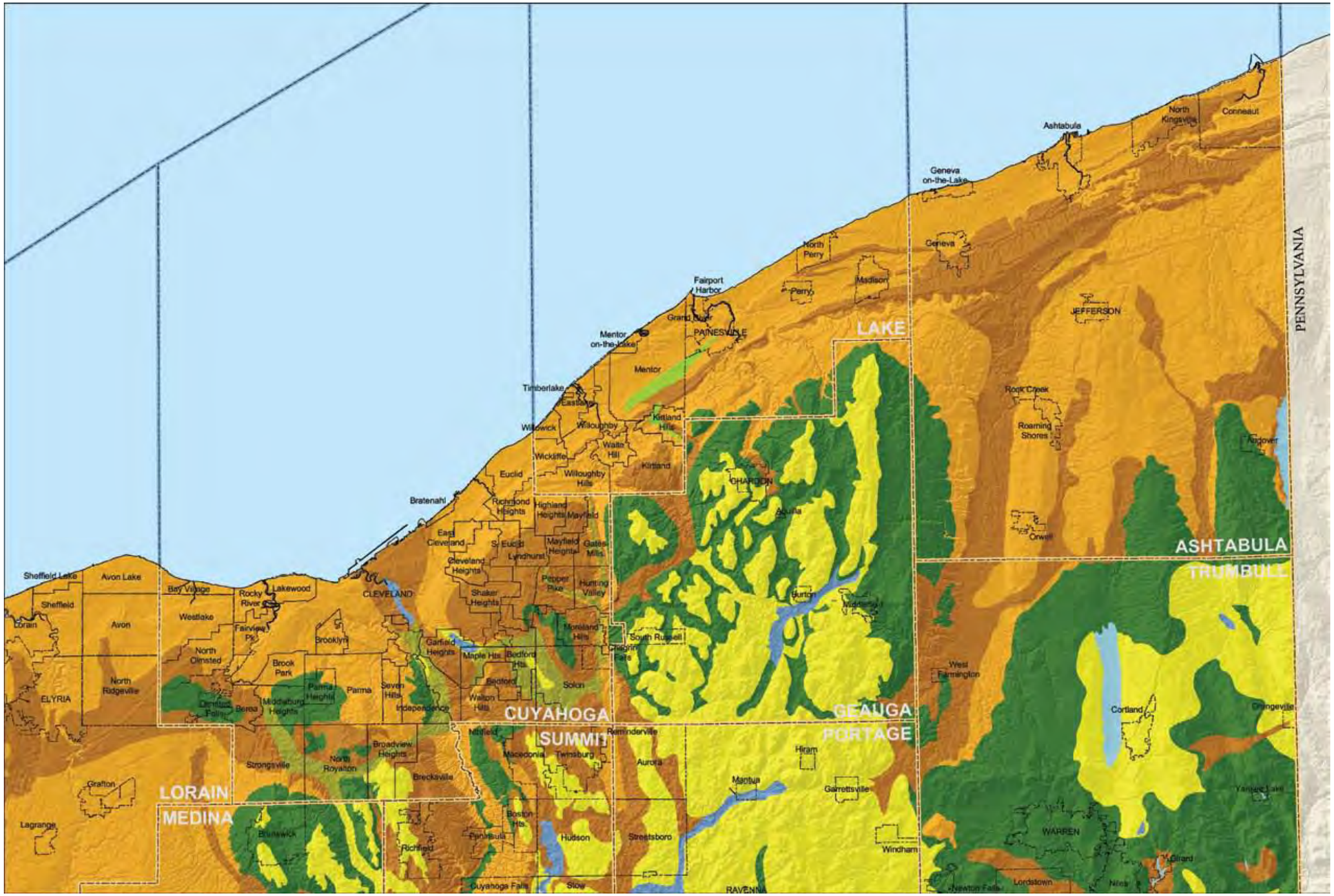
Grand River, Lake County

Tinkers Creek, Cuyahoga County



Map 39 GIS data citation in Appendices

Ground Water Resources



Map 39 GIS data citation in Appendices

GROUND WATER RESOURCES

[gpm] gallons per minute

0-3 gpm Wells are completed in the Devonian-age shale bedrock. A thin layer of clay or sandy clay overlies the shale. Dry wells are not uncommon.

3-10 gpm Wells are completed in fine sand interbedded in clayey glacial deposits or the ancient beach ridges in Lake and Ashtabula counties or from sandy shale or fine sandstone formations.

5-15 gpm Wells are completed in thin discontinuous sand and gravel lenses interbedded in thick clay. Higher yields are available from the underlying limestone and dolomite (carbonate) bedrock at depths greater than 120 feet.

5-25 gpm Average yields of less than 15 gpm are developed from wells completed in the carbonate bedrock. Depth to the bedrock is usually less than 10 feet. Well depths are typically less than 100 feet.

10-25 gpm Wells are completed in the Mississippian-age sandstones and sandy shales at depths ranging from 50 to 150 feet.

25-100 gpm In Lucas, Wood, Ottawa and Sandusky counties, wells are completed in the Silurian-age carbonate formations. In Erie and central Cuyahoga counties, wells are completed in sand and gravel deposits within buried valley settings. In southern Cuyahoga County, wells are completed in the Pennsylvanian-age sandstones at depths less than 75 feet.

100-500 gpm In Lucas, Wood, Ottawa, Sandusky and Erie counties, wells are completed in the Devonian and Silurian-age carbonate formations at depths ranging from 30 to 400 feet. In southern Erie and Cuyahoga counties, ground water is obtained from the permeable sand and gravel deposits.

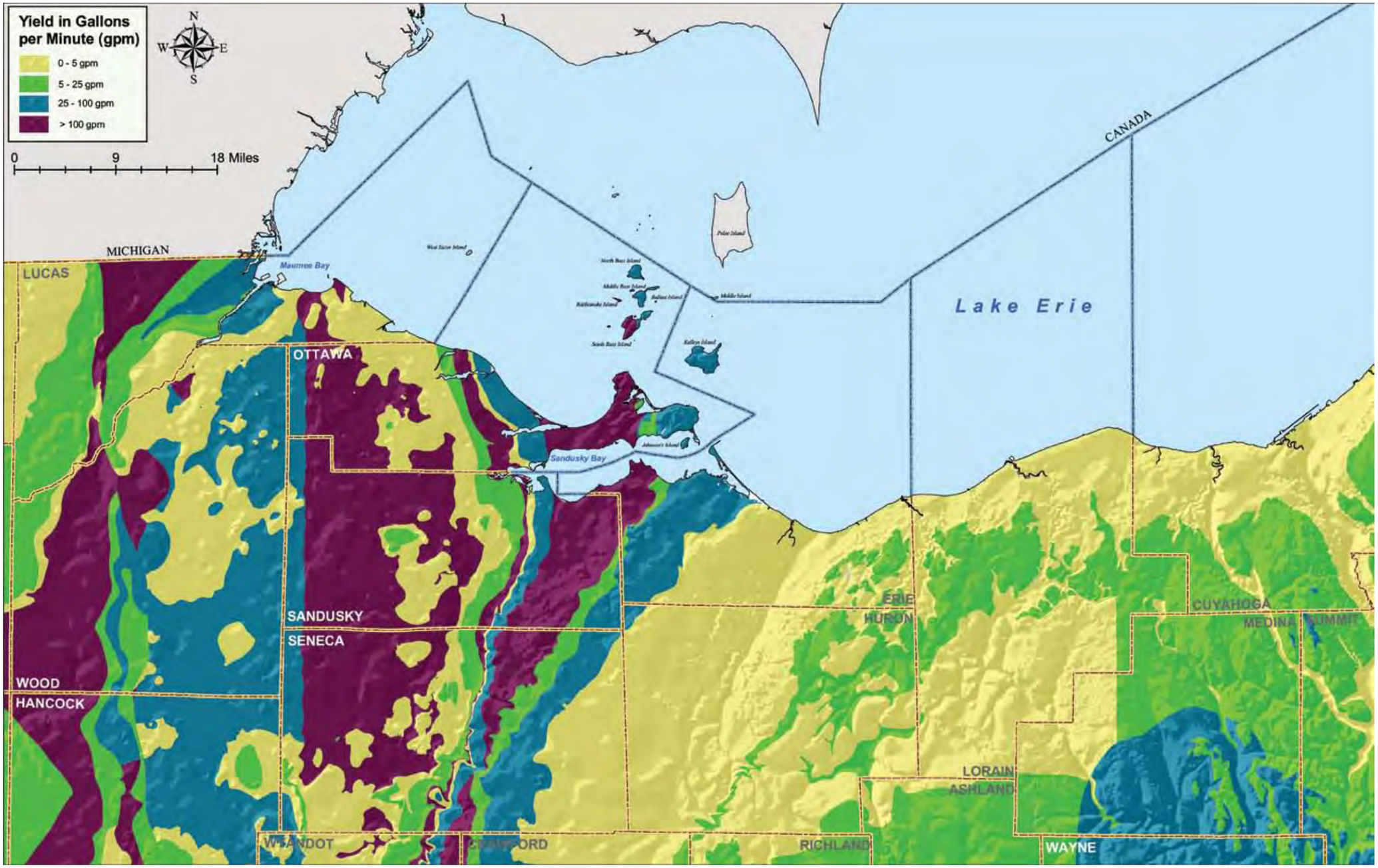
Yields of the Uppermost Bedrock Aquifers

Ashtabula County

Old Woman Creek, Erie County

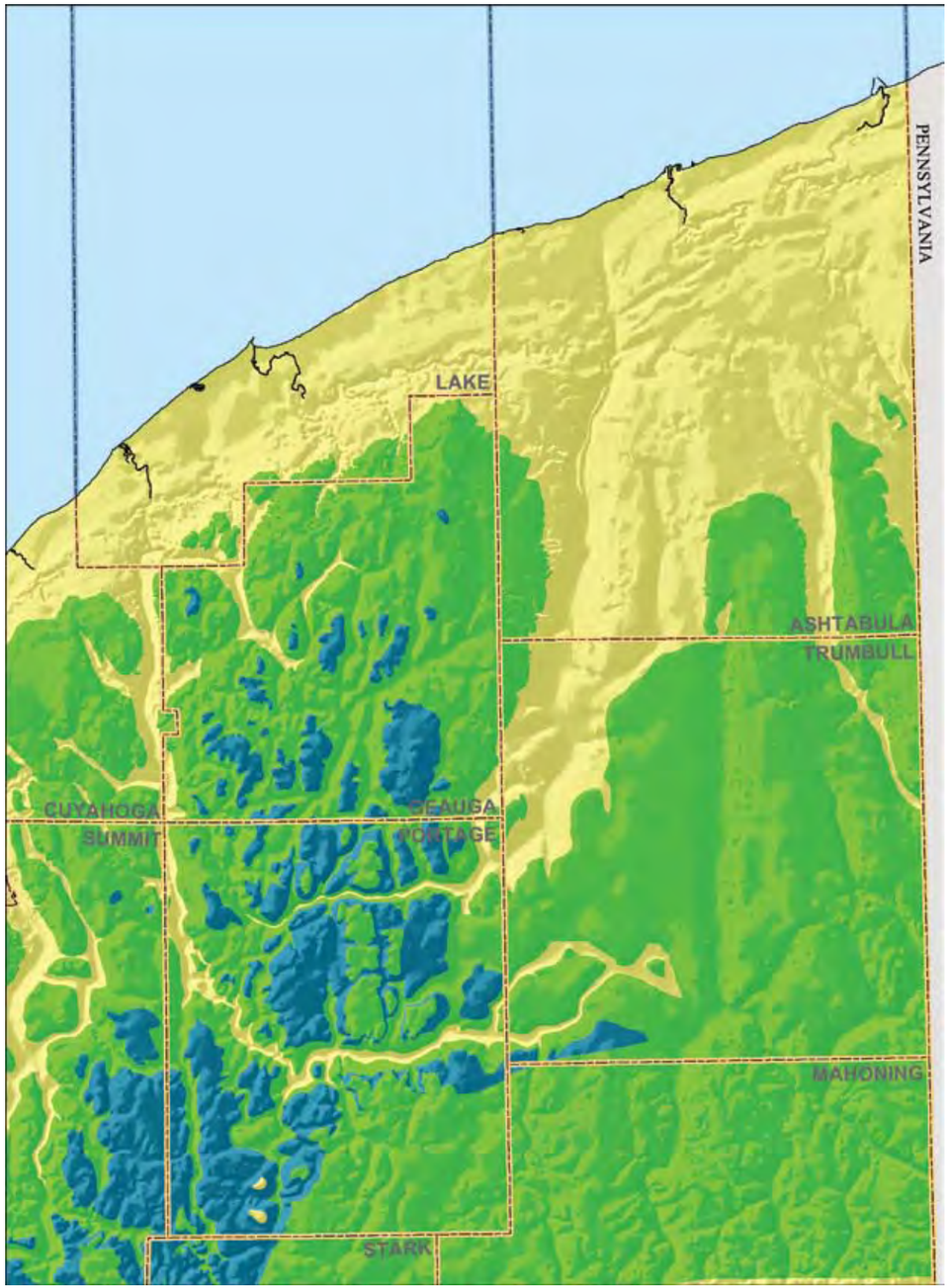
Chagrin State Scenic River

Toussaint River, Ottawa County



Map 40 GIS data citation in Appendices

Yields of the Uppermost Bedrock Aquifers



Map 40 GIS data citation in Appendices

The Yields of the Uppermost Bedrock Aquifers map shows the yield, in gallons per minute (gpm), of the uppermost bedrock formation encountered. In most areas of the coastal region, the bedrock is not visible but is covered by clay, sand and gravel. In most areas, the depth to the bedrock is less than 50 feet.

The oldest bedrock formations are found in the western end of the Lake Erie basin. The Silurian-age Tymochtee and Greenfield make up the uppermost aquifer in the majority of Lucas, Wood, Hancock, Ottawa, Seneca and Sandusky counties. The Tymochtee and Greenfield are gray to brown dolomites. Yields vary primarily due to the thickness of the formation. Within the counties mentioned above, there is another deeper aquifer, the Lockport Dolomite, that is capable of yielding more than 25 gpm to a well.

In a six- to eight-mile wide band starting at the eastern edge of Sandusky Bay and trending southwest, the Delaware and Columbus limestones are the uppermost aquifer. Yields from these formations vary from 5 to 100 gpm. Beneath this area are other limestone and dolomite aquifers capable of yielding more than 25 gpm.

Starting in central Erie County and trending along the lake to Ashtabula County, the Ohio and Olentangy shales are the uppermost bedrock formations. This aquifer typically yields less than 5 gpm and is the only potable aquifer. This area is shown as yellow. Public water systems utilizing Lake Erie as the source of water provide water in most of this area.

Areas shown as green from Erie and Huron counties and east indicate where the Cuyahoga Group is the uppermost aquifer. This aquifer is comprised of sandstone and shale units and typically yields 10 to 25 gpm. The blue areas in Medina and Wayne counties show where the Logan and Black Hand formations can yield 25 to 100 gpm. In areas of Cuyahoga, Geauga and Trumbull counties, the Berea Sandstone is an aquifer below the Cuyahoga Group aquifer.

Areas shown as blue in Geauga, Portage and Summit counties are where the Pennsylvanian-age Sharon and Massillon sandstones are the uppermost aquifer. Yields from these aquifers are usually greater than 25 gpm. The Cuyahoga Group and the Berea sandstones underlie this aquifer in the majority of this area.

The generalized Bedrock Stratigraphy and Aquifer Description Table on the next pages describes each aquifer and gives the location where each is present in the Lake Erie coastal region.

Water Efficiency at Home

Water is one of Ohio's most abundant natural resources, but it is a resource that should not be taken for granted. To ensure an adequate supply of water for daily needs today and in the future, there are practical ways to conserve Ohio's water resources right at home.

Toilets: *In many homes, 43 percent of daily water consumption is used to flush toilets. A standard toilet uses more than 5 gallons of water for each flush, but that can be reduced to 3.5 gallons or less by filling a gallon plastic jug with water and placing it in the tank to displace water that would otherwise be flushed. Or, install a newer low-consumption toilet – some of which are designed to use as little as 1.6 gallons at a time.*

Showers: *Showers are the second biggest water waster in homes, pouring out 5 to 10 gallons per minute (gpm). Reduce waste by limiting shower time and replacing old showerheads with a low-flow model. Bathing is usually more water-efficient than showering.*

Sinks: *Inexpensive low-flow aerators save water in sinks. A single indoor faucet without a low-flow aerator can pour out 2 to 8 gpm. Another water-saving tip is to fill the sink with water, rather than letting it run nonstop while cleaning vegetables and fruits, shaving, washing, etc.*

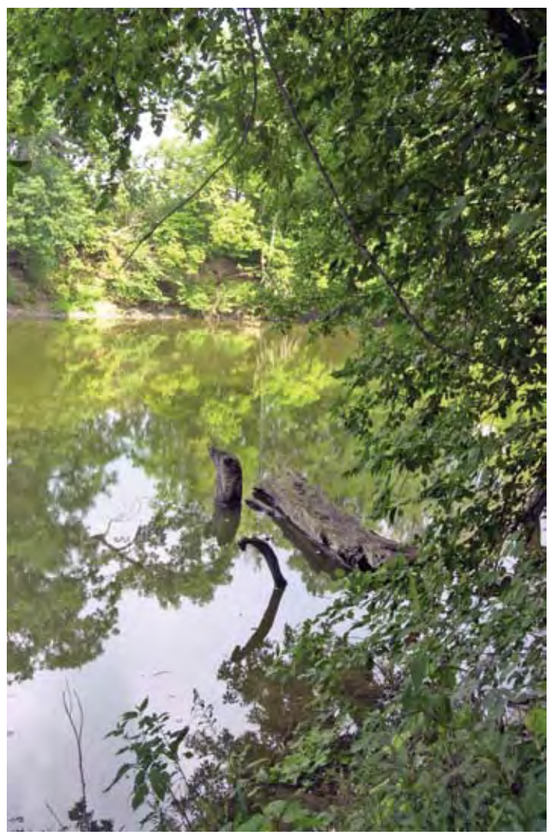
Dishwasher and Washing Machines: *Washing machines and automatic dishwashers can account for 20 percent of weekly household water needs: 30 gallons for each load of laundry and 17 gallons per load of dishes. Consolidate loads as often as possible. When it is time to purchase a new appliance, make water efficiency a top consideration.*

Leaks: *Repairing a dripping faucet saves water as leaks can account for as much as 20 percent of an average household's water use. A leaking toilet can waste up to 200 gallons a day. Toilet leaks can be detected by adding a few drops of food coloring to the tank water. If colored water shows up in the bowl, without flushing, a leak is present.*

Lawns and Gardens: *During hot, dry summer months, frequent watering of lawns and gardens can more than double the normal household's water usage. Water resources are conserved by watering lawns and gardens early in the day, before 10 a.m., to reduce evaporation and sun scalding. Lawns should only be watered once a week with no more than 1 inch of water applied.*

For more information/ Source: *ODNR Division of Water - ohiodnr.com/water/pubs/fs_div/default.htm*

Generalized Bedrock Stratigraphy



Sandusky State Scenic River at Collier State Nature Preserve, Seneca County

Generalized Bedrock Statigraphy and Aquifer Description of the Lake Erie Coastal Region

Geologic System	Formation	Aquifer Description	Location of Aquifer in Lake Erie Coastal Region
Pennsylvanian	Sharon and Massillon Sandstones	Loosely cemented, cross-bedded, course- to medium-grained gray-white to light reddish tan sandstone with interbedded zones of pebbly conglomerate. Yields range from 5 to 100 gpm	Geauga, Portage, Summit, Trumbull and south-central Cuyahoga counties
Mississippian	Cuyahoga Group	Gray to brown, thin- to thick-bedded shale, with interbedded sandstone and siltstone. Thickness is typically greater than 100 feet, with yields of 5 to 25 gpm everywhere	Lorain, Cuyahoga and southern Ashtabula counties
	Sunbury Shale	The Sunbury Shale is considered an aquifer only when it is underlain by the Berea Sandstone. This aquifer is a black to brownish-black carbonaceous shale, with a thickness that typically does not exceed 100 feet. Yields range from 0 to 5 gpm.	Lorain, eastern Erie and southern Ashtabula counties
	Berea Sandstone	The Berea Sandstone aquifer consists of a very-fine-grained, light greenish-gray sandstone. The aquifer is considered non-potable in the areas where total dissolved solids exceed 2000 parts per million (ppm). Aquifer thickness does not exceed 100 feet, and yields range from 5 to 25 gpm.	Geauga, Trumbull, southern Ashtabula and southern Cuyahoga counties
	Bedford Shale	The Bedford is a gray to brown to reddish brown shale interbedded with sandstone and siltstone. Thickness is less than 100 feet, with yields of less than 5 gpm.	Central and eastern Erie, Lorain, Cuyahoga, Lake and Ashtabula counties
Devonian	Ohio and Olentangy Shales	The Ohio Shale is a brownish-black, thin-bedded, carbonaceous shale. The Olentangy Shale is greenish-gray, thin-bedded and contains limestone nodules in the lower third of the formation. The thickness of these shales can exceed 250 feet. These shales are poor aquifers, with yields from wells ranging between 0 and 5 gpm. The presence of hydrogen sulfide is also a problem with this aquifer.	Central and eastern Erie, northern Lorain, Cuyahoga, Lake and Ashtabula counties
	Delaware and Columbus Limestones	The Delaware is a gray-brown, thin-bedded to massive, argillaceous, carbonaceous limestone. The Columbus is a gray to brown, fossiliferous, massive-bedded limestone and dolomite. Karst features also commonly occur in the Columbus. Thickness of this aquifer can range from less than 50 to greater than 120 feet. Yields from wells developed in this aquifer can range from 5 to 100 gpm, depending on thickness and the presence of karst features. The Columbus is the more prolific of the two formations due to the presence of the karst features.	Western Erie, eastern Sandusky and eastern Ottawa counties
	Traverse Group, Dundee Limestone and Detroit River Group	The Traverse Group consists of gray to light brown cherty dolomite and olive gray fossiliferous shale interbedded with limestone. The Dundee Limestone is thinly bedded and fossiliferous in the upper portion, and medium to thick-bedded cherty dolomite in the lower portion. The Detroit River Group is a medium to thick-bedded dolomite with the basal section becoming a sandy dolomite or fine-grained sandstone. Yield is 5 to 25 gpm except along the easternmost edge of the aquifer where the yield is 0 to 5 gpm.	Northwestern Lucas County
Silurian	Salina undifferentiated	This aquifer consists of gray to brown, thin-bedded dolomite. Occasional anhydrite and gypsum zones occur throughout the aquifer. Yield varies from 25 to greater than 100 gpm depending on the thickness encountered.	Wood, Lucas, Ottawa and Sandusky counties
	Tymochtee and Greenfield Dolomites	Both formations are thin- to massive-bedded dolomites, olive-gray to yellow-brown in color. The Tymochtee also contains carbonaceous shale partings, while the Greenfield has a laminated dolomite lithology. Yields from wells developed in this aquifer can range from 25 to greater than 100 gpm. The yields are often significantly higher from the Tymochtee. This aquifer is considered not viable beneath the Ohio and Olentangy Shales.	Wood, Lucas, Ottawa and Sandusky counties
	Lockport Dolomite	The Lockport is a white to medium gray, medium- to massive-bedded dolomite, often with cavernous zones present at or near the contact with overlying formations. Yields can range from 25 to greater than 100 gpm, depending on thickness and the presence of karst features.The aquifer is not considered viable below the Ohio and Olentangy Shales.	Wood, Lucas, Ottawa and Sandusky counties

Local Glacial Aquifer Names

Rocky River, Cuyahoga County

The following is a list and brief description of local glacial aquifer names:

Alliance Large, relatively flat-lying upland area in northeastern Ohio. Contains very clayey till and minor sand and gravel.

Black River Alluvium and short buried valleys adjacent to the Black River in Medina and Lorain counties.

Brecksville Large area of clayey till upland in northeastern Ohio.

Chagrin Highly variable deposits lying adjacent to the Chagrin River in eastern Cuyahoga County and western Geauga County.

Chardon Large area of thin till over sandstone in northeastern Ohio.

Cuyahoga Alluvium and buried valley deposits that reflect current and ancestral channels of the Cuyahoga and Little Cuyahoga Rivers.

Galion Large area in north central Ohio that contains end moraine, ground moraine and thin upland settings. Yields are commonly 5-25 gpm.

Grand River Large complex buried valley system in Trumbull, Ashtabula and Lake counties. Deposits and yields vary considerably.

Green Creek Small buried valley system south of Sandusky Bay.

Huron Fine-grained alluvial settings associated with the Huron River.

Lake Erie Islands Thin, clayey till covering a number of small islands located in Lake Erie, including Kelleys Island and the Bass Islands.

Lake Erie Tributary Refers to a number of small, non-related tributary streams that empty into Lake Erie and contain fine-grained sediments.

Lake Maumee Large, flat plain of fine-grained sediments that reflects sediments derived from ancestral Lake Erie in northwestern Ohio.

Lorain Upland area of clayey till in central Lorain County.

Mahoning Complex alluvium and buried valleys associated with the Mahoning River.

Maumee River Large river system containing fine-grained sediment in northwestern Ohio.

Medina Area of clayey till uplands and moraines in central Medina County.

Muddy Creek Small tributary of Sandusky Bay containing fine-grained alluvial and lacustrine sediments.

Norwalk Short buried valley system containing mix of high-yielding sand and gravel and silt in western Huron and Lorain counties.

Oak Openings Large area of fine-grained beach deposits in northwestern Ohio.

Painesville Narrow, flat plain of fine-grained sediments that reflects sediments derived from ancestral Lake Erie in northeastern Ohio.

Portage River Fine-grained alluvium in a tributary of Lake Erie draining much of Ottawa County and northern Wood County.

Pymatuning Large upland area of clayey till covering much of Ashtabula and Trumbull counties.

Rocky River Alluvium and buried valleys associated with the Rocky River in western Cuyahoga County and northern Medina County.

Sandusky River Fine-grained alluvium of the Sandusky River.

Shenango Narrow buried valleys associated with tributaries of the Shenango River (in Pennsylvania) in eastern Trumbull and Ashtabula counties. Contains fine-grained till and alluvial sediments.

Tiffin Area of clayey till moraines and uplands in the western end of the Lake Erie Basin.

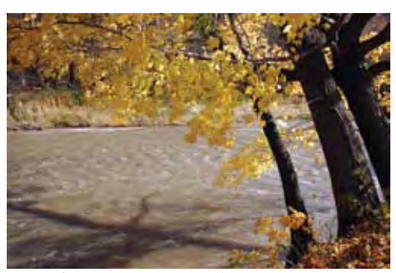
Vermilion Alluvium and buried valleys associated with the Vermilion River in parts of Lorain, Erie, and eastern Huron counties.

Local Glacial Aquifer Names

Black River at Cascade Park, Lorain County

Brandywine Falls, Cuyahoga Valley National Park

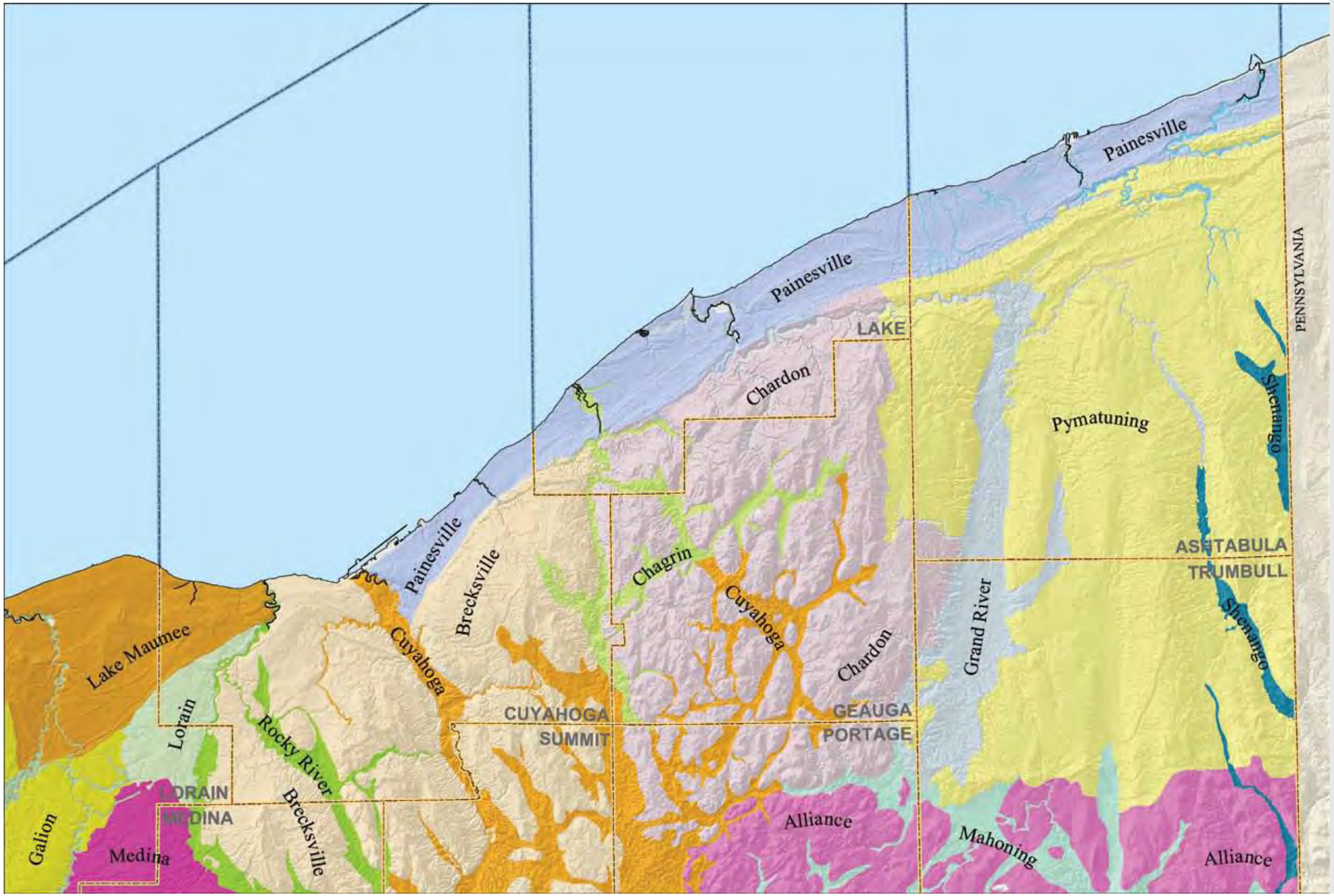
Sandusky River, Seneca County



Vermilion River, Lorain County

Map 41 GIS data citation in Appendices

Local Glacial Aquifer Names



Map 41 GIS data citation in Appendices

Where is Your Water From?

Of the finite quantity of water on the Earth, roughly 98 percent is saline and is found in the oceans. The remaining 2 percent is fresh water found mostly in the atmosphere and locked up in glaciers. Drinkable water in lakes, rivers and ground water accounts for less than 2 percent of the planet's fresh water reserves.

The Great Lakes are the largest system of fresh surface water on earth, containing roughly 6 quadrillion gallons of water or about 95 percent of the United States' fresh surface water and 18 percent of the world's fresh surface water supply. Lake Erie supplies more than 3 million Ohioans, including communities such as Toledo and Greater Cleveland, with daily potable water.

However, in Ohio, more than 4.5 million people (40 percent of the state's population) depend on ground water to meet their daily water needs. This includes large municipalities such as Dayton, Canton and Columbus, which rely on ground water to provide all or part of their water supply. More than 700,000 domestic water wells also supply individual homes throughout the state.

Industries in Ohio pump more than 240 million gallons of ground water per day; irrigation withdrawals total almost 2 million gallons per day. Total ground water pumped for all uses in Ohio is estimated at 730 million gallons per day or more than 266 billion gallons per year.

Sources:
ODNR Division of Water
U.S. EPA

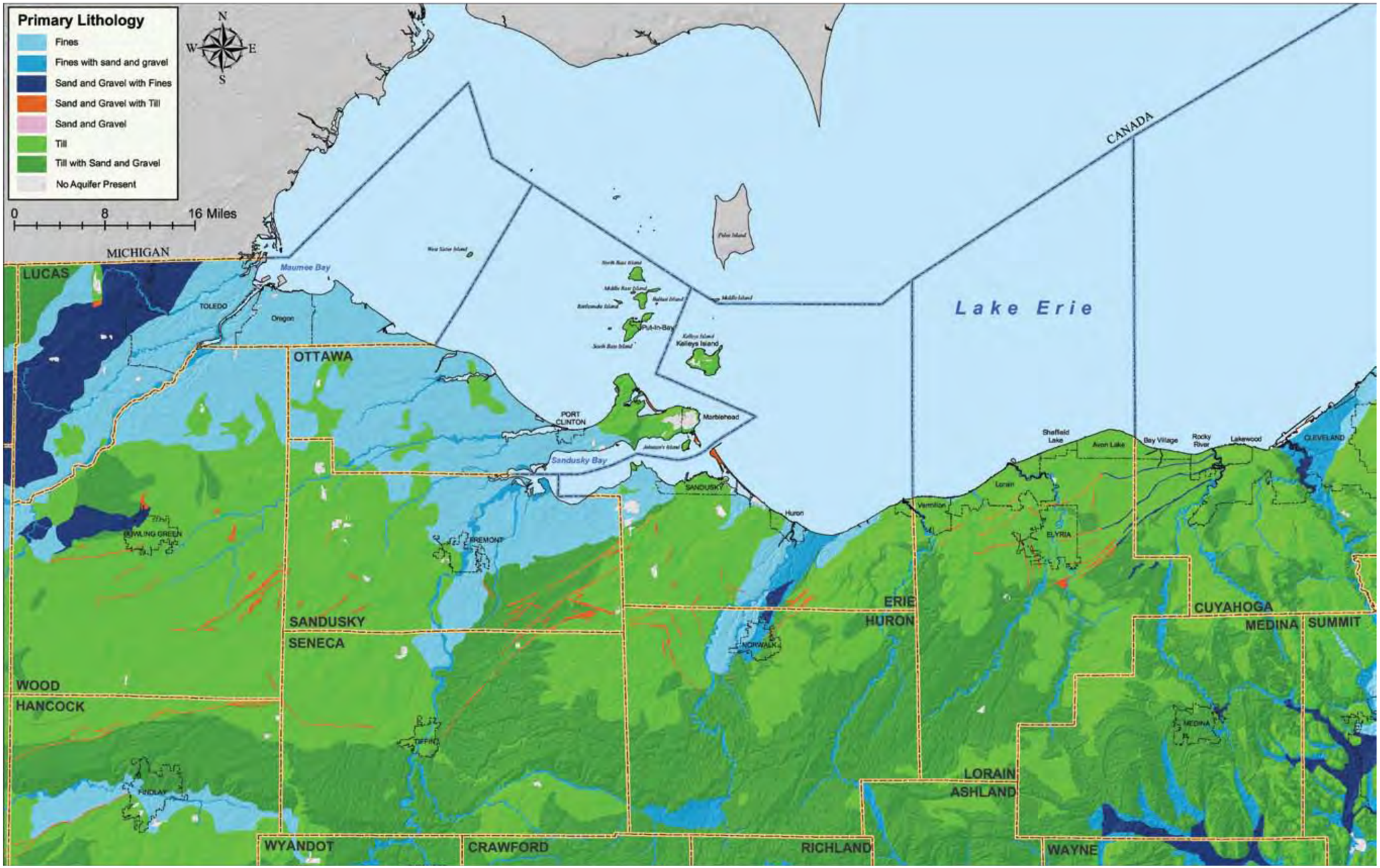
Primary Lithology of Glacial Deposits

Cedar Point Chaussee area, Erie County

Cuyahoga River, Cuyahoga County

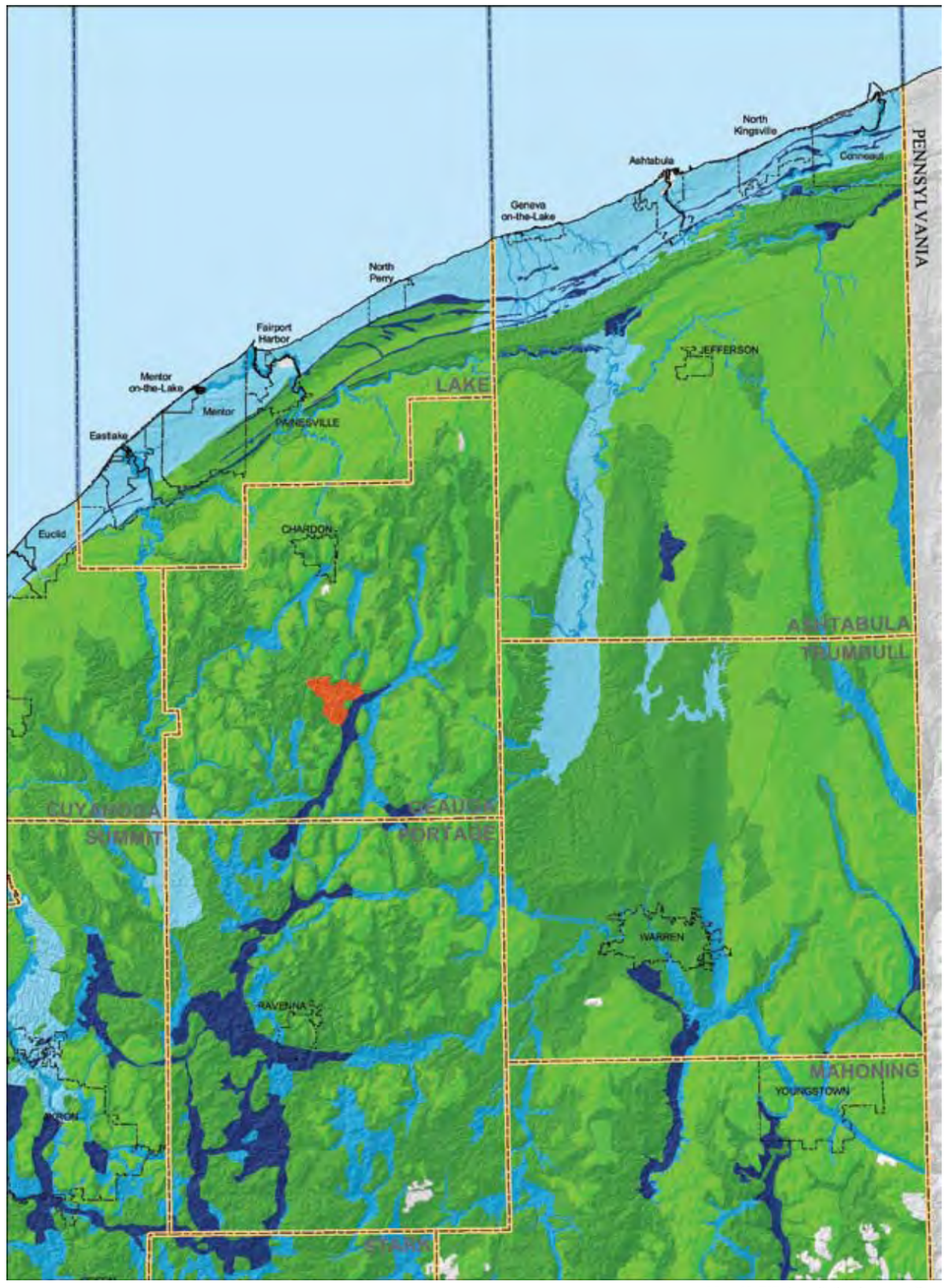
Rocky River, Cuyahoga County

Vermilion River, Erie County



Map 42 GIS data citation in Appendices

Primary Lithology of Glacial Deposits



Map 42 GIS data citation in Appendices

The Primary Lithology map shows the primary composition of glacial deposits in Ohio. It also includes related deposits such as lacustrine (lakebed) deposits associated with the ancestral stages of Lake Erie and alluvial (stream and river) deposits. These deposits are referred to as unconsolidated deposits in order to differentiate them from the underlying consolidated deposits or bedrock. An older, commonly used term for unconsolidated deposits is glacial drift.

Till and Till with Sand and Gravel

Till and till with sand and gravel are the two most prominent primary lithologies encountered in the Lake Erie Basin. Till is an unsorted, non-layered mix of silt, clay and sand, and smaller proportions of gravel, cobbles and even boulders. Till was directly deposited by the ice sheet.

It is common for sand and gravel layers or lenses to be interbedded within deposits of glacial till. Till with sand and gravel was mapped wherever water well records, engineering logs, geologic maps, reports or soils maps indicated the presence or likelihood of sand and gravel layers in the till. In some areas, these sand and gravel layers supply an adequate amount of ground water for domestic or small farm purposes.

Areas mapped as till generally lacked indication of sand and gravel layers based upon well log data, geologic maps and soils data. In many areas these till deposits are very thin, averaging only 20-feet thick or less before bedrock is encountered.

Fines

Fines consist of fine-grained silt and clay particles, essentially mud, which were deposited in the deeper, quieter-water portions of these ancestral lakes, similar to the fine-grained sediments that are being deposited in deeper portions of Lake Erie today.

The fines are common in the western part of the basin including almost all of Ottawa County and portions of Wood, Henry, Sandusky and Erie counties. A similar, but thinner band of fines fringes the coast along eastern Erie County and Lake and Ashtabula counties. These fines represent remnants of the higher, ancestral stands of Lake Erie.

Fines with Sand and Gravel

In the Lake Erie Basin, fines with sand and gravel are commonly associated with alluvial (stream or river) or buried valley deposits. Ancestral stream channels filled with glacial/alluvial sediments are referred to as buried valleys. These channels were cut into underlying bedrock before the advance of the ice and were subsequently filled in or buried.

Elsewhere throughout the Lake Erie drainage basin, fines with sand and gravel denote alluvial (stream or river) deposits. This includes many of the major rivers such as the Maumee, Sandusky and Vermilion. Wells completed in these deposits are commonly capable of sustaining domestic needs.

Sand and Gravel with Fines

Deposits of sand and gravel with fines fall into two major categories in the Lake Erie Basin. The less common type consists of relatively coarse-grained outwash deposits that are associated with buried valley systems. The more widespread category of sand and gravel with fines is related to beach ridge deposits. Beach ridges were deposited along the high-energy shores of the ancestral lakes. Although these features are small, they may locally serve as an aquifer. Wells are typically either shallow large-diameter dug wells or driven well points. In the western part of the basin there is a set of wide, extensive beach deposits referred to as the Oak Openings that cover much of western Lucas County and portions of adjoining Wood, Henry and Fulton counties.

Sand and Gravel with Till

Two different categories of sand and gravel with till deposits occur within the Lake Erie Basin. In the eastern portion of the basin, the deposits are associated with kames and eskers. Kames and eskers are ice contact features. The other category of sand and gravel with till consists of very thin beach ridge and dune deposits that overlie weathered glacial till. These deposits are found in the western part of the basin, primarily in Sandusky, Wood and Fulton counties. In this category, both the sand and gravel beach ridge/dune deposits and the underlying till are very thin.

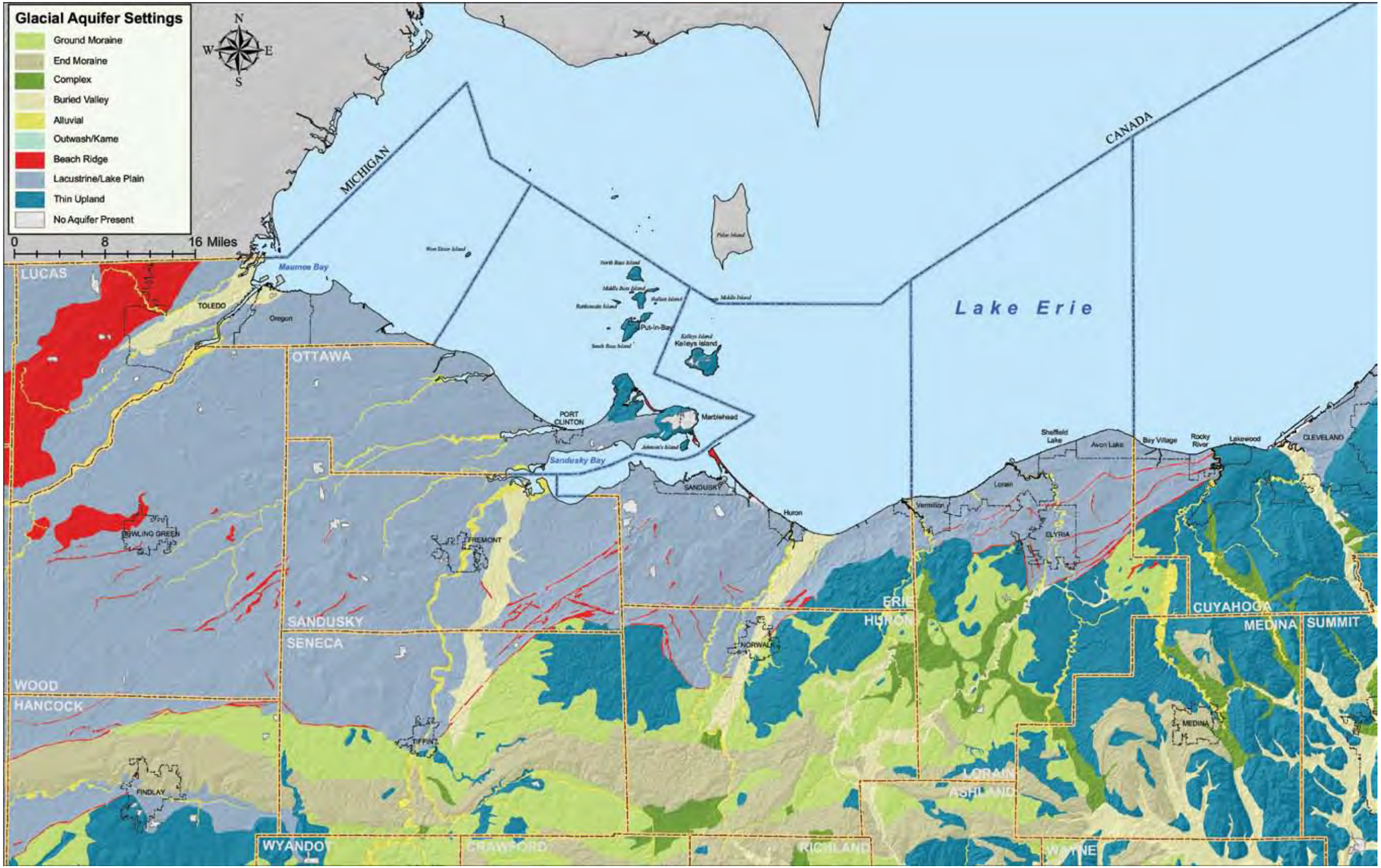
Glacial Aquifer Settings

Conneaut Creek State Scenic River, Ashtabula County

Huron River, Erie County

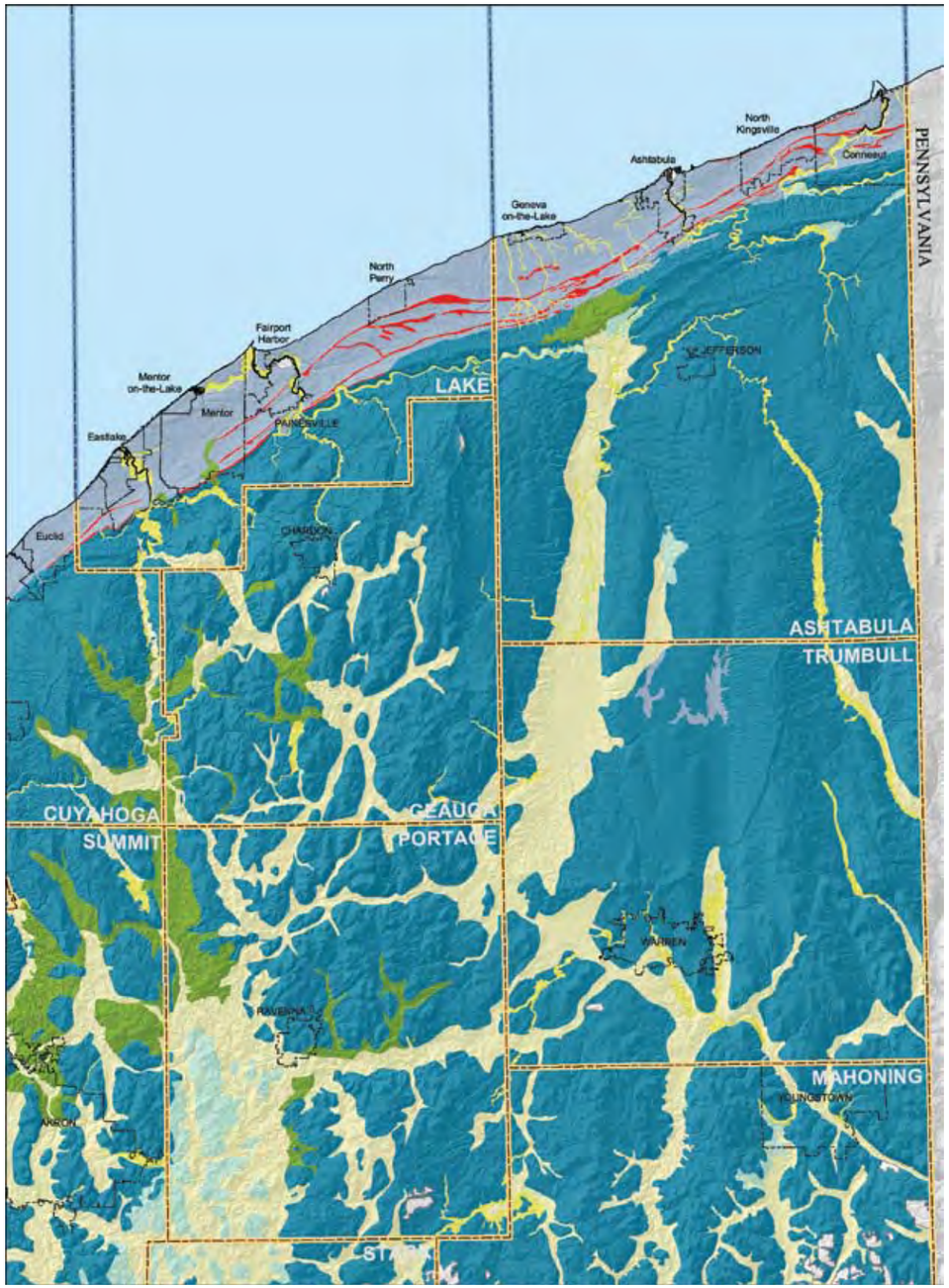
Maumee River, Lucas and Wood counties

Portage River, Ottawa County
Photo by Elaine A. Moebius



Map 43 GIS data citation in Appendices

Glacial Aquifer Settings



Map 43 GIS data citation in Appendices

Glacial Aquifer settings have been delineated as a part of the Glacial (Unconsolidated) State Aquifer Map for Ohio. Aquifer settings relate hydrogeologic properties of glacial aquifers to common geomorphic features. This combination helps to attach aquifer characteristics to easily recognizable surficial features and processes.

Ten aquifer settings were established for the Glacial (Unconsolidated) State Aquifer Map, and nine of these are present in the Lake Erie Basin. One 'new' setting, termed "complex" was created specifically for this project.

Buried Valley

Ancestral stream channels filled with glacial/alluvial sediments are referred to as buried valleys. These channels were cut into underlying bedrock before the advance of the ice and were subsequently filled or buried. The fill can vary widely from fine-grained silts, clay and till to coarse sand and gravel outwash deposits. Modern streams may overlie buried valleys and contribute recharge to the aquifers. Yield from wells completed in the buried valleys varies considerably depending upon the nature of the deposits

Major buried valley systems in the Lake Erie Basin include ones: underlying Toledo, just east of the Sandusky River, just east of the Huron River, the Rocky River Valley, the Cuyahoga River Valley and the Grand River in central Ashtabula County.

Ground Moraine

Ground moraines are commonly flat, open areas also referred to as till plains. They are composed of glacial till that was deposited by actively moving ice. Till is an unsorted, non-layered mix of silt, clay and sand, and smaller proportions of gravel, cobbles and even boulders. The till may contain thin layers or lenses of sand and gravel that may be sufficient in size to supply adequate water for domestic purposes.

End Moraine

End moraines are long narrow ridges primarily composed of till. They typically have a rolling, bumpy, land surface and function as local drainage divides. End moraines may contain an appreciable thickness of sand and gravel layers. End moraines commonly serve as local areas of recharge. Wells developed in these sand and gravel layers are adequate for domestic and farm purposes.

Complex

Complexes are areas of thick till accumulation. They commonly lack any significant amount of sand and gravel or modern overlying streams and are a poor source of water.

Alluvial

Alluvial settings are streams and rivers not overlying or associated with a buried valley setting. Alluvial deposits include the finer-grained silts and clays and minor fine sand. Moderate yields may be obtained from wells completed in these deposits. The streams help provide additional recharge to the aquifers.

Outwash/Kames

This setting refers to outwash and kame deposits not overlying or associated with buried valleys. Outwash deposits contain relatively clean, coarse, layered sand and gravel, and are capable of producing high yields. Kames are ice-contact features composed of poorly sorted sand, gravel and till deposited by a melting ice sheet. Kames can produce a moderate supply of water and provide good recharge to underlying aquifers.

Beach Ridges

Beach ridges were deposited along the high-energy shores of the ancestral lakes. The majority of these features are long, narrow and rise about 20 feet above the land surface. They may locally serve as an aquifer. An example is the Oak Openings, a large, wide body of beach sand found in the western end of the basin.

Lacustrine/Lake Plain

The lacustrine/lake plain setting consists of fine-grained silt and clay sediments deposited in the ancestral lakes that preceded Lake Erie. Higher elevation portions of the lake plain are areas of ground moraine that were eroded by wave activity. This is a very poor aquifer area.

Thin Upland

Thin upland refers to areas of thin glacial drift overlying bedrock. The surface topography mimics that of the underlying bedrock. The underlying bedrock is usually the aquifer.

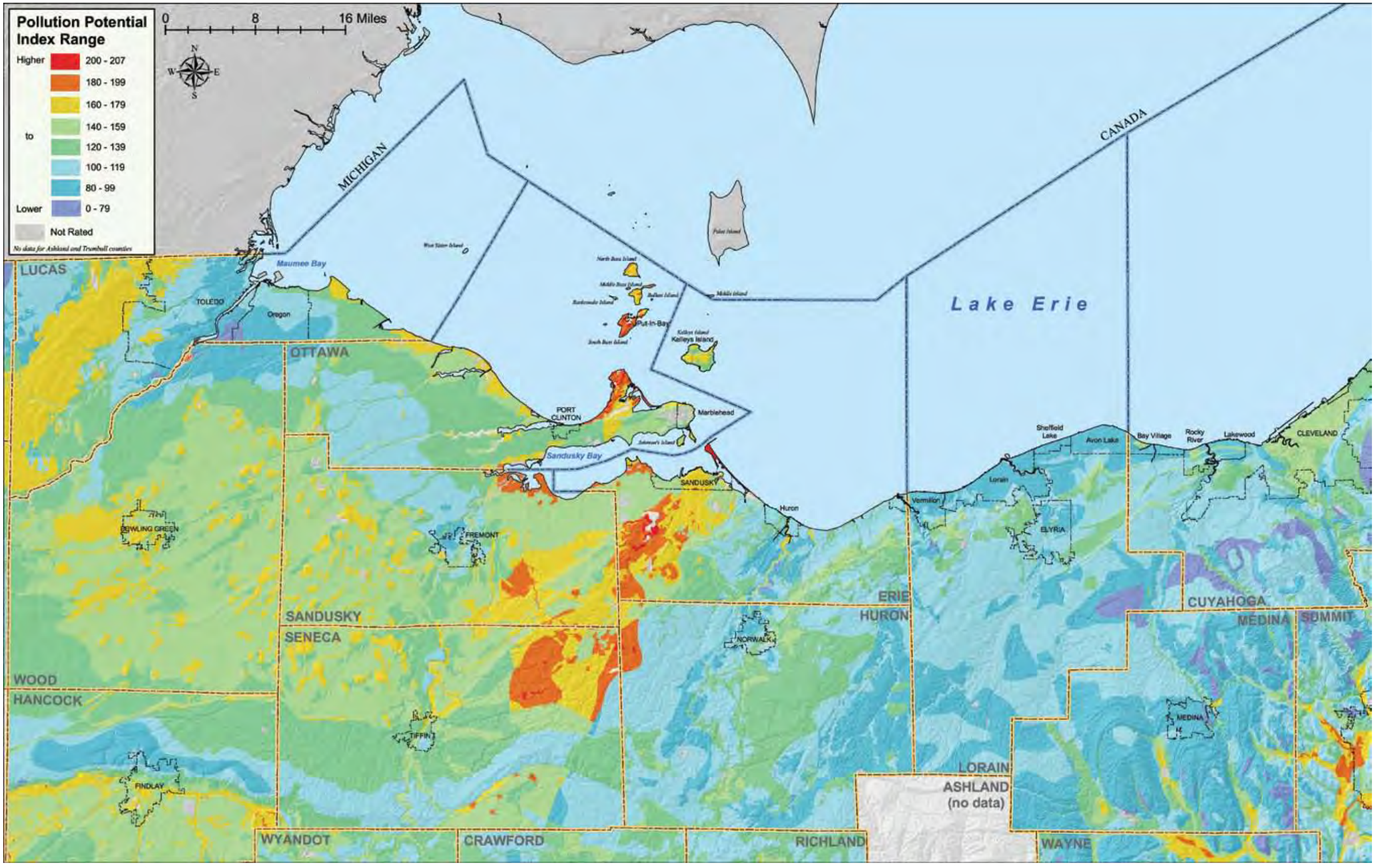
Ground Water Pollution Potential

State Route 2 bridge over Huron River, Erie County

Oncoming train

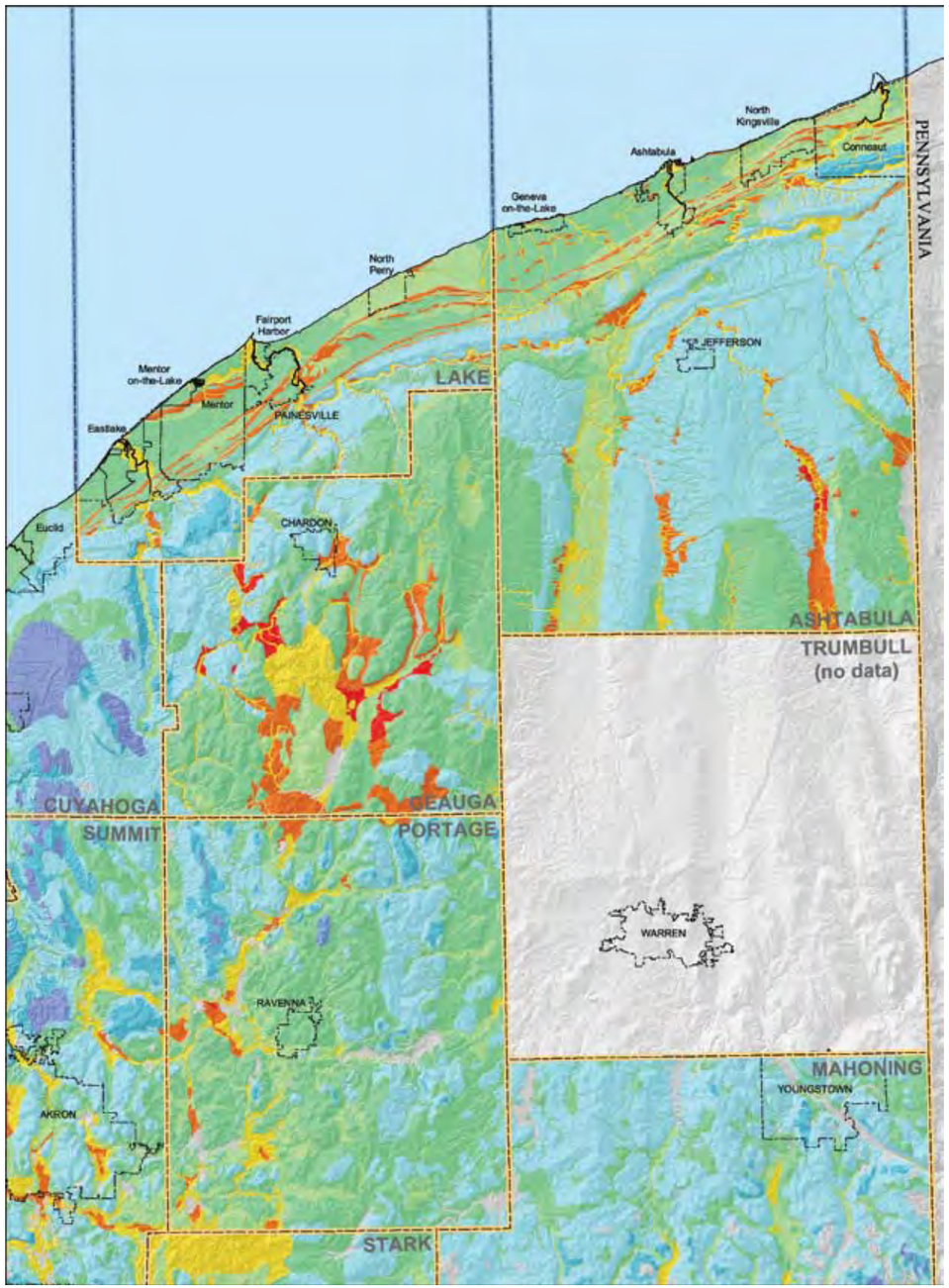
Quarry in Ottawa County

Factory in Lorain County



Map 44 GIS data citation in Appendices

Ground Water Pollution Potential



Map 44 GIS data citation in Appendices

Ground Water Pollution Potential (GWPP) maps show the relative vulnerability of the uppermost aquifer to pollution from a contaminant at the ground surface. Potential sources of contaminants include spills and over-application of chemicals. Maps and an accompanying report are completed on a county basis and provide a useful "first look" for county planners, consultants, developers and scientists.

Ground Water Pollution Potential maps are created using a standardized, nationally used system developed for the U.S. EPA known as "DRASTIC." DRASTIC is an acronym for **D**epth to water, net **R**echarge, **A**quifer media, **S**oil media, **T**opography (slope), **I**mpact of the vadose zone, and hydraulic **C**onductivity. Together these seven factors are run through a set of weights and ratings to determine a final pollution potential index. The pollution potential index for each area is then grouped in color-coded ranges. "Cool" colors such as blues and purples indicate areas with a low vulnerability to contamination. Green colors show an intermediate vulnerability. "Warm" colors such as yellow, orange and red show a relatively high vulnerability to contamination. Large areas that have been altered by man such as quarries, strip mines and landfills are not rated.

Every area on a GWPP map is placed in a hydrogeologic setting in addition to receiving a pollution potential index value. Examples of typical hydrogeologic settings include Glacial Till over Limestone, Glacial Lake Deposits and River Alluvium over Bedrock. The report contains detailed descriptions and tables that detail the setting and show how the pollution potential index was derived for all mapped areas.

In the region adjacent to Lake Erie, areas of low vulnerability (blues and purple) include areas of low-yielding shale or shale interbedded with fine-grained sandstone bedrock, areas covered by thick, clayey deposits of glacial till or lake sediments or a combination of these. The aquifers are generally deep, soils are clayey, and recharge (the ability of precipitation to infiltrate down to the water table or aquifer) is low. In some of these areas, the topography consists of steep slopes that increase runoff and decrease recharge.

Areas of moderate vulnerability (greens) include areas where higher-yielding limestone or sand and gravel aquifers are covered by thick, clayey glacial till, lake deposits or river (alluvial) deposits. Intermediate areas may also include some lower-yielding aquifers that are very close to the ground surface (are lacking a protective cover) or areas where moderate-size streams directly overlie lower-yielding aquifers.

Areas of high vulnerability (yellow, orange and red) include areas where high-yielding limestone, sandstone or sand and gravel aquifers are close to the surface; areas where sandy glacial deposits are the aquifer or overlie the aquifer; areas where the high-yielding deposits are close to the ground surface or have very shallow water tables, soils are sandy, and topography is typically very flat, which decreases runoff. Highly productive aquifers may directly underlie river valleys. Examples of areas with high vulnerability include sandy beach ridges, karst (solution) limestone, sandstone ridges and coastal marshes.

For more information

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Pictured to the left: Pollutants reach the ground water from many sources such as roads, railroads and industrial operations.

Coming to the Surface

Over time ground water will travel to the surface. Ground water is discharged to the surface through several ways. Such examples would be the formation of natural springs, discharge to river and stream banks, discharge under river and stream beds, or direct discharge to the lake. Where and how ground water is discharged to the surface depends on the water table. Surface water will appear where the water table intersects the surface topography.

Many streams and rivers throughout Ohio are strongly influenced by ground water. As streams flow, their primary source of recharge is precipitation, during times of drought or low precipitation streams may rely totally on ground water input.

Ground water contribution may range from zero to 100 percent of normal flowing streams. Depending on the height of the water table and discharge of ground water, the contribution to the stream will vary. Along certain stretches of a stream path, ground water may discharge into the stream and the volume of the stream increases. This is called a gaining stream. Conversely, certain streams may overlie a deeply buried water table. During dry or arid conditions, water may seep from the stream down to the water table causing a reduction in the flow volume of the surface water. This is called a losing stream. Annually, Ohio has humid conditions, so water tables are generally high and losing streams are not common.

Source: ODNR Division of Water