GROUND WATER POLLUTION POTENTIAL OF PORTAGE COUNTY, OHIO

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OCTOBER, 1990

REVISED 2011

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GROUND WATER POLLUTION POTENTIAL REPORT NO. 22

OHIO DEPARTMENT OF NATURAL RESOURCES

DIVISION OF SOIL AND WATER RESOURCES

WATER RESOURCES SECTION

ABSTRACT

A ground water pollution potential map of Portage County has been prepared using the DRASTIC mapping process. The DRASTIC system consists of two major elements: the designation of mappable units, termed hydrogeologic settings, and the superposition of a relative rating system for pollution potential.

Hydrogeologic settings incorporate the major hydrogeologic factors that control ground water movement and occurrence including depth to water, net recharge, aquifer media, soil media, topography, impact of the vadose zone media, and hydraulic conductivity of the aquifer. The relative ranking scheme uses a combination of weights and ratings to produce a numerical value called the pollution potential index that helps prioritize areas with respect to ground water contamination vulnerability. Hydrogeologic settings and the corresponding pollution potential indexes are displayed graphically on maps.

Both general and pesticide DRASTIC maps were prepared for Portage County. General DRASTIC evaluates an area's relative susceptibility to a contaminant that has the mobility of water, whereas pesticide DRASTIC evaluates areas with respect to ground water contamination vulnerability to pesticides.

Portage County lies within the Glaciated Central hydrogeologic region. The entire county is covered by variable thicknesses of glacial till and outwash sands and gravels that have a moderate to high pollution potential index. The county is crossed by a network of buried valleys that constitute a major ground water resource and exhibit a moderate to high vulnerability to contamination. The glacial deposits are underlain by sandstone and shale sequences; both are used for domestic and municipal supplies. Areas containing recent alluvium in valleys exhibit moderately high susceptibility to contamination. Pollution potential indexes for these areas range from moderate to moderately high. Eleven hydrogeologic settings were identified in the county with ground water pollution potential indexes ranging from 71 to 204 for general DRASTIC and 87 to 230 for pesticide DRASTIC.

Ground water pollution potential maps of Portage County have been prepared to assist planners, managers, and local officials in evaluating the potential for contamination from various sources of pollution. This information can be used to help direct resources and land use activities to appropriate areas, or to assist in protection, monitoring, and clean-up efforts.

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INTRODUCTION

The need for protection and management of ground water resources in Ohio has been clearly recognized. About 42 per cent of Ohio citizens rely on ground water for their drinking and household uses from both municipal and private wells. Industry and agriculture also utilize significant quantities of ground water for processing and irrigation. In Ohio, about 700,000 rural households depend on private wells; approximately 12,000 of these wells exist in Portage County.

The characteristics of the many aquifer systems in the state make ground water highly vulnerable to contamination. Measures to protect ground water from contamination usually cost less and create less impact on ground water users than cleanup of a polluted aquifer. Based on these concerns for protection of the resource, staff of the Division of Water conducted a review of various mapping strategies useful for identifying vulnerable aquifer areas. They placed particular emphasis on reviewing mapping systems that would assist in state and local protection and management programs. Based on these factors and the quantity and quality of available data on ground water resources, the DRASTIC mapping process (Aller et al., 1987) was selected for application in the program.

Considerable interest in the mapping program followed successful production of a demonstration county map and led to the inclusion of the program as a recommended initiative in the Ohio Ground Water Protection and Management Strategy (Ohio EPA, 1986). Based on this recommendation, the Ohio General Assembly funded the mapping program. A dedicated mapping unit has been established in the Division of Water, Ground Water Resources Section, to implement the ground water pollution potential mapping program on a county-wide basis in Ohio.

The purpose of this report and maps is to aid in the protection of our ground water resources. This protection can be enhanced partly by understanding and implementing the results of this study which utilizes the DRASTIC system of evaluating an area's potential for ground-water pollution. The mapping program identifies areas that are more or less vulnerable to contamination and displays this information graphically on maps. The system was not designed or intended to replace site-specific investigations, but rather to be used as a planning and management tool. The results of the map and report can be combined with other information to assist in prioritizing local resources and in making land use decisions.

APPLICATIONS OF POLLUTION POTENTIAL MAPS

The pollution potential mapping program offers a wide variety of applications in many counties. The ground water pollution potential map of Portage County has been prepared to assist planners, managers, and state and local officials in evaluating the relative vulnerability of areas to ground-water contamination from various sources of pollution. This information can be used to help direct resources and land use activities to appropriate areas, or to assist in protection, monitoring and cleanup efforts.

An important application of the pollution potential maps for many areas will be to assist in county land use planning and resource expenditures related to solid waste disposal. A county may use the map to help identify areas that are more or less suitable for land disposal activities. Once these areas have been identified, a county can collect more site-specific information and combine this with other local factors to determine site suitability.

Pollution potential maps may also be applied successfully where non-point source contamination is a concern. Non-point source contamination occurs where land use activities over large areas impact water quality. Maps providing information on relative vulnerability can be used to guide the selection and implementation of appropriate best management practices in different areas. Best management practices should be chosen based upon consideration of the chemical and physical processes that occur from the practice, and the effect these processes may have in areas of moderate to high vulnerability to contamination. For example, the use of agricultural best management practices that limit the infiltration of nitrates, or promote denitrification above the water table, would be beneficial to implement in areas of relatively high vulnerability to contamination.

A pollution potential map can also assist in developing ground-water protection strategies. By identifying areas more vulnerable to contamination, officials can direct resources to areas where special attention or protection efforts might be warranted. This information can be utilized effectively at the local level for integration into land use decisions and as an educational tool to promote public awareness of ground water resources. Pollution potential maps may also be used to prioritize ground water monitoring and/or contamination cleanup efforts. Areas that are identified as being vulnerable to contamination may benefit from increased ground water monitoring for pollutants or from additional efforts to clean up an aquifer.

Other beneficial uses of the pollution potential maps will be recognized by individuals in the county who are familiar with specific land use and management problems. Planning commissions and zoning boards can use these maps to help make informed decisions about the development of areas within their jurisdiction. Developments proposed to occur within ground-water sensitive areas may be required to show how ground water will be protected.

Regardless of the application, emphasis must be placed on the fact that the system is not designed to replace a site specific investigation. The strength of the system lies in its ability to make a "first-cut approximation" by identifying areas that are vulnerable to contamination.

Any potential applications of the system should also recognize the assumptions inherent in the system.

SUMMARY OF THE DRASTIC MAPPING PROCESS

The system chosen for implementation of a ground water pollution potential mapping program in Ohio, DRASTIC, was developed by the National Water Well Association for the United States Environmental Protection Agency. A detailed discussion of this system can be found in Aller et al. (1987).

The DRASTIC mapping system allows the pollution potential of any area to be evaluated systematically using existing information. The vulnerability of an area to contamination is a combination of hydrogeologic factors, anthropogenic influences, and sources of contamination in any given area. The DRASTIC system focuses only on those hydrogeologic factors which influence ground water pollution potential. The system consists of two major elements: the designation of mappable units, termed hydrogeologic settings, and the superposition of a relative rating system to determine pollution potential.

The application of DRASTIC to an area requires the recognition of a set of assumptions made in the development of the system. DRASTIC evaluates the pollution potential of an area assuming a contaminant with the mobility of water, introduced at the surface, and flushed into the ground water by precipitation. Most important, DRASTIC cannot be applied to areas smaller than one-hundred acres in size, and is not intended or designed to replace site specific investigations.

A specialized version of the DRASTIC mapping process, known as pesticide DRASTIC, has also been produced for Portage County. Pesticide DRASTIC evaluates an areas relative vulnerability to contamination by pesticides through consideration of important processes that offset pesticide fate and transport. Maps produced using both general and pesticide DRASTIC are included with this report.

Hydrogeologic Settings and Factors

To facilitate the designation of mappable units, the DRASTIC system uses the framework of an existing classification system developed by Heath (1984), which divides the United States into fifteen ground water regions based on the factors in a ground water system that affect occurrence and availability.

Within each major hydrogeologic region, smaller units representing specific hydrogeologic settings are identified. Hydrogeologic settings form the basis of the system and represent a composite description of the major geologic and hydrogeologic factors that control ground water movement into, through, and out of an area. A hydrogeologic setting represents a mappable unit with common hydrogeologic characteristics, and, as a consequence, common vulnerability to contamination (Aller et al., 1987).

Figure 1 illustrates the format and description of a typical hydrogeologic setting found within Portage County. Inherent within each hydrogeologic setting are the physical characteristics which affect the ground water pollution potential. These characteristics or factors identified during the development of the DRASTIC system include:

D - Depth to Water

R - Net Recharge

A - Aquifer Media

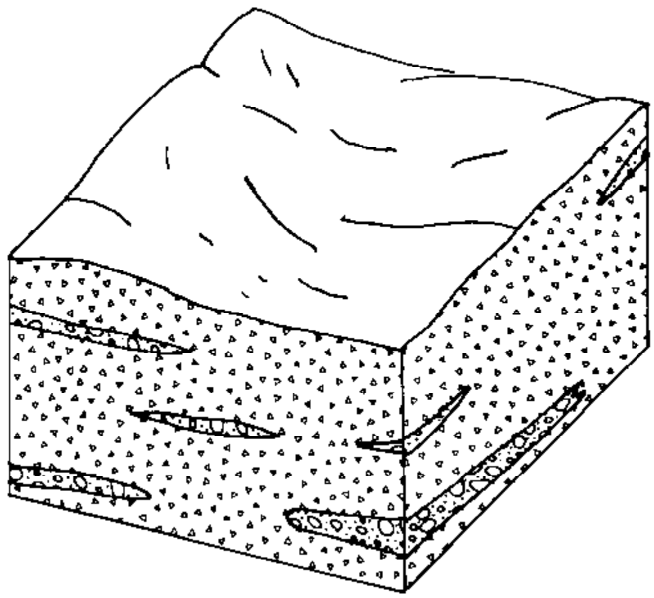
S - Soil Media

T - Topography

I - Impact of the Vadose Zone Media

C - Conductivity (Hydraulic) of the Aquifer

These factors incorporate concepts and mechanisms such as attenuation, retardation and time or distance of travel of a contaminant with respect to the physical characteristics of the hydrogeologic setting. Broad consideration of these factors and mechanisms, coupled with existing conditions in a setting, provide a basis for determination of the area's relative vulnerability to contamination.



7Af Sand and Gravel Interbedded in Glacial Till

This hydrogeologic setting is characterized by low topography with sand and gravel deposits interbedded within glacial till. The till is composed primarily of clay with varying amounts of unsorted silt, sand, and gravel. The sand and gravel may be relatively thin and discontinuous lens-shaped bodies or they may be thick and cover a large area. These units are usually confined to common horizons within the till. Ground water occurs in both the till and the sand and gravel; however, the sand and gravel serves as the principal aquifer. Recharge to the sand and gravel is primarily due to infiltration of precipitation through the till. Depth to water is highly variable. Soils are typically classified as clay loam.

Figure 1. Format and description of the hydrogeologic setting - 7Af Sand and Gravel Interbedded in Glacial Till.

Depth to water is considered to be the depth from the ground surface to the water table in unconfined aquifer conditions or the depth to the top of the aquifer under confined aquifer conditions. The depth to water determines the distance a contaminant would have to travel before reaching the aquifer. The greater the distance the contaminant has to travel the greater the opportunity for attenuation to occur or restriction of movement by relatively impermeable layers.

Net recharge is the total amount of water reaching the land surface that infiltrates into the aquifer measured in inches per year. Recharge water is available to transport a contaminant from the surface into the aquifer and also affects the quantity of water available for dilution and dispersion of a contaminant. Factors to be included in the determination of net recharge include contributions due to infiltration of precipitation, in addition to infiltration from rivers, streams and lakes, irrigation, and artificial recharge.

Aquifer media represents consolidated or unconsolidated rock material capable of yielding sufficient quantities of water for use. Aquifer media accounts for the various physical characteristics of the rock that provide mechanisms of attenuation, retardation and flow pathways that affect a contaminant reaching and moving through an aquifer. Soil media refers to the upper six feet of the unsaturated zone that is characterized by significant biological activity. The type of soil media can influence the amount of recharge that can move through the soil column due to variations in soil permeability. Various soil types also have the ability to attenuate or retard a contaminant as it moves throughout the soil profile. Soil media is based on textural classifications of soils and considers relative thicknesses and attenuation characteristics of each profile within the soil.

Topography refers to the slope of the land expressed as percent slope. The amount of slope in an area affects the likelihood that a contaminant will run off from an area or be ponded and ultimately infiltrate into the subsurface. Topography also affects soil development and often can be used to help determine the direction and gradient of ground water flow under water table conditions.

The impact of the vadose zone media refers to the attenuation and retardation processes that can occur as a contaminant moves through the unsaturated zone above the aquifer. The vadose zone represents that area below the soil horizon and above the aquifer that is unsaturated or discontinuously saturated. Various attenuation, travel time and distance mechanisms related to the types of geologic materials present can affect the movement of contaminants in the vadose zone. Where an aquifer is unconfined, the vadose zone media represents the materials below the soil horizon and above the water table. Under confined aquifer conditions, the vadose zone is simply referred to as a confining layer. The presence of the confining layer in the unsaturated zone significantly impacts the pollution potential of the ground water in an area.

Hydraulic conductivity of an aquifer is a measure of the ability of the aquifer to transmit water, and is also related to ground water velocity and gradient. Hydraulic conductivity is dependent upon the amount and interconnectivity of void spaces and fractures within a consolidated or unconsolidated rock unit. Higher hydraulic conductivity typically corresponds to higher vulnerability to contamination. Hydraulic conductivity considers the capability for a contaminant that reaches an aquifer to be transported throughout that aquifer over time.

Weighting and Rating System

DRASTIC uses a numerical weighting and rating system that is combined with the DRASTIC factors to calculate a ground water pollution potential index or relative measure of vulnerability to contamination. The DRASTIC factors are weighted from 1 to 5 according to their relative importance to each other with regard to contamination potential (Table 1). Each factor is then divided into ranges or media types and assigned a rating from 1 to 10 based on their significance to pollution potential (Tables 2-8). The rating for each factor is selected based on available information and professional judgment. The selected rating for each factor is multiplied by the assigned weight for each factor. These numbers are summed to calculate the DRASTIC or pollution potential index.

Once a DRASTIC index has been calculated, it is possible to identify areas that are more likely to be susceptible to ground water contamination relative to other areas. Greater vulnerability to contamination is indicated by higher DRASTIC index numbers. The index generated provides only a relative evaluation tool and is not designed to produce absolute answers or to represent units of vulnerability. Pollution potential indexes of various settings should be compared to each other only with consideration of the factors that were evaluated in determining the vulnerability of the area.

Pesticide DRASTIC

A special version of DRASTIC was developed for use where the application of pesticides is a concern. The weights assigned to the DRASTIC factors were changed to reflect the processes that affect pesticide movement into the subsurface with particular emphasis on soils. Where other agricultural practices, such as the application of fertilizers, are a concern, general DRASTIC should be used to evaluate relative vulnerability to contamination. The process for calculating the Pesticide DRASTIC index is identical to the process used for calculating the general DRASTIC index. However, general DRASTIC and Pesticide DRASTIC numbers should not be compared because the conceptual basis in factor weighting and evaluation differs significantly. Table 1 lists the weights used for general and pesticide DRASTIC.

Table 1. Assigned weights for DRASTIC features

Feature	**General DRASTIC Weight**	**Pesticide DRASTIC Weight**
Depth to Water	5	5
Net Recharge	4	4
Aquifer Media	3	3
Soil Media	2	5
Topography	1	3
Impact of the Vadose Zone Media	5	4
Hydraulic Conductivity of the Aquifer	3	2

Table 2. Ranges and ratings for depth to water

Depth to Water (feet)	
Range	**Rating**
0-5	10
5-15	9
15-30	7
30-50	5
50-75	3
75-100	2
100+	1
Weight: 5	Pesticide Weight: 5

Table 3. Ranges and ratings for net recharge

Net Recharge (inches)	
Range	**Rating**
0-2	1
2-4	3
4-7	6
7-10	8
10+	9
Weight: 4	Pesticide Weight: 4

Table 4. Ranges and ratings for aquifer media

Aquifer Media		
Range	**Rating**	**Typical Rating**
Shale	1-3	2
Glacial Till	4-6	5
Sandstone	4-9	6
Limestone	4-9	6
Sand and Gravel	4-9	8
Interbedded Ss/Sh/Ls/Coal	2-10	9
Karst Limestone	9-10	10
Weight: 3	Pesticide Weight: 3	

Table 5. Ranges and ratings for soil media

Soil Media	
Range	**Rating**
Thin or Absent	10
Gravel	10
Sand	9
Peat	8
Shrink/Swell Clay	7
Sandy Loam	6
Loam	5
Silty Loam	4
Clay Loam	3
Muck	2
Clay	1
Weight: 2	Pesticide Weight: 5

Table 6. Ranges and ratings for topography

Topography (percent slope)	
Range	**Rating**
0-2	10
2-6	9
6-12	5
12-18	3
18+	1
Weight: 1	Pesticide Weight: 3

Table 7. Ranges and ratings for impact of the vadose zone media

Impact of the Vadose Zone Media		
Range	**Rating**	**Typical Rating**
Confining Layer	1	1
Silt/Clay	2-6	3
Shale	2-5	3
Limestone	2-7	6
Sandstone	4-8	6
Interbedded Ss/Sh/Ls/Coal	4-8	6
Sand and Gravel with Silt and Clay	4-8	6
Glacial Till	2-6	4
Sand and Gravel	6-9	8
Karst Limestone	8-10	10
Weight: 5	Pesticide Weight: 4	

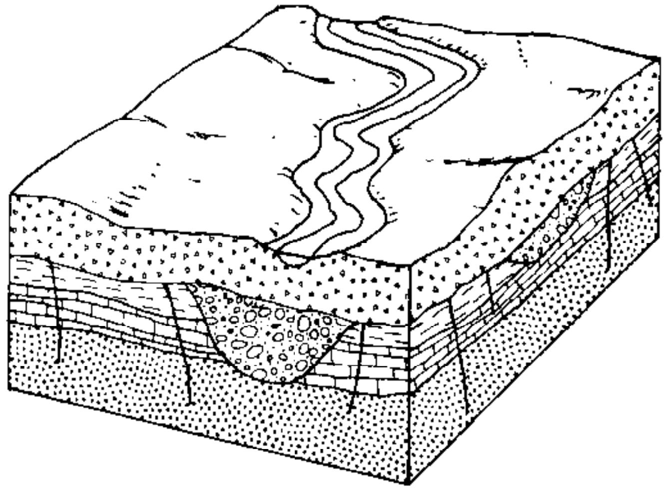
Table 8. Ranges and ratings for hydraulic conductivity

Hydraulic Conductivity (GPD/FT^2)	
Range	**Rating**
1-100	1
100-300	2
300-700	4
700-1000	6
1000-2000	8
2000+	10
Weight: 3	Pesticide Weight: 2

Integration of Hydrogeologic Settings and DRASTIC Factors

Figure 2 illustrates the hydrogeologic setting 7D1 Buried Valley, identified in mapping Portage County, and the pollution potential index calculated for the setting by both general and pesticide DRASTIC. Based on selected ratings for this setting, the pollution potential index is calculated to be 151 for general DRASTIC and 169 for pesticide DRASTIC. This numerical value has no intrinsic meaning, but can be readily compared to a value obtained for other settings in the county. DRASTIC indexes for typical hydrogeologic settings and values across the United States range from 65 to 223. The diversity of hydrogeologic conditions in Portage County produces settings with a wide range of vulnerability to ground water contamination. Calculated pollution potential indexes for the 11 settings identified in the county range from 71 to 204 for general DRASTIC and 87 to 230 for pesticide DRASTIC.

Hydrogeologic settings identified in an area are combined with the pollution potential indexes to create units that can be graphically displayed on maps. Pollution potential mapping in Portage County resulted in a map with symbols and colors that illustrate areas of ground water vulnerability. The maps describing the general and pesticide ground water pollution potential of Portage County are included with this report.



SETTING 7D1		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	NUMBER
Depth to Water	5-15	5	5	25
Net Recharge	7-10	4	6	24
Aquifer Media	Sand & Gravel	3	8	24
Soil Media	Loam	2	5	10
Topography	0-2%	1	9	9
Impact Vadose Zone	Sand & Gravel	5	7	35
Hydraulic Conductivity	1000-2000	3	8	24
		DRASTIC	INDEX	151

SETTING 7D1		PESTICIDE		
FEATURE	RANGE	WEIGHT	RATING	NUMBER
Depth to Water	5-15	5	5	25
Net Recharge	7-10	4	6	24
Aquifer Media	Sand & Gravel	3	8	24
Soil Media	Loam	5	5	25
Topography	0-2%	3	9	27
Impact Vadose Zone	Sand & Gravel	4	7	28
Hydraulic Conductivity	1000-2000	2	8	16
		DRASTIC	INDEX	169

Figure 2. Description of the hydrogeologic setting - 7D1 Buried Valley (general DRASTIC and pesticide DRASTIC).

INTERPRETATION AND USE OF A GROUND WATER POLLUTION POTENTIAL MAP

The application of the DRASTIC system to evaluate an area's vulnerability to contamination produces hydrogeologic settings with corresponding pollution potential indexes. Greater susceptibility to contamination is indicated by higher pollution potential index numbers. This numeric value determined for one area can be compared to the pollution potential index calculated for another area.

The maps accompanying this report display both the hydrogeologic settings identified in the county and the associated pollution potential indexes calculated in those hydrogeologic settings. The symbols on the map represent the following information:

7D1 - defines the hydrogeologic region and setting
185 - defines the relative pollution potential

Here the first number (**7D1**) refers to the major hydrogeologic region and the upper and lower case letters refer to a specific hydrogeologic setting. The following number references a certain set of DRASTIC parameters that are unique to this setting and are described in the corresponding setting chart. The second number (**185**) is the calculated pollution potential index for this unique setting. The charts for each setting provide a reference to show how the pollution potential index was derived in an area.

The maps are color coded using ranges depicted on the map legend. The color codes used are part of a national color coding scheme developed to assist the user in gaining a general insight into the vulnerability of the ground water in the area. The color codes were chosen to represent the colors of the spectrum, with warm colors (red, orange, and yellow), representing areas of higher vulnerability (higher pollution potential indexes), and cool colors (greens, blues, and violet), representing areas of lower vulnerability to contamination.

The maps also include information on the locations of selected observation wells. Available information on these observation wells is referenced in Appendix A, Description of the Logic in Factor Selection. Large man-made features such as landfills, quarries or strip mines have also been marked on the map for reference.

GENERAL INFORMATION ABOUT PORTAGE COUNTY

Portage County occupies an area of approximately 495 square miles in northeastern Ohio. It is bounded to the east by Trumbull County, to the southeast by Mahoning County, to the south by Stark County, to the west by Summit County, and to the north by Geauga County (Figure 3). Elevation ranges from 910 feet in Windham Township to 1,340 feet in Hiram Township.

The approximate population of Portage County according to estimates taken from the 1980 Census was 135,800. The most rapid population growth is in the western third of the county, which is in close proximity of Akron, Canton, and Cleveland.

The northeast region of Ohio, which includes all of Portage County, has a fifty year (1931-1980) average annual precipitation of 36.97 inches (Marozzi, 1984). The average annual temperature for the same period was 49.7 degrees Fahrenheit (U.S. Department of Commerce, 1981).

Physiography and Topography

Portage County lies within the Glaciated Allegheny Plateaus Section of the Appalachian Plateaus Province (Fenneman, 1938; Winslow and White, 1966; Sedam, 1973, and Brockman, 1998). Topography in the central and eastern portions of Portage County shows a predominant bedrock influence; whereas topography in western, and particularly southwestern Portage County, is glacially derived. Relief is highest in northern and northeastern Portage County, where sandstone-capped ridges resisted glacial erosion and have subsequently been steeply dissected by stream drainage. In central and eastern Portage County, prominent sandstone-capped ridges are separated by flat-lying, poorly-drained areas. The relief generally is less pronounced in southeastern Portage County, particularly in Atwater and Deerfield Townships, due to the less resistant nature of the bedrock in that area.

Topography in the western third of Portage County is dominated by the steep to rolling (hummocky) topography associated with the Kent Moraine (Winslow and White, 1966) and the Kent Kame Complex (White, 1982, and McQuown, 1988). Moderately steep, rounded to irregularly shaped kames are interspersed with low-lying, poorly-drained kettles. Many of these kettles are roughly interconnected, forming sluggishly drained waterways.

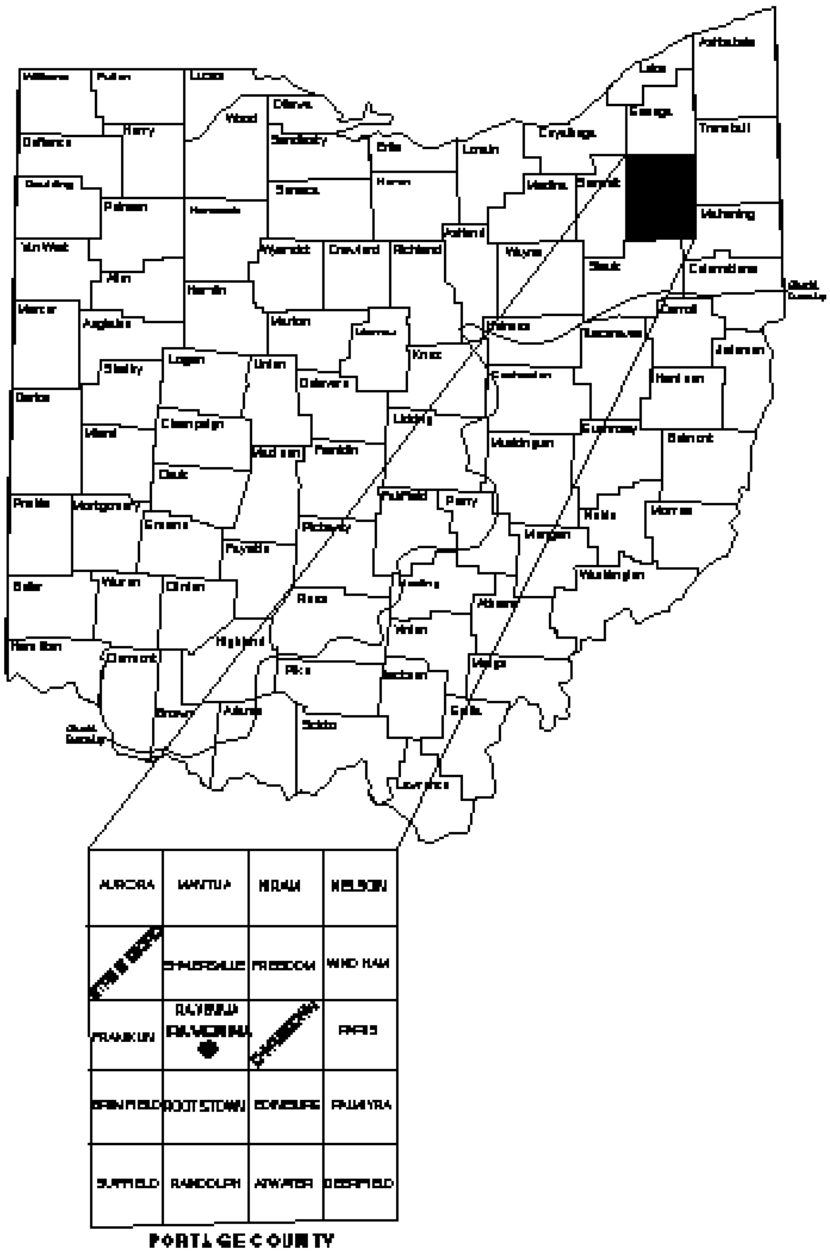


Figure 3. Location of Portage County.

Modern Drainage

The modern drainage divide in Portage County runs roughly north-south from eastern Randolph Township to Hiram Township (Winslow and White, 1966). Streams to the west of the divide drain into the Little Cuyahoga River and the Cuyahoga River, which turns northward in Summit County and eventually drains into Lake Erie. Streams east of the divide primarily drain into either Eagle Creek or the Mahoning River which ultimately empty into the Ohio River.

Stream drainage in Portage County, with the exception of the steeply-dissected drainages in northern Portage County and along certain stretches of the Cuyahoga River, is overall relatively sluggish. Many streams in Portage County have been dammed to create a network of reservoirs; these impoundments are critical to the water supply of northeastern Ohio.

Glacial Geology

During the Pleistocene Epoch (2 million to 10,000 years ago) at least four major episodes of glaciation, referred to as stages, occurred in north-central North America (Table 9). Each major stage experienced numerous periods of advance and retreat referred to as substages. During each substage, the ice front underwent numerous fluctuations. Each of these substages brought complex changes to Portage County. Bedrock and previous unconsolidated deposits were eroded, drainages were altered, and deposition of till, sand, gravel, clay, and silt occurred.

Till is an unconsolidated, poorly-sorted, non-stratified (layered) mixture of clay, silt, sand, and gravel directly deposited by ice. Actively moving ice deposits compacted (dense) lodgement till, whereas stagnating, non-moving ice deposits less-compacted ablation or melt-out till. Till associated with a single ice advance or sheet may be deposited unevenly over the landscape and may be variable in nature as well.

Evidence for the two earliest major glacial stages, the Nebraskan and Kansan (collectively referred to as the pre-Illinoian) is lacking or obscured in Portage County and throughout much of Ohio with the possible exception of the Cincinnati area (Norton et al., 1984). Evidence exists for the two later stages, the Illinoian, which occurred at least 120,000 years ago, and the Wisconsinan which occurred between 70,000 and 10,000 years ago. The stratigraphic relation of the Pleistocene units in Portage County is given in Table 9.

Pre-glacial (Teays time) drainage was believed to have been northwards for the Portage County region with the major north-south drainage divide being well to the south in Holmes and Tuscarawas Counties (Stout et al., 1943; Smith and White, 1953, Totten, 1988a). Upon advance of the ice sheets numerous changes occurred. The ice scoured and greatly deepened

TABLE 9. GLACIAL STRATIGRAPHY OF PORTAGE COUNTY, OHIO

Epoch	Stage	Substage	Unit or Interval
Pleistocene	Late Wisconsinan	Woodfordian	Hiram Till Lavery Till Kent Till Mogadore/Titusville Till[1]
	Middle Wisconsinan	Farmdalian	Stony paleosol?
	Early Wisconsinan	Altonian	Mogadore/Titusville Till[1]
	Sangamonian		Unknown
	Illinoian		Mogadore/Titusville Till[1]
	pre-Illinoian		Not exposed

1 Age and duration of the Mogadore/Titusville Tills is currently unknown.

the pre-existing valleys in some locales (Winslow and White, 1966). The degree of deepening depended upon the nature of the rock (lithology, faulting, fracturing, bedding planes, etc.) and the orientation of the valley. Valleys parallel to the direction of ice flow typically show a higher degree of scouring than those oriented perpendicular to the direction of flow. Meltwater from the ice sheets may also have caused deeper stream channel erosion. Subsequently, many of these valleys were later filled by mixtures of till, sand, gravel, clay, and silt deposited by the ice sheets and associated meltwater.

As the ice sheet advanced, streams were blocked and drainage was diverted southwards. Presumably by (or during) the Illinoian (Winslow and White, 1966; White, 1982), a rough drainage divide existed in Portage County. Upon the advance of subsequent ice sheets, northerly-flowing streams were blocked, became ponded, and were overrun. Such valleys were filled with fine lacustrine (silts and clay) deposits and till. Valleys leading southwards from the divide served as conduits for meltwater and were filled with coarse, bedded sands and gravels (Winslow and White, 1966; White, 1982). Over time, many of these valley systems were filled or "buried". The pathways of these buried valleys may be visible at the present surface where they separate bedrock uplands or they may be totally obscured by late Wisconsinan deposits. Modern streams may overlie the buried channels, but in many portions of the county, the most recent glaciations have to such an extent deranged previous drainages that any correlation is difficult to make. Modern streams may preferentially cut channels in bedrock as opposed to following the pre-existing valleys.

Numerous studies have been undertaken to determine the nature of the bedrock surface and hence the location of buried valleys. Winslow and White (1966) and Risser (1983a; b) have mapped the bedrock topography of the entire county. Numerous geophysical studies were undertaken to refine and supplement our knowledge of the buried valley systems; these include investigations by Schultz (1973), Barber (1981), Kraig (1982), and McQuown (1988). The Ohio Drilling Company (Mayhew, 1971) utilized core drilling and geophysics to help characterize and delineate certain key buried valleys in Portage County.

Illinoian deposits, as classically defined, are absent at the surface in Portage County; they are limited to deeper excavations, particularly sand and gravel pits and quarries. Illinoian deposits include both till and thin gravels (Winslow and White, 1966; Totten, 1988a).

Prominent, resistant sandstone ridges to the north in Geauga County caused the flow of ice to divert into two major lobes, the Grand River Lobe, which entered Portage County from the northeast (White, 1960; Winslow and White, 1966; White, 1982) and the Cuyahoga Lobe, which entered Portage County from the northwest corner (Winslow and White, 1966; White, 1982; White, 1984). The Grand River Lobe ice deposited the Titusville Till and associated gravels, whereas the Cuyahoga Lobe deposited the similar Mogadore Till along the western border of what is now Portage County. The two tills are lithologically similar and would be difficult to differentiate, particularly in the subsurface (Winslow and White, 1966; Miller, 1970; White, 1982; McQuown, 1988). Both tills are very dense, compacted, sandy and stony, and contain numerous sand lenses.

The age and extent of the two tills is in question; there appears to have been a physical gap between the two ice sheets, referred to as the interlobate area (Winslow and White, 1966; McQuown, 1988). This interlobate area was filled with a complex, chaotic mix of sand, gravel, and till (Winslow and White, 1966; Totten, 1988a). As the ice sheets stagnated, ablation till and numerous kames were deposited. These features were created as meltwater deposited sand and gravel into cavities and crevasses (channels) in the ice. Abundant meltwater leading away from the ice sheet in major stream channels created extensive outwash valley trains.

The Mogadore and Titusville Tills were classically interpreted as having been deposited during the early (Altonian sub-stage) Wisconsinan (Winslow and White, 1966; White, 1982). This interpretation has come under question as recent research (Eyles and Westgate, 1987) suggests that the ice sheet build-up in North America at this time was not substantial enough to have extended into the southern Great Lakes from Canada during the early or middle (Farmdalian sub-stage) Wisconsinan. These tills therefore may conceivably be late Illinoian in age, or possibly late (Woodfordian sub-stage) Wisconsinan. Possibly, these tills comprise several units which span the range of time from late Illinoian to the early Woodfordian sub-stage (Totten, 1988a, b)

A major ice re-advance deposited the Woodfordian Kent Till throughout most of Portage County (Winslow and White, 1966; White, 1982). The Kent Till within Portage County was deposited entirely by Grand River Lobe ice which advanced into the county from the northeast. The Kent Till is a non-compact, friable, sandy, and stony till containing many sand and gravel lenses. The Kent Till associated with the Cuyahoga Lobe was not believed to have been deposited any further south than Cuyahoga County (Fernandez, 1983; Szabo, 1987; Ford, 1987). The Northampton Till (Ryan, 1980; Fernandez, 1983; and Szabo, 1987), which crops out between the Kent Till and the Mogadore Till in Cuyahoga and Summit Counties, has not been identified in Portage County.

The ice sheet that deposited the Kent Till was largely responsible for the deposition of the Kent Moraine (Winslow and White, 1966). Moraines represent a thickening of till created, in this circumstance, primarily by deposition along the margin of a stagnating ice sheet. The eastern belt of the Kent Moraine, which ranges from two to five miles wide, is formed primarily of till. Small, discontinuous lenses of sand and gravel are commonly associated with the eastern portion of the Kent Moraine. The western portion of the Kent Moraine, forming a four to eight mile wide belt, is composed primarily of sand and gravel kame deposits which contain lenses of ablation till and flow till (McQuown, 1988). Due to the abundance of kames, this portion of the moraine is referred to as a kame moraine, or more specifically, the Kent Kame Complex (McQuown, 1988). The Kent Kame Complex is the largest such feature in Ohio and extends from central Geauga County (Totten, 1988a) into eastern Portage County, southeastern Summit County (White, 1984), and northern Stark County (DeLong and White, 1963). These deposits overlie and closely resemble the interlobate deposits associated with the earlier Mogadore-Titusville Tills (Winslow and White, 1966; McQuown, 1988). Leading from the edge of the kame fields are extensive outwash deposits, including both sheet-like outwash plains and valley trains. The latter were deposited as meltwater funneled into major drainage channels. Due to the complexity of the area and the large volumes of meltwater present, differentiating between the overlapping proximal (close to the ice) outwash, kame, and interlobate deposits becomes difficult (Hull, 1980 and 1987; McQuown, 1988).

The Lavery Till overlies the Kent Till in much of central and eastern Portage County. The maximum western extent of the Lavery Till is less than that of the Kent Till. Deposition of the Lavery Till in Portage County appears to be limited to the Grand River Lobe (Winslow and

White, 1966); however, the Lavery Till is associated with the Cuyahoga Lobe in Cuyahoga (Ford, 1987) and Summit (White, 1984) Counties. The Lavery Till is fairly continuous in eastern Portage County; however, it becomes "patchy" or discontinuous farther westward in central Portage County (Winslow and White, 1966; Hull, 1987). Compositionally, the Lavery Till is a moderately compact, silty to clayey till, and is much less sandy and stony than the Kent Till.

The Lavery Till comprises the surficial till only along a narrow belt in east-central Portage County; it is overlain by the Hiram Till in eastern Portage County. The Hiram Till is the youngest till found in Portage County (Winslow and White, 1966; White 1982) and was deposited by the Grand River Lobe in eastern Portage County and by the Cuyahoga Lobe in the northwestern corner of the county as well. The Hiram Till is not very well compacted, and is very clayey and non-stony, particularly in eastern Portage County. Presumably, the Hiram Till overrode numerous clayey and silty lakebeds in Ashtabula (White and Totten, 1979) and Trumbull (White, 1971) Counties, which help account for its particularly clayey nature. Erosion and incorporation of the clayey Devonian Ohio Shale in Ashtabula County (White and Totten, 1979; White, 1982) may also help explain the clayey nature of the Hiram Till. Incorporation of shales and lakebed sediments within the Cuyahoga River Valley is believed to be the reason why the Hiram Till is so fine-grained in northwestern Portage County. The Hiram Till is commonly fairly thin and may be difficult to distinguish from the Lavery Till in some locales (Winslow and White, 1966). Due to the clayey nature of the Hiram Till, surficial drainage is extremely poor in flat-lying areas.

A thin sheet of sand is found overlying the Lavery Till over a limited area in northeastern Portage County. Referred to as the Windham Sand (Winslow and White, 1966), this deposit may comprise the surficial unit, or may instead be overlain by the Hiram Till. The Windham Sand is presumed to be an outwash deposit associated with the melting Lavery ice sheet (Winslow and White, 1966). The deposit is quite fine-grained and has been reworked by the wind creating a limited number of small dunes.

The sand and gravel deposits constitute some of the highest-yielding aquifers in the county (Winslow and White, 1966; Mayhew, 1971; and Walker, 1979). Coarse, well-sorted sands and gravels within the buried valleys in the vicinity of Kent and Ravenna are capable of producing yields well over 500 gallons per minute (gpm), with some wells yielding in excess of 1000 gpm. Sands and gravels in the interlobate and Kame Kent complex areas in southwestern Portage County may produce from 25 to over 300 gallons per minute depending upon the extent and nature of the unconsolidated deposits. Where sands and gravels within the Kent Moraine become more interbedded with tills, yields range from 10 to 50 gpm. The relative proportion of sand and gravel versus till, and the lateral continuity of the coarser deposits, are the major factors controlling their ability to produce water. The spectacular kames in the far southwestern corner of the county generally are not great water producers (despite their highly permeable nature) because they are typically at an elevation well above the water table (Winslow and White, 1966; McQuown, 1988).

A highly-productive buried valley sand and gravel aquifer extends from Kent towards Mantua. Yields up to 500 gpm may be expected from properly developed wells within the valley sediments (Walker, 1979).

In contrast, buried valleys in southeastern, northeastern and northwestern Portage County generally are low-yielding (Winslow and White, 1966: Mayhew, 1971; Walker, 1979). The valleys may be filled with saturated fine sand and silts. Due to the fine nature of these deposits, wells are difficult to develop and maintain. Many of the more northerly buried valleys are filled with interbedded, compact, fine tills and lacustrine sediments. Wells in these areas tend to produce less than 5 gpm. In extreme northwestern Portage County, the valley fill is exceptionally fine and thick; well yields average less than 3 gpm and dry holes are not uncommon.

The tills in Portage County in general do not constitute an aquifer of regional importance. Locally, sand and gravel lenses within or between till units comprise a limited aquifer suitable for domestic use. The sandy, more friable portions of the Kent Till associated with the Kent Moraine are commonly situated above the water table and therefore do not constitute important aquifers.

Bedrock Geology

Bedrock underlying Portage County belongs to the Devonian, Mississippian, and Pennsylvanian Systems (Table 10). These formations are predominantly shales, sandstones, and conglomerates. Only the Pennsylvanian rocks commonly outcrop at the surface within Portage County.

The Devonian early, pre-Berea units such as the Cussewago and the Bedford Formations are primarily encountered along the axis of only the deepest entrenched buried valleys (Fuller, 1965 and Winslow and White, 1966). The Berea Sandstone, while not exposed at the surface, serves as an important aquifer in localized areas. Wells developed in the Berea Sandstone are primarily limited to the northeastern section of the county. The city of Garrettsville's well field is developed in the Berea Sandstone.

South of an east-west line passing through Ravenna, the Berea becomes brackish to saline and may also contain pockets of naturally-occurring petroleum (Winslow and White, 1966; Rau, 1969). Elsewhere within the county, random zones of brine or petroleum contamination

TABLE 10. BEDROCK STRATIGRAPHY OF PORTAGE COUNTY, OHIO

System (Age)	Group/Formation (Symbol)	Significant Members or Beds	Lithologic Description
PENNSYLVANIAN (318.1 to 299 million years)	Allegheny and Pottsville Group, undifferentiated (Pap)	Homewood Sandstone Mercer Shale Massillon Sandstone Sharon Shale Sharon Sandstone	The Homewood Sandstone is a medium-to fine-grained sandstone with sandy shale lenses common. The Mercer Shale is a silty to carbonaceous shale interbedded with thin sandstone, coal seams, clays, and siltstones. The Massillon Sandstone is a coarse- to medium-grained sandstone, may contain minor shale and conglomerate lenses. The Sharon Shale is a gray-black, sandy to silty shale with minor siltstone beds and coal seams. The Sharon Sandstone is a coarse- to medium-grained, light colored sandstone and may contain conglomeratic zones. Also known as Sharon Conglomerate.
MISSISSIPPIAN (359.2 to 318.1 million years)	Logan and Cuyahoga Formations, undivided (Mlc)	Meadville Shale Sharpsville Sandstone Orangeville Shale	The Logan Formation is not found in Portage County. The members of the Cuyahoga Formation consist of alternating, thin-bedded, gray silty shales, sandy shales, siltstones and fine-grained sandstones. Shaley facies is generally predominant in Portage County.
DEVONIAN (416 to 359.2 million years)	Berea Sandstone and Bedford Shale, undivided (Dbb)	Berea Sandstone Bedford Shale Cussewago Sandstone	The Berea Sandstone is a massive, cross-bedded fine-grained sandstone, gray to brown in color. The Bedford Shale is light gray, red, or brown fissile, silty to clayey shale. The Cussewago Sandstone is a fine-grained sandstone that occurs within the Bedford Shale.
	Ohio Shale (Doh)	Cleveland Member Chagrin Member Huron Member	The Ohio Shale is a massive, dark, bituminous shale. Concretions, high organics, and pyrite are common.

occur in the Berea and younger rocks. These occurrences are usually much more limited in extent and stem from improperly developed petroleum wells or disposal (annular) wells.

Roughly associated with the Berea sandstone is the underlying Cussewago Sandstone, which has a very limited extent in northeastern Ohio (Winslow and White, 1966; Rau, 1969). The Cussewago Sandstone is a sandy unit found within the Bedford Shale. It may be difficult to distinguish between the Cussewago and Berea Sandstone from well log records, as both units are found at depth and have similar characteristics.

Overlying the Berea Sandstone is the Cuyahoga Formation, which has a limited outcrop area in northeastern Portage County. The Cuyahoga Formation is also encountered along the valley walls flanking the major buried valleys. The Cuyahoga Formation has been subdivided into three members in Cuyahoga (Winslow et al., 1953) and Summit (Smith and White, 1953) Counties, as well as in Portage County (Winslow and White, 1966). The three constituent members (in ascending order) are the Orangeville Shale, the Sharpsville Sandstone, and the Meadville Shale. These similar units are composed of interbedded shales, siltstones, and sandstones. The Cuyahoga Formation is rarely utilized for water in Portage County; most wells drilled into the Cuyahoga pass through this formation and are developed in the Berea Sandstone.

Overlying the Cuyahoga Formation are the various units within the Pennsylvanian Pottsville Group. The Sharon Sandstone is the basal unit of the Pottsville and is present throughout most of Portage County. The Sharon is referred to as both sandstone and conglomerate. In Portage County (Fuller, 1965; Winslow and White, 1966), the Sharon contains numerous conglomeratic zones, particularly in the lower portion. The conglomeratic zones are marked by a distinctive zone of well-rounded, milky-white quartzite pebbles. These zones are believed to represent channel lag deposits within a broad fluvial system.

The Sharon Sandstone is a very resistant unit which caps many of steep ridges, particularly in northern Portage County, and is the most commonly utilized bedrock aquifer in the county (Winslow and White, 1966; Sedam, 1973; Walker, 1979). Overall, the Sharon Sandstone is the highest yielding bedrock unit within the county (Winslow and White, 1966; Sedam, 1973).

Overlying the Sharon Sandstone (conglomerate), particularly in central Portage County, is the Sharon Shale. This relatively dense unit is comprised of dark interbedded siltstone and shale. In some locations, the shale is absent due to erosion.

The Sharon Shale, or if absent, the Sharon Sandstone, underlies the Massillon (Connoquenessing) Sandstone. This unit is also relatively resistant and, where it overlies the Sharon Sandstone, may aid in creating a resistant cap of bedrock on ridge tops. The Massillon Sandstone is slightly finer (contains more matrix) than the Sharon and is commonly thinner. The Massillon Sandstone is often utilized for domestic wells, particularly in northern and central Portage County; however, the Massillon generally lacks the high-yielding zones found in the Sharon Sandstone (Winslow and White, 1966; Sedam, 1973).

Overlying the Massillon Sandstone is the Mercer Formation. The Mercer is a silty, organic-rich shale which contains thin, interbedded coals, limestones and underclays. Water availability is generally low, although the coals, and in limited instances, the limestones, can be moderately productive.

The youngest unit is the Homewood Sandstone. The Homewood generally overlies the Mercer Formation, or, in limited areas, the Massillon Sandstone. The Homewood Sandstone typically is a lower-yielding sandstone capable of supplying only domestic needs.

Yields of the pre-Pottsville units are generally less than 5 gpm except for the Berea Sandstone (Winslow and White, 1966). Yields for the Berea Sandstone average between 10-20 gpm, with limited high producing zones such as at Garrettsville, where yields up to 100 gpm have been reported (Winslow and White, 1966). The Sharon Sandstone yields usually range between 10 and 50 gpm (Winslow and White, 1966; Sedam, 1973; and Walker, 1979). Wells developed in the Sharon Sandstone in nearby Kent and Mantua have yields in excess of 300 gpm. These high-yielding wells are generally in close hydrogeologic contact with overlying saturated sands and gravels. Yields for the Massillon Sandstone generally are under 50 gpm and average between 10 and 20 gpm (Winslow and White, 1966; Sedam, 1973; Walker, 1979). Yields in the Sharon Shale and Mercer Shale are less than 5 gpm except for coal seams in the latter formation. Yields within the Homewood Sandstone are generally less than 10 gpm.

In many areas, wells penetrate numerous units. For example, a well may penetrate the Massillon Sandstone, the Sharon Shale, and the Sharon Sandstone, drawing water from all three units and contacts. Yields of such wells will vary from 5 gpm to over 100 gpm depending upon the nature of the rock and the degree of well development. The presence of fracture zones (Winslow and White, 1966; Stanley, 1973; Sedam, 1973; Kammer, 1982) within the bedrock, particularly the Sharon, is critical. Increasing numbers of bedding planes and contacts generally provide for increased yields to wells. The amount of till cover and recharge to the bedrock aquifer are additional critical factors (Butz, 1973) in determining the yield of the bedrock units.

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APPENDIX A

DESCRIPTION OF THE LOGIC IN FACTOR SELECTION

Depth to Water

Water level information was taken from a variety of sources including the studies of Winslow and White (1966), Rau (1969), Sedam (1973), and Walker (1979). Thesis data from Carothers (1972), Schultz (1973), Young (1980), Kammer (1982), Krulik (1982), Robertson (1983), Stroebel (1983), Bendula (1985), and Roeper (1988) were useful in determining depth to water in localized areas. The primary source of water level information was obtained by using located water well log and drilling report data available at the Ohio Department of Natural Resources, Division of Soil and Water Resources. Approximately 15,000 water wells were plotted and analyzed.

Two particular complications arose during the determination of depth to water. The first was determining a rating in areas with highly variable water depths. Generally in such cases, more than one aquifer was being utilized in an area and a determination as to which aquifer should be rated had to be made first. The second problem was perched water zones. These zones are usually very shallow (near surface) and reflect poor drainage due to impermeable soils and topographic lows. Careful determinations were needed to distinguish whether a shallow depth to water was a true representation of the water table, or if it instead represented a perched zone, in which case the true water level was much deeper.

Water levels vary greatly in Portage County for both consolidated and unconsolidated aquifers. This is particularly true in areas with sand and gravel aquifers; notably those overlying buried valleys and those within the Kent Kame Complex. The variable nature of the bedrock and the number of bedrock units that were penetrated by a well were also critical factors affecting the depth to water.

Depths of 5 to 15 feet were typical of areas near floodplains and within ground water discharge areas near the stream headwaters. A limited number of bogs and swampy floodplain areas had depths less than 5 feet (10). The majority of ratings were between 15 to 30 feet (7) and 30 to 50 feet (5), especially for those areas with bedrock aquifers or the non-buried valley gravel aquifers. Commonly, higher elevation features such as prominent sandstone ridges, large kames, and some portions of the Kent Moraine had depths to water of at least 30 to 50 feet (5) ranging upwards to 50 to 75 feet (3) and 75 to 100 feet (2) in a few extreme cases. Depth to water for sand and gravel aquifers within buried valleys varied greatly. In areas immediately adjacent to streams or nearby discharge zones from surrounding bedrock uplands and kames, depths commonly range from 5 to 15 feet (9) and 15 to 30 feet (7). As the total depth to the aquifer increased so did the static level, especially for buried valleys in far northeastern and northwestern Portage County. Thick intervals of "dry sand" were noted in well logs or observed in sand and gravel pits. Depths in these areas ranged from 30 to 50 feet (5) to 50 to 75 feet (3) with very isolated zones of 75 to 100 feet (2). Water levels near the man-made reservoirs generally ranged between 15 to 30 feet (7) and 30 to 50 feet (5), i.e., the water levels were not tremendously influenced by these artificial water bodies.

Net Recharge

This factor was evaluated using many criteria including depth to water, topography, soil type, surface drainage, and annual precipitation. Unpublished thesis data of Butz (1973), Stanley (1973), Schultz (1973), Young (1980), Kammer (1982), and Stroebel (1983), were useful in helping to select rough recharge values for various settings. These theses indicated that recharge varied greatly with respect to the nature and thickness of the overlying glacial deposits, with typical values of 6 inches or less per year.

Values of 4 to 7 inches per year (6) were assigned to the majority of the county recognizing that values were at the lower end of the range where till deposits were thicker. Values of 7 to 10 inches per year (8) and 10+ inches per year (9) were used in areas of highly permeable soils overlying outwash and buried valley deposits. Values of 7 to 10 inches per year (8) were commonly utilized for sensitive peat bog and kettle areas. Values ranged from 4 to 7 inches per year (6) to 7 to 10 inches per year (8) for stream valleys depending upon the nature and thickness of the alluvial deposits and the proximity of the water table to the streambed. Values of 2 to 4 inches per year (3) and 0 to 2 inches per year (1) were primarily utilized for high, steep ridges where the till cover was extremely thick. Values of 2 to 4 inches per year (3) were also utilized for portions of buried valleys containing extremely thick, fine-grained deposits.

Aquifer Media

Information on aquifer media was primarily derived from: Smith and White (1953), Fuller (1965), Winslow and White (1966), Rau (1969), Mayhew (1971), Sedam (1973), Walker (1979), and Hull (1980, 1987). The theses of Carothers (1972), Barber (1981), Young (1980), Kammer (1982), Kraig (1982), Krulik (1982), Robertson (1983), McQuown (1988), and Roeper (1988) were highly useful for helping to evaluate and categorize the aquifer within specific areas.

Well log and drilling reports and unpublished pumping test data from the Ohio Department of Natural Resources, Division of Soil and Water Resources were invaluable for making aquifer determinations across the county. The reports of Aller and Ballou (1990) and Williams (1990) were also very useful for helping to assign aquifer ratings in complex settings. Numerous sand and gravel pits and small sandstone quarries were visited to provide additional information on the nature of the aquifer.

Bedrock was chosen as the aquifer for the majority of central and eastern Portage County. Two bedrock settings were utilized: Glacial Till over Bedded Sedimentary Rock (7Aa) and Glacial Till over Sandstone (7Ad). These settings were largely determined by reviewing well log and drilling report data; where such data were lacking, the studies of Fuller (1965) Winslow and White (1966), Rau (1969), Walker (1979), Sedam (1973), and Kammer (1982) were utilized. In areas where well log and drilling reports indicated the entire thickness of the well was completed in sandstone or where the Sharon Sandstone or Massillon (Connoquenessing) Sandstone were indicated by Winslow and White (1966), sandstone was selected as the aquifer and given a rating of (6). Because it was difficult to differentiate between sandstone formations, and due to the likelihood of wells penetrating multiple formations in many areas, different ratings were not ascribed to the various sandstone units. Where appreciable amounts of shale and sandstone were encountered in the well log and drilling reports, interbedded sedimentary rocks were selected as the aquifer. These interbedded sedimentary rocks were also given a rating of (6) due to their highly fractured nature and the high number of bedding planes. In southeastern Portage County the interbedded sedimentary rock sequence contained numerous thin coals, limestones, and underclays. The aquifer rating of (6) was retained to help balance between high permeability units such as coal and sandstone and low permeability units such as the underclays.

Sand and gravel aquifers were delineated in a variety of hydrogeologic settings. Aquifer ratings varied with the nature of the sand and gravel, including sorting, grain size, and cleanliness. The lateral extent and continuity of the deposits was particularly difficult to determine in some regions. Buried valleys were first delineated and then the more continuous sand and gravel deposits within the valley margins were rated. Ratings of (5) and (6) were assigned to poorly-sorted, predominantly silty-to-sandy, gravel-poor aquifers. The buried valleys in the far northeastern and northwestern corners of Portage County were given these lower ratings. Tributaries, headwaters and the margins alongside the highly productive valleys in central and western Portage County were given ratings of (6) and (7). The high-yielding sands and gravels occupying the major valley systems were given ratings of (8) and (9). The outwash, interlobate, and kame deposits associated with the Kent Kame Complex and the western margin of the Kent Moraine were quite difficult to rate due to the variable nature of the sands and gravels and because of the varying proportion of till interbedded with these deposits. Ratings of (6), (7), and (8) were used within these regions. Where the outwash was finer and some wells were completed in bedrock, a rating of (6) was utilized. In isolated areas away from buried valleys and the sand-and gravel- rich portions of the Kent Kame Complex and the Kent Moraine, wells were developed in the small, discontinuous sand and gravel lenses within the till (particularly the Kent Till). Such deposits were typically given a rating of (6), although some deeper, exceptionally low-yielding sands and gravels were given a rating of (5). In areas where sand and gravel wells and bedrock wells were roughly equal in number and yield, sand and gravel was chosen as an aquifer and a rating of (6), which is equal to the rating for sandstone or interbedded sediments, was assigned.

Soil Media

This factor was primarily evaluated by using the *Soil Survey for Portage County* (Ritchie et al., 1978). Information on every indicated soil type was evaluated and appropriate ratings were selected (Table 11). The surficial materials map of Hull (1987) was a useful secondary source of information for determination of soil media.

The tills within Portage County weather into a variety of soils. The clay-rich Hiram Till weathers into clay (1), clay loam (3), and high shrink-swell (aggregated) clay (7). The silty-clayey Lavery Till weathers into clay loam (3), or silt loam (4) soils. The loamy Kent Till and rarely the Mogadore/Titusville Till weather into silt loam (4), loam (5), or even sandy loam (6) soils. Alluvium within streams is highly variable; in poorly-drained depressional areas soils include clay (1) and clay loams (3), better drained floodplains contain silt loam (4), loam (5), and (along the Cuyahoga River) sandy loam soils (6). Outwash and kame deposits are typically overlain by loam (5) or sandy loam (6) soils. There is generally a thick enough till cap over these deposits to prevent them from developing into sand or gravel soils. Sand (9) soil occurrences are limited to a few residual, weathered sandstone knobs and to dune areas associated with the Windham Sand. Thin bedrock soils (bedrock <5 feet) are typically rated as silt loam (4) or sandy loam (6). Depressional, kettle areas may contain clay (1), muck (2), or peat (8) soils. Soils were rated as thin or absent (10) in strip-mined areas.

The Rittman-Wadsworth soils, which are associated with the Lavery Till in portions of central Portage County, and the Wooster-Ravenna-Canfield soils, associated with areas containing thicker Kent and Mogadore/Titusville Till, contain fragipans. A fragipan is a dense, impermeable zone found within certain loamy, till-derived soils. Fragipans may notably restrict the downward movement of water (Butz, 1973; Schultz, 1973; Ritchie et al., 1978; Williams, 1990). The net effect of the fragipan is to reduce the overall permeability of a soil within a given textural range (Aller et al., 1987). Hence, a soil with a loam (5) texture would be rated equivalent to a silt loam (4), and a soil with a silt loam (4) texture would be rated as a clay loam (3) due to the presence of a fragipan (see Table 11).

Topography

Percent slope was estimated by using 7 1/2 minute USGS topographic quadrangle maps. Topography averages 2 to 6 percent (9) in the majority of the County. Areas of 0 to 2 percent (10) slope are also quite common; these flat-lying areas typically are indicated as having poor drainage, especially in central and eastern Portage County. Slopes of 6 to 12 percent (5) are common in the kame and moraine areas of southwestern Portage County and along many of the bedrock ridges. Slopes of 6 to 12 percent (5) are also commonly found adjacent to the large reservoirs in eastern Portage County. Steeper slopes of 12 to 18 percent (3) were limited to a few extremely steep, isolated sandstone knobs and kames. Slopes of 18+ percent (1) were quite rare, being limited to a few sandstone cliffs in far northeastern Portage County.

TABLE 11. PORTAGE COUNTY SOILS

Soil Name	Parent Material or Setting	DRASTIC Rating	Soil Media
Bogart	outwash, kames	5	loam
Bogart-Haskins	outwash, kames	5	loam
Candice	lakebeds, kettles	2	muck
Canfield	till	4*	silty loam
Carlisle	kettles, bogs	8	peat
Chili	outwash, kames	5	loam
Chili-Oshtemo	outwash, kames	6	sandy loam
Chili-Wooster	outwash, kames	5	loam
Damascus	outwash	5	loam
Dekalb	till over sandstone	6	sandy loam
Ellsworth	till	3	clay loam
Fitchville	alluvium, lakebed	3	clay loam
Frenchtown	alluvium, lakebed	3	clay loam
Geebury	lakebed, till	7	shrink/swell clay
Glenford	lakebed,delta	4	silt loam
Haskins	till	3	clay loam
Holly	alluvium	4	silty loam
Hornell	till over shale	3	clay loam
Jimtown	outwash, kames	6	sandy loam
Lakin	outwash, kames, dunes	9	sand
Linwood	kettles, bogs	8	peat
Loudonville	till over sandstone	4	silty loam
Mahoning	till	3	clay loam
Mitiwanga	till over sandstone	3	clay loam
Olmstead	outwash	6	sandy loam
Orrville	alluvium	5	loam
Oshtemo	outwash, kames	6	sandy loam
Ravenna	till	4*	silty loam
Rittman	till	3*	clay loam
Sebring	lakebed, terrace	3	clay loam
Tioga	outwash, alluvium	6	sandy loam
Trumbull	lakebed, kettles	1	clay
Typic Udorthents	strip mines	10	thin or absent
Wadsworth	till	3*	clay loam
Willkill	kettles, bogs	8	peat
Wheeling	outwash, terraces	4	silty loam
Wooster	till	4*	silty loam

*Soil contains a fragipan

Vadose Zone Media

This factor was primarily determined using the water well log and drilling reports on file at the Ohio Department of Natural Resources, Division of Soil and Water Resources and from the surficial materials map of Hull (1987). Other useful information was obtained from Fuller (1965), Winslow and White (1966), Mayhew (1971), Walker (1979), and Hull (1980). The theses of Carothers (1972), Stanley (1973), Butz (1973), Schultz (1973), Barber (1981), Young (1980), Kammer (1982), Kraig (1982), Krulik (1982), Robertson (1983), Stroebel (1983), and McQuown (1988) were also helpful, particularly in areas of buried valleys. Numerous sand and gravel pits and minor sandstone quarries were field checked to help better ascertain the nature of the vadose zone media.

Bedrock was rated as the vadose zone media only in limited areas where the till cover was very thin over bedrock. Typically, these areas were steep-sided, sandstone-capped knobs and ridges. Depth to water is usually greater than 30 feet and the overlying till comprises only a very small proportion of the vadose zone. Bedrock was also selected as the vadose zone for the rated strip-mined areas. Bedrock was rated as a (6) for both interbedded sedimentary sequences and sandstone.

The thickness and nature of unconsolidated deposits varied considerably within Portage County. Values of (8) and (9) were utilized where sand and gravel was rated as the vadose zone media within the clean, coarse kame, outwash, and buried valley deposits. Where sand and gravel deposits were more poorly sorted ("dirtier"), or where they were interbedded with thin till or lacustrine fill, the vadose zone media was determined as being sand and gravel with significant silt and clay and values of (5), (6), or (7) were utilized. Areas with coarser stream alluvium and shallow water tables were also rated as sand and gravel with significant silt and clay and given a rating of (5), (6), or (7). Where the alluvium was finer grained, as well as in some depressional areas, silt and clay was chosen as the vadose zone media and given a value of either (4) or (5). Peat was given the highest value (6) for the silt and clay vadose media category due to its relatively high permeability. Silt and clay was selected as the vadose media for the glacial lake (lacustrine) sediments found adjacent to Geauga County (Aller and Ballou, 1990) and was assigned a value of (5).

Till was by far the most common vadose zone media for the majority of Portage County. Aller and Ballou (1990) and Williams (1990) assigned the various surficial tills specific ratings. The studies of Winslow and White (1966) and Hull (1987) were particularly useful in helping to delineate the boundaries of the surficial tills. The *Soil Survey of Portage County* (Ritchie et al., 1978) was also utilized to help differentiate till units. Where the surficial deposits were designated as the Hiram Till, a value of (4) was assigned, where Lavery Till was designated, a value of (5) was assigned to reflect the coarser till texture, and where the Kent Till was designated, a value of (6) was utilized to reflect the sandy nature of this till unit. A value of (5) was utilized to demonstrate the locally sandier, more highly weathered nature of the till where the surficial Hiram Till was very thin and capping a sandstone knob (Stanley, 1973; Butz, 1973; Schultz, 1973; Szabo; Angle, 1983). Where the till was very thick a value of (3) was utilized to reflect the greater compaction and presumed absence of weathering or fracturing.

Hydraulic Conductivity

Hydraulic conductivity data was found in Mayhew (1971), Sedam (1973), Barber (1982), Kammer (1982), Krulik (1982), Robertson (1983), Stroebel (1983), McQuown (1988), and Roeper (1988). In some instances, hydraulic conductivity was estimated by taking the transmissivity and dividing by an estimated saturated thickness value. This technique was used to estimate the hydraulic conductivity values derived from several unpublished pumping tests on file at the Ohio Department of Natural Resources, Division of Soil and Water Resources. Textbook tables (Freeze and Cherry, 1979; Fetter, 1980) were useful in obtaining estimated values for a variety of sediments.

Wells developed in the higher-yielding, fractured zones (Stanley, 1973) of the Sharon Sandstone were given conductivity values ranging from 300 to 700 gallons per day per square foot (4). These high-yielding areas reflect localized recharge areas generally limited to northern Portage County and around the City of Kent (Sedam, 1973; Kammer, 1982; Stroebel, 1983). Lower-yielding sandstone wells developed elsewhere in the Sharon Sandstone, Massillon Sandstone, or Homewood Sandstone were assigned conductivity values of 100 to 300 gallons per day per square foot (2). For wells developed in the interbedded sedimentary rock sequences, conductivity values ranged from 100 to 300 gallons per day per square foot (2). This includes the sequences in southeastern Portage County which contain coal, limestone, and underclay in addition to shale and sandstone.

Hydraulic conductivity values varied considerably within the unconsolidated sediments. Values ranging from 0 to 100 gallons per day per square foot (1), were utilized for limited portions of the very fine-grained, low-yielding sediments within the buried valleys in northwestern Portage County. Values ranging from 100 to 300 gallons per day per square foot (2) were assigned to finer-grained, less well-sorted sand and gravel deposits. This included areas of fine sands in buried valleys, the minor tributaries of the buried valley systems, areas within the Kent Kame Complex and Kent Moraine containing appreciable amounts of till, and sand and gravel lenses interbedded in glacial till. Hydraulic conductivity values ranging from 700 to 100 gallons per day per square foot (8) were assigned to the well-sorted (clean), coarse sand and gravel deposits associated with outwash, kame, and buried valleys in southwestern and central Portage County. The highest values, averaging 2000+ gallons per day per square foot (10), were assigned to the limited area of very high-yielding, buried valley deposits just west of Brady Lake and Lake Rockwell.

Areas of Special Concern

Certain areas within Portage County require special consideration, primarily due to past/present land usage and the suitability of these areas for future activities. Many of these areas, if over 100 acres in extent, have not been specifically rated by the DRASTIC system; features under 100 acres are incorporated within the surrounding DRASTIC setting.

Sand and Gravel Pits

Numerous sand and gravel pits are found in Portage County, particularly within the Kent Kame Complex (Hull, 1980; McQuown, 1988). While such pits are not specifically rated, these sites are typically highly vulnerable due to the absence of soil cover, the highly permeable nature of the material within the pit, and, typically, a high water table. Usage of these pits for landfills (Bendula, 1985; Roeper, 1988), or other industrial/transportation uses requires an extensive site-specific study including ground water monitoring.

Sandstone Quarries

Many small- to medium-sized sandstone quarries are located in Portage County, particularly in the eastern and northern portions of the county. Quarries are typically relatively vulnerable due to the absence of soil cover, the exposed, generally fractured nature of the bedrock, and potentially high water table. Usage of abandoned quarries for landfills, or for other industrial/transportation facilities requires an extensive site-specific study including ground water monitoring.

Strip Mines

Strip mines in Portage County are limited to Deerfield and Atwater Townships, where the Bedford coal member of the Mercer Shale was the principal coal being mined (Winslow and White, 1966). The strip-mined areas over 100 acres in size were rated using the DRASTIC system, primarily due to the current trend of locating landfills in non-operating strip mines (Bendula, 1985; Illes, 1987). The primary data sources for evaluating these strip-mined areas were the theses of Bendula (1985), Illes (1987), and Roeper (1988), as well as information taken from surrounding water well log and drilling reports. The calculated index for each strip-mined area reflects an average value as conditions are sure to vary within the strip mine. Rating the strip-mined areas does not preclude the need for site-specific studies to be conducted before further use of these areas.

Abandoned Underground Mines

Abandoned underground mines are known to exist in east-central Deerfield Township. The relationship between these mines and local ground water conditions is not known. Bendula (1985) and Illes (1987) reported that the damming of the Mahoning River to create the Berlin Reservoir in the 1940's flooded these mines. The presence of abandoned underground mines may have little, or conversely, major effects on ground water. Effects may include subsidence (or settling) of rock units which can increase fracturing, and the presence of air shafts, vents, and test holes, which could serve as conduits for the migration of contaminants. Determining the presence of underground mines and investigating their potential influence should be included as part of any extensive site-specific study in suspect areas. The Ohio Department of Natural Resources, Division of Geological Survey has a series of both county and USGS 7 1/2 minute quadrangle maps depicting the location of known abandoned underground mines.

APPENDIX B

DESCRIPTION OF HYDROGEOLOGIC SETTINGS AND CHARTS FOR DRASTIC

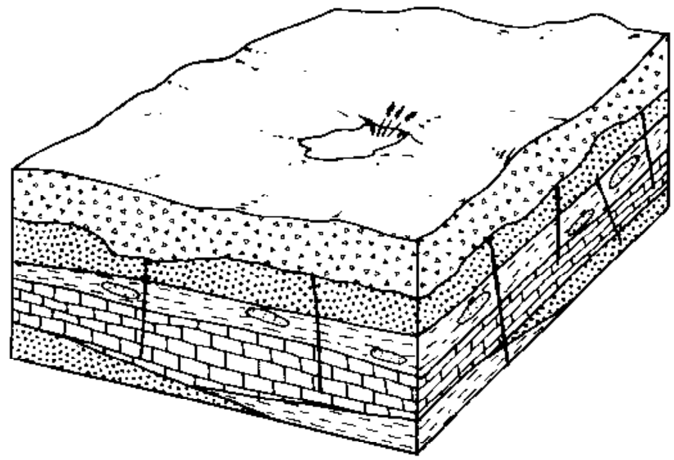
TABLE 12. HYDROGEOLOGIC SETTINGS MAPPED IN PORTAGE COUNTY, OHIO, FOR GENERAL DRASTIC

Hydrogeologic Settings	Range of GWPP Indexes	Number of Index Calculations
7Aa1 -Glacial Till Over Bedded Sedimentary Rocks	71-157	101
7Ad - Glacial Till Over Sandstone	82-158	67
7Af - Sand & Gravel Interbedded in Glacial Till	91-142	30
7Ba - Outwash	100-197	117
7Bb - Outwash Over Bedded Sedimentary Rocks	76-189	16
7D - Buried Valley	85-204	206
7Eb - Alluvium Without Overbank Deposits	149-153	3
7Ec - Alluvium Over Bedded Sedimentary Rocks	125-164	14
7Ed - Alluvium Over Glacial Till	139-143	3
7F - Glacial Lake Deposits	130	1
7G - Thin Till Over Bedded Sedimentary Rock	152-157	2

TABLE 13. HYDROGEOLOGIC SETTINGS MAPPED IN PORTAGE COUNTY, OHIO, FOR PESTICIDE DRASTIC

Hydrogeologic Settings	Range of GWPP Indexes	Number of Index Calculations
7Aa1 -Glacial Till Over Bedded Sedimentary Rocks	87-193	101
7Ad - Glacial Till Over Sandstone	95-187	67
7Af - Sand & Gravel Interbedded in Glacial Till	111-176	30
7Ba - Outwash	114-227	117
7Bb - Outwash Over Bedded Sedimentary Rocks	95-223	16
7D - Buried Valley	105-230	206
7Eb - Alluvium Without Overbank Deposits	168-177	3
7Ec - Alluvium Over Bedded Sedimentary Rocks	142-192	14
7Ed - Alluvium Over Glacial Till	160-170	3
7F - Glacial Lake Deposits	161	1
7G - Thin Till Over Bedded Sedimentary Rock	192-197	2

The following information provides a description of each hydrogeologic setting identified in the county, a block diagram illustrating the characteristics of the setting and a listing of the charts for each unique combination of pollution potential indexes calculated for each setting. The charts provide information on how the ground water pollution potential index was derived and are a quick and easy reference for the accompanying ground water pollution potential map. A complete discussion of the rating and evaluation of each factor in the hydrogeologic settings is provided in Appendix A, Description of the Logic in Factor Selection.



<u>7Aa Glacial Till Over Bedded Sedimentary Rocks</u>

This hydrogeologic setting is characterized by high relief with prominent, steep-sided ridges, and by relatively flat-lying, fractured sedimentary rocks. The rocks are predominantly sandstones and shales which are covered by varying thicknesses of glacial till. In the southeastern part of Portage County, the sedimentary sequences include thin coals, limestones, and underclays. The thin coal seams are usually highly fractured and are quite permeable. Thin clay and shale zones tend to impede vertical water movement and create "perched" water tables. The till is basically an unsorted deposit which contains localized deposits of sand and gravel. Although precipitation is abundant in the region, recharge is generally moderate due to the relatively greater depth to water (low water table) and the corresponding thick vadose zone composed of compacted tills. Depth to water is variable, but generally ranges between 25 to 50 feet.

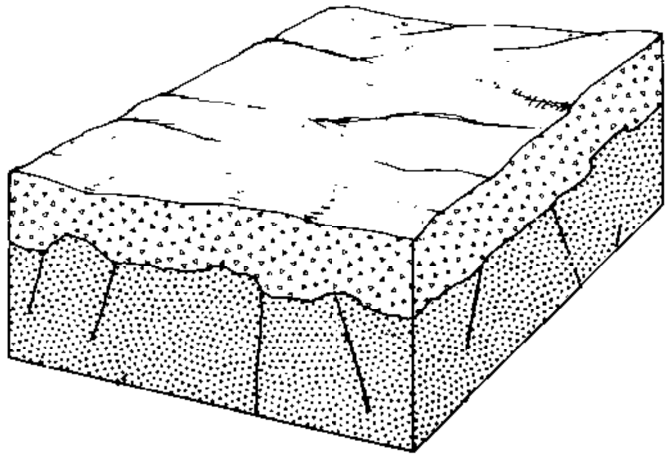
Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Aa1	30-50	4-7	Bedded Sandstone, Shale	Silty Loam	2-6	Till	100-300	115	138
7Aa2	30-50	4-7	Bedded Sandstone, Shale	Silty Loam	2-6	Till	100-300	120	142
7Aa3	30-50	4-7	Bedded Sandstone, Shale	Sand	2-6	Till	100-300	130	167
7Aa4	30-50	4-7	Bedded Sandstone, Shale	Loam	2-6	Till	100-300	122	147
7Aa5	15-30	4-7	Bedded Sandstone, Shale	Loam	2-6	Till	100-300	132	157
7Aa6	15-30	4-7	Bedded Sandstone, Shale	Loam	0-2	Till	100-300	133	160
7Aa7	5-15	4-7	Bedded Sandstone, Shale	Silty Loam	2-6	Till	100-300	140	162
7Aa8	5-15	4-7	Bedded Sandstone, Shale	Silty Loam	0-2	Till	100-300	141	165
7Aa9	30-50	4-7	Bedded Sandstone, Shale	Loam	0-2	Till	100-300	123	150
7Aa10	15-30	4-7	Bedded Sandstone, Shale	Silty Loam	2-6	Till	100-300	130	152

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Aa11	15-30	4-7	Bedded Sandstone, Shale	Clay Loam	0-2	Till	100-300	129	150
7Aa12	5-15	4-7	Bedded Sandstone, Shale	Loam	0-2	Till	100-300	143	170
7Aa13	5-15	4-7	Bedded Sandstone, Shale	Loam	2-6	Till	100-300	142	167
7Aa14	15-30	4-7	Bedded Sandstone, Shale	Silty Loam	0-2	Till	100-300	131	155
7Aa15	15-30	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	0-2	Till	100-300	137	170
7Aa16	30-50	4-7	Bedded Sandstone, Shale	Silty Loam	0-2	Till	100-300	121	145
7Aa17	5-15	4-7	Bedded Sandstone, Shale	Clay Loam	0-2	Till	100-300	139	160
7Aa18	30-50	4-7	Bedded Sandstone, Shale	Loam	6-12	Till	100-300	118	135
7Aa19	30-50	4-7	Bedded Sandstone, Shale	Sandy Loam	6-12	Till	100-300	120	140
7Aa20	30-50	4-7	Bedded Sandstone, Shale	Sandy Loam	12-18	Till	100-300	118	134
7Aa21	30-50	4-7	Bedded Sandstone, Shale	Clay Loam	6-12	Till	100-300	104	117
7Aa22	50-75	2-4	Bedded Sandstone, Shale	Clay Loam	6-12	Till	100-300	82	95
7Aa23	30-50	4-7	Bedded Sandstone, Shale	Clay Loam	2-6	Till	100-300	108	129
7Aa24	50-75	2-4	Bedded Sandstone, Shale	Clay Loam	2-6	Till	100-300	86	107
7Aa25	50-75	2-4	Bedded Sandstone, Shale	Clay Loam	0-2	Till	100-300	87	110
7Aa26	15-30	4-7	Bedded Sandstone, Shale	Clay Loam	6-12	Till	100-300	114	127
7Aa27	50-75	2-4	Bedded Sandstone, Shale	Nonshrinking and Nonaggregated Cl	0-2	Till	100-300	83	100
7Aa28	75-100	2-4	Bedded Sandstone, Shale	Clay Loam	2-6	Till	100-300	76	98
7Aa29	30-50	4-7	Bedded Sandstone, Shale	Clay Loam	0-2	Till	100-300	109	132
7Aa30	15-30	4-7	Bedded Sandstone, Shale	Nonshrinking and Nonaggregated Cl	0-2	Till	100-300	115	132
7Aa31	15-30	4-7	Bedded Sandstone, Shale	Clay Loam	2-6	Till	100-300	118	139
7Aa32	30-50	4-7	Bedded Sandstone, Shale	Loam	2-6	Till	100-300	117	143
7Aa33	15-30	4-7	Bedded Sandstone, Shale	Loam	6-12	Till	100-300	128	145
7Aa34	15-30	4-7	Bedded Sandstone, Shale	Silty Loam	6-12	Till	100-300	126	140
7Aa35	15-30	4-7	Bedded Sandstone, Shale	Silty Loam	12-18	Till	100-300	124	134
7Aa36	30-50	4-7	Bedded Sandstone, Shale	Silty Loam	6-12	Till	100-300	116	130

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Aa37	50-75	2-4	Bedded Sandstone, Shale	Silty Loam	2-6	Till	100-300	98	120
7Aa38	15-30	4-7	Bedded Sandstone, Shale	Clay Loam	2-6	Till	100-300	128	147
7Aa39	50-75	2-4	Bedded Sandstone, Shale	Clay Loam	2-6	Till	100-300	91	111
7Aa40	30-50	4-7	Bedded Sandstone, Shale	Silty Loam	12-18	Till	100-300	114	124
7Aa41	15-30	4-7	Bedded Sandstone, Shale	Clay Loam	2-6	Till	100-300	123	143
7Aa42	15-30	4-7	Bedded Sandstone, Shale	Clay Loam	6-12	Till	100-300	119	131
7Aa43	30-50	4-7	Bedded Sandstone, Shale	Clay Loam	2-6	Till	100-300	113	133
7Aa44	30-50	4-7	Bedded Sandstone, Shale	Silty Loam	6-12	Till	100-300	111	126
7Aa45	30-50	4-7	Bedded Sandstone, Shale	Clay Loam	6-12	Till	100-300	109	121
7Aa46	15-30	4-7	Bedded Sandstone, Shale	Nonshrinking and Nonaggregated Cl	0-2	Till	100-300	120	136
7Aa47	50-75	2-4	Bedded Sandstone, Shale	Silty Loam	12-18	Till	100-300	87	98
7Aa48	50-75	2-4	Bedded Sandstone, Shale	Sandy Loam	12-18	Till	100-300	96	112
7Aa49	50-75	2-4	Bedded Sandstone, Shale	Loam	6-12	Till	100-300	96	113
7Aa50	5-15	4-7	Bedded Sandstone, Shale	Clay Loam	2-6	Till	100-300	133	153
7Aa51	15-30	4-7	Bedded Sandstone, Shale	Clay Loam	0-2	Till	100-300	124	146
7Aa52	15-30	4-7	Bedded Sandstone, Shale	Clay Loam	2-6	Interbedded sst & sh	100-300	123	143
7Aa53	30-50	4-7	Bedded Sandstone, Shale	Clay Loam	2-6	Till	100-300	108	129
7Aa54	50-75	2-4	Bedded Sandstone, Shale	Silty Loam	6-12	Till	100-300	84	100
7Aa55	15-30	4-7	Bedded Sandstone, Shale	Clay Loam	0-2	Till	100-300	119	142
7Aa56	50-75	2-4	Bedded Sandstone, Shale	Clay Loam	6-12	Interbedded sst & sh	100-300	92	103
7Aa57	30-50	4-7	Bedded Sandstone, Shale	Clay Loam	2-6	Interbedded sst & sh	100-300	118	137
7Aa58	5-15	4-7	Bedded Sandstone, Shale	Clay Loam	2-6	Till	100-300	128	149
7Aa59	5-15	4-7	Bedded Sandstone, Shale	Loam	0-2	Till	100-300	138	166
7Aa60	5-15	4-7	Bedded Sandstone, Shale	Silty Loam	0-2	Till	100-300	136	161
7Aa61	5-15	4-7	Bedded Sandstone, Shale	Clay Loam	0-2	Till	100-300	129	152
7Aa62	5-15	4-7	Bedded Sandstone, Shale	Sand	0-2	Till	100-300	146	186
7Aa63	30-50	4-7	Bedded Sandstone, Shale	Silty Loam	6-12	Till	100-300	106	122

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Aa64	15-30	4-7	Bedded Sandstone, Shale	Silty Loam	2-6	Till	100-300	120	144
7Aa65	0-5	7-10	Bedded Sandstone, Shale	Loam	0-2	Till	100-300	146	175
7Aa66	15-30	4-7	Bedded Sandstone, Shale	Silty Loam	0-2	Till	100-300	121	147
7Aa67	15-30	4-7	Bedded Sandstone, Shale	Sandy Loam	6-12	Till	100-300	125	146
7Aa68	5-15	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	6-12	Till	100-300	132	157
7Aa69	5-15	4-7	Bedded Sandstone, Shale	Loam	2-6	Till	100-300	132	159
7Aa70	15-30	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	0-2	Till	100-300	127	162
7Aa71	30-50	4-7	Bedded Sandstone, Shale	Sandy Loam	6-12	Till	100-300	115	136
7Aa72	30-50	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	6-12	Till	100-300	112	137
7Aa73	15-30	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	2-6	Till	100-300	126	159
7Aa74	15-30	4-7	Bedded Sandstone, Shale	Nonshrinking and Nonaggregated Cl	2-6	Till	100-300	114	129
7Aa75	30-50	4-7	Bedded Sandstone, Shale	Sandy Loam	6-12	Till	100-300	110	132
7Aa76	15-30	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	6-12	Till	100-300	122	147
7Aa77	50-75	2-4	Bedded Sandstone, Shale	Shrink/Swell Clay	2-6	Till	100-300	94	127
7Aa78	30-50	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	2-6	Till	100-300	116	149
7Aa79	15-30	4-7	Bedded Sandstone, Shale	Sandy Loam	2-6	Interbedded sst & sh	100-300	134	162
7Aa80	15-30	4-7	Bedded Sandstone, Shale	Sandy Loam	6-12	Interbedded sst & sh	100-300	130	150
7Aa81	30-50	4-7	Bedded Sandstone, Shale	Silty Loam	2-6	Till	100-300	110	134
7Aa82	5-15	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	0-2	Till	100-300	137	172
7Aa83	5-15	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	2-6	Till	100-300	136	169
7Aa84	5-15	4-7	Bedded Sandstone, Shale	Nonshrinking and Nonaggregated Cl	0-2	Till	100-300	125	142
7Aa85	30-50	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	0-2	Till	100-300	117	152
7Aa86	0-5	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	0-2	Till	100-300	147	181
7Aa87	30-50	4-7	Bedded Sandstone, Shale	Silty Loam	0-2	Till	100-300	116	141
7Aa88	30-50	4-7	Bedded Sandstone, Shale	Clay Loam	0-2	Till	100-300	114	136
7Aa89	15-30	4-7	Bedded Sandstone, Shale	Silty Loam	0-2	Till	100-300	126	151

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Aa90	15-30	4-7	Bedded Sandstone, Shale	Silty Loam	2-6	Till	100-300	125	148
7Aa91	5-15	4-7	Bedded Sandstone, Shale	Clay Loam	0-2	Till	100-300	134	156
7Aa92	50-75	2-4	Bedded Sandstone, Shale	Silty Loam	2-6	Till	100-300	93	116
7Aa93	30-50	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	2-6	Till	100-300	121	153
7Aa94	30-50	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	6-12	Till	100-300	117	141
7Aa95	15-30	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	2-6	Till	100-300	131	163
7Aa96	15-30	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	6-12	Till	100-300	127	151
7Aa97	5-15	4-7	Bedded Sandstone, Shale	Shrink/Swell Clay	2-6	Till	100-300	141	173
7Aa98	5-15	7-10	Bedded Sandstone, Shale	Peat	0-2	Silt/Clay	100-300	157	193
7Aa99	15-30	4-7	Bedded Sandstone, Shale	Silty Loam	6-12	Till	100-300	121	136
7Aa100	5-15	4-7	Bedded Sandstone, Shale	Nonshrinking and Nonaggregated Cl	0-2	Till	100-300	130	146
7Aa101	75-100	0-2	Bedded Sandstone, Shale	Silty Loam	6-12	Till	100-300	71	87



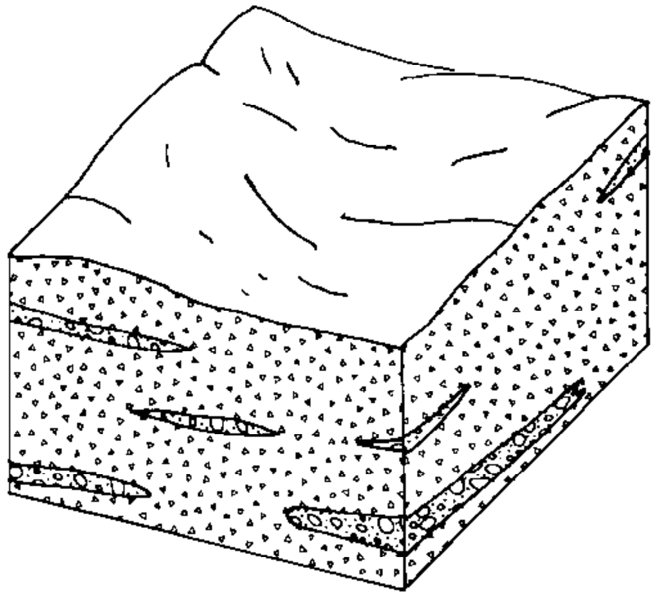
7Ad Glacial Till over Sandstone

This hydrogeologic setting is characterized by moderate to high relief. The topography varies from rolling hills to very prominent ridges, comprised of relatively flat-lying, resistant sandstones. The sandstones are generally fine-grained; their permeability largely reflects their highly-fractured nature and the frequency of bedding planes. Cemented conglomeratic zones are common in the Sharon Sandstone. The Sharon Sandstone and Massillon Sandstone create the steep-sided ridges and ledges. The Massillon Sandstone has a more clayey matrix than the Sharon Sandstone and generally yields less water than the Sharon. The Homewood Sandstone is typically thin and may be shaley, and is suitable for only small, domestic wells. The Berea Sandstone is usually encountered at depths over 100 feet, and may be contaminated by gas and brine south of Ravenna. The sandstone is overlain by varying thicknesses of glacial till. The till is basically an unsorted deposit containing sand and gravel lenses. Although ground water occurs in both the glacial deposits and in the intersecting bedrock fractures, the bedrock is the principal aquifer. The glacial till serves as a source of recharge to the underlying bedrock. Although precipitation is abundant in most of the region, recharge is moderate due to the compactness of the overlying till and the high runoff associated with steep slopes. Depth is highly variable depending upon (1) which particular sandstone aquifer is being used, (2) whether the well is located along the crest of a ridge, or along the valley side, and (3) the thickness of the overlying glacial till. Depth to water is usually less than 40 feet for the Massillon, Homewood, and Sharon Sandstones and is typically over 75 feet for the Berea Sandstone.

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Ad1	50-75	2-4	Sandstone	Clay Loam	2-6	Till	100-300	86	107
7Ad2	30-50	4-7	Sandstone	Clay Loam	2-6	Till	100-300	108	129
7Ad3	75-100	2-4	Sandstone	Clay Loam	0-2	Till	100-300	77	101
7Ad4	30-50	4-7	Sandstone	Loam	6-12	Till	100-300	108	127

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Ad5	15-30	4-7	Sandstone	Loam	2-6	Till	100-300	132	157
7Ad6	5-15	7-10	Sandstone	Sandy Loam	0-2	Sd&Gvl w/Sl&Cl	100-300	158	187
7Ad7	15-30	4-7	Sandstone	Clay Loam	6-12	Till	100-300	124	135
7Ad8	15-30	4-7	Sandstone	Clay Loam	2-6	Till	100-300	118	139
7Ad9	30-50	4-7	Sandstone	Clay Loam	0-2	Till	100-300	109	132
7Ad10	30-50	4-7	Sandstone	Clay Loam	6-12	Till	100-300	104	117
7Ad11	50-75	2-4	Sandstone	Clay Loam	6-12	Till	100-300	82	95
7Ad12	50-75	2-4	Sandstone	Clay Loam	0-2	Till	100-300	87	110
7Ad13	30-50	4-7	Sandstone	Clay Loam	2-6	Sandstone	300-700	124	141
7Ad14	15-30	4-7	Sandstone	Clay Loam	0-2	Till	300-700	125	146
7Ad15	30-50	4-7	Sandstone	Clay Loam	2-6	Till	300-700	114	133
7Ad16	50-75	2-4	Sandstone	Silty Loam	2-6	Till	300-700	94	116
7Ad17	15-30	4-7	Sandstone	Clay Loam	2-6	Till	300-700	124	143
7Ad18	5-15	4-7	Sandstone	Clay Loam	0-2	Till	300-700	135	156
7Ad19	15-30	4-7	Sandstone	Nonshrinking & Nonaggregated Cl	0-2	Till	300-700	121	136
7Ad20	15-30	4-7	Sandstone	Clay Loam	0-2	Till	100-300	119	142
7Ad21	15-30	4-7	Sandstone	Silty Loam	6-12	Till	100-300	126	140
7Ad22	30-50	4-7	Sandstone	Silty Loam	6-12	Sandstone	100-300	116	130
7Ad23	30-50	2-4	Sandstone	Clay Loam	12-18	Till	100-300	90	99
7Ad24	15-30	4-7	Sandstone	Loam	2-6	Sandstone	300-700	138	161
7Ad25	30-50	4-7	Sandstone	Clay Loam	2-6	Till	100-300	118	137
7Ad26	15-30	4-7	Sandstone	Clay Loam	2-6	Till	100-300	128	147
7Ad27	30-50	4-7	Sandstone	Sandy Loam	12-18	Till	300-700	124	138
7Ad28	50-75	2-4	Sandstone	Silty Loam	2-6	Till	300-700	104	124
7Ad29	15-30	4-7	Sandstone	Nonshrinking & Nonaggregated Cl	0-2	Till	300-700	121	136
7Ad30	30-50	4-7	Sandstone	Clay Loam	6-12	Till	300-700	110	121
7Ad31	50-75	2-4	Sandstone	Clay Loam	2-6	Till	300-700	92	111
7Ad32	75-100	2-4	Sandstone	Clay Loam	2-6	Till	300-700	82	102
7Ad33	15-30	4-7	Sandstone	Silty Loam	12-18	Till	100-300	124	134
7Ad34	15-30	4-7	Sandstone	Silty Loam	2-6	Till	100-300	130	152
7Ad35	15-30	4-7	Sandstone	Clay Loam	0-2	Till	1-100	116	140
7Ad36	30-50	4-7	Sandstone	Silty Loam	12-18	Till	300-700	120	128
7Ad37	15-30	4-7	Sandstone	Clay Loam	2-6	Till	100-300	118	139
7Ad38	15-30	4-7	Sandstone	Silty Loam	2-6	Till	100-300	125	148
7Ad39	30-50	4-7	Sandstone	Silty Loam	2-6	Till	100-300	120	142
7Ad40	15-30	4-7	Sandstone	Sandy Loam	12-18	Till	300-700	129	144
7Ad41	15-30	4-7	Sandstone	Silty Loam	18+	Sandstone	300-700	128	132
7Ad42	15-30	4-7	Sandstone	Silty Loam	2-6	Till	300-700	131	152

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Ad43	75-100	2-4	Sandstone	Silty Loam	2-6	Till	300-700	84	107
7Ad44	50-75	2-4	Bedded Sandstone, Shale	Clay Loam	6-12	Till	300-700	88	99
7Ad45	50-75	2-4	Bedded Sandstone, Shale	Silty Loam	6-12	Till	300-700	90	104
7Ad46	5-15	4-7	Sandstone	Loam	0-2	Till	300-700	144	170
7Ad47	15-30	4-7	Sandstone	Clay Loam	0-2	Till	300-700	130	150
7Ad48	30-50	4-7	Sandstone	Sandy Loam	2-6	Sandstone	300-700	130	156
7Ad49	30-50	4-7	Sandstone	Silty Loam	2-6	Till	300-700	116	138
7Ad50	15-30	4-7	Sandstone	Silty Loam	2-6	Till	300-700	126	148
7Ad51	15-30	4-7	Sandstone	Sandy Loam	6-12	Till	300-700	131	150
7Ad52	30-50	4-7	Sandstone	Sandy Loam	2-6	Till	300-700	120	148
7Ad53	75-100	2-4	Sandstone	Clay Loam	2-6	Till	300-700	87	106
7Ad54	30-50	4-7	Sandstone	Clay Loam	2-6	Till	300-700	114	133
7Ad55	30-50	4-7	Sandstone	Clay Loam	0-2	Till	300-700	120	140
7Ad56	15-30	4-7	Sandstone	Loam	2-6	Till	300-700	128	153
7Ad57	15-30	4-7	Sandstone	Clay Loam	6-12	Till	300-700	120	131
7Ad58	5-15	4-7	Sandstone	Nonshrinking & Nonaggregated Cl	0-2	Till	300-700	131	146
7Ad59	15-30	4-7	Sandstone	Nonshrinking & Nonaggregated Cl	0-2	Till	100-300	115	132
7Ad60	5-15	4-7	Sandstone	Clay Loam	0-2	Till	100-300	129	152
7Ad61	15-30	4-7	Sandstone	Nonshrinking & Nonaggregated Cl	0-2	Till	300-700	121	136
7Ad62	0-5	4-7	Sandstone	Clay Loam	0-2	Till	300-700	140	161
7Ad63	0-5	4-7	Sandstone	Nonshrinking & Nonaggregated Cl	0-2	Till	300-700	136	151
7Ad64	5-15	4-7	Sandstone	Loam	0-2	Till	300-700	139	166
7Ad65	5-15	4-7	Sandstone	Shrink/Swell Clay	0-2	Till	300-700	143	176
7Ad66	15-30	4-7	Sandstone	Shrink/Swell Clay	2-6	Till	100-300	131	163
7Ad67	5-15	4-7	Bedded Sandstone, Shale	Clay Loam	0-2	Till	100-300	134	156



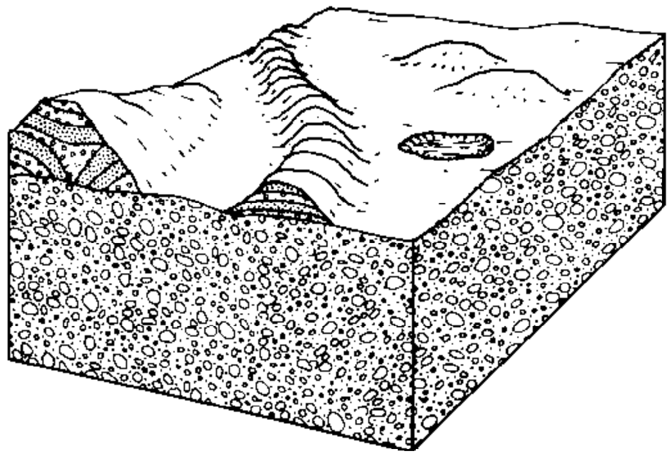
7Af Sand and Gravel Interbedded in Glacial Till

This hydrogeologic setting is characterized by moderate relief in eastern and central Portage County and by rolling, hummocky topography within areas of end moraines. The Hiram and Lavery Tills are primarily unsorted silt and clay with minor amounts of sand and gravel. Soils are typically clay loams. The Kent Till and Mogadore/Titusville Till are much sandier and contain more sand and gravel lenses. Soils are typically silt loams or loams. Ground water occurs in both the till and sand and gravel deposits; however, the sand and gravel serves as the principal aquifer. The sand and gravel may exist as relatively thin and discontinuous lens-shaped bodies, or as thick lenses or sheets that cover a large area. These units are sometimes confined to common horizons within the till. Areas containing appreciable amounts of sand and gravel within the till generally are located adjacent to buried valleys or are adjacent to the outwash and kame deposits in southwestern Portage County. Recharge is from percolation through the till and is highly dependent upon fracturing and the amount of sand and gravel above the zone of saturation. Depth to the water table is highly variable, but usually ranges between 30 to 50 feet.

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Af1	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Till	300-700	143	163
7Af2	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	300-700	133	153
7Af3	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	300-700	138	157
7Af4	30-50	4-7	Sand and Gravel	Clay Loam	2-6	Till	300-700	127	144

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Af5	15-30	4-7	Sand and Gravel	Clay Loam	2-6	Till	300-700	137	154
7Af6	15-30	4-7	Sand and Gravel	Clay Loam	2-6	Till	100-300	123	143
7Af7	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	139	164
7Af8	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	124	146
7Af9	30-50	4-7	Sand and Gravel	Clay Loam	2-6	Till	100-300	113	133
7Af10	5-15	4-7	Sand and Gravel	Shrink/Swell Clay	0-2	Till	100-300	142	176
7Af11	5-15	4-7	Sand and Gravel	Nonshrinking and Nonaggregated Cl	0-2	Till	100-300	130	146
7Af12	50-75	2-4	Sand and Gravel	Clay Loam	2-6	Till	100-300	91	111
7Af13	50-75	2-4	Sand and Gravel	Clay Loam	2-6	Till	100-300	99	118
7Af14	30-50	4-7	Sand and Gravel	Clay Loam	2-6	Till	100-300	118	137
7Af15	15-30	4-7	Sand and Gravel	Clay Loam	2-6	Till	100-300	128	147
7Af16	15-30	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	131	155
7Af17	15-30	4-7	Sand and Gravel	Loam	0-2	Till	100-300	133	160
7Af18	30-50	4-7	Sand and Gravel	Silty Loam	2-6	Till	100-300	120	142
7Af19	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	126	149
7Af20	5-15	4-7	Sand and Gravel	Nonshrinking and Nonaggregated Cl	0-2	Till	100-300	122	139
7Af21	15-30	4-7	Sand and Gravel	Shrinking and/or Aggregated Clay	0-2	Till	300-700	133	166
7Af22	15-30	4-7	Sand and Gravel	Silty Loam	2-6	Till	100-300	122	145
7Af23	15-30	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	123	148
7Af24	15-30	4-7	Sand and Gravel	Clay Loam	2-6	Till	300-700	129	147
7Af25	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	124	146
7Af26	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	119	142
7Af27	15-30	4-7	Sand and Gravel	Nonshrinking and Nonaggregated Cl	0-2	Till	100-300	120	136
7Af28	15-30	4-7	Sand and	Shrink/Swell	0-2	Till	100-300	132	166

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
			Gravel	Clay					
7Af29	30-50	4-7	Sand and Gravel	Shrink/Swell Clay	2-6	Till	100-300	121	153
7Af30	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	141	165



7Ba Outwash

This hydrogeologic setting is characterized by the rolling, hummocky, "kame and kettle" topography primarily associated with the Kent Kame Complex and Kent Moraine. Outwash deposits include ice-contact-derived kames, depressional kettles and bogs, outwash plains, and channeled outwash valley trains associated with the stagnation of the Late Wisconsinan Kent Till. These outwash deposits overlie older, interlobate deposits. Outwash deposits typically overlie buried valleys; in some areas they overlie fractured sedimentary rocks. These deposits contain varying amounts of till and finer silty deposits, which may somewhat impede recharge. Sands and gravels serve as the aquifer; the nature and extent of such units is highly variable. Recharge is moderate to high and soils are typically loams or sandy loams with peat or clay occurring in the depressions and kettles. Water levels are highly variable but generally range between 20 and 40 feet. The depth to water is greater for the more prominent kames and is usually shallower near kettles. These deposits may be in direct hydraulic connection with underlying, fractured bedrock.

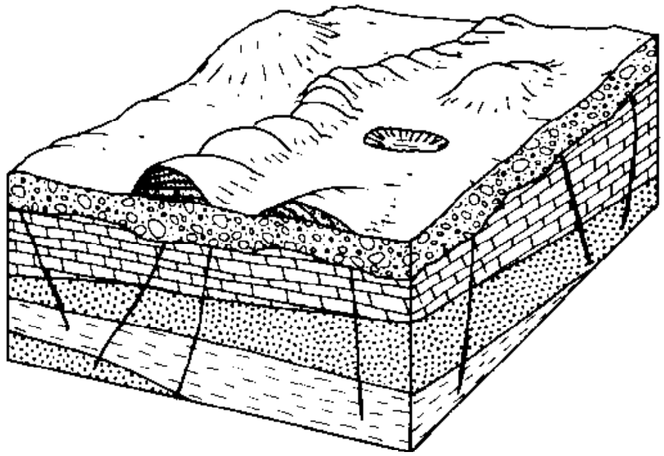
Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Ba1	15-30	7-10	Sand and Gravel	Sand	2-6	Sd&Gvl w/Sl&Cl	700-1000	168	200
7Ba2	5-15	7-10	Sand and Gravel	Muck	0-2	Sd&Gvl w/Sl&Cl	1000-2000	174	185
7Ba3	5-15	7-10	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	1000-2000	180	200
7Ba4	15-30	7-10	Sand and Gravel	Sandy Loam	2-6	Sd&Gvl w/Sl&Cl	700-1000	162	185
7Ba5	30-50	4-7	Sand and Gravel	Loam	2-6	Sd&Gvl w/Sl&Cl	700-1000	142	162
7Ba6	30-50	4-7	Sand and Gravel	Clay Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	139	155
7Ba7	30-50	4-7	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	700-1000	149	180
7Ba8	30-50	4-7	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	143	165
7Ba9	30-50	4-7	Sand and Gravel	Silty Loam	2-6	Sd&Gvl w/Sl&Cl	700-1000	140	157
7Ba10	15-30	7-10	Sand and Gravel	Loam	2-6	Sd&Gvl w/Sl&Cl	1000-2000	169	187

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Ba11	15-30	4-7	Sand and Gravel	Silty Loam	2-6	Sd&Gvl w/Sl&Cl	700-1000	150	167
7Ba12	5-15	7-10	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	700-1000	177	208
7Ba13	15-30	7-10	Sand and Gravel	Silty Loam	2-6	Sd&Gvl w/Sl&Cl	700-1000	158	175
7Ba14	15-30	7-10	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	1000-2000	176	205
7Ba15	5-15	7-10	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	174	196
7Ba16	15-30	7-10	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	1000-2000	170	190
7Ba17	15-30	4-7	Sand and Gravel	Silty Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	154	173
7Ba18	30-50	4-7	Sand and Gravel	Silty Loam	2-6	Sd&Gvl w/Sl&Cl	700-1000	143	160
7Ba19	15-30	4-7	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	1000-2000	168	197
7Ba20	15-30	7-10	Sand and Gravel	Clay Loam	0-2	Till	700-1000	152	169
7Ba21	5-15	7-10	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	166	189
7Ba22	15-30	4-7	Sand and Gravel	Loam	0-2	Till	700-1000	148	171
7Ba23	30-50	4-7	Sand and Gravel	Loam	2-6	Till	700-1000	137	158
7Ba24	30-50	4-7	Sand and Gravel	Loam	0-2	Till	700-1000	138	161
7Ba25	30-50	4-7	Sand and Gravel	Silty Loam	2-6	Till	700-1000	135	153
7Ba26	30-50	4-7	Sand and Gravel	Loam	2-6	Till	700-1000	137	158
7Ba27	5-15	7-10	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	700-1000	172	204
7Ba28	15-30	4-7	Sand and Gravel	Silty Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	146	166
7Ba29	5-15	7-10	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	1000-2000	186	215
7Ba30	5-15	7-10	Sand and Gravel	Clay Loam	0-2	Sd&Gvl w/Sl&Cl	1000-2000	176	190
7Ba31	15-30	4-7	Sand and Gravel	Loam	2-6	Sd&Gvl w/Sl&Cl	700-1000	155	175
7Ba32	30-50	4-7	Sand and Gravel	Loam	2-6	Sd&Gvl w/Sl&Cl	700-1000	145	165
7Ba33	30-50	4-7	Sand and Gravel	Loam	6-12	Till	700-1000	133	146
7Ba34	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Till	300-700	150	172
7Ba35	5-15	4-7	Sand and Gravel	Loam	0-2	Till	300-700	152	177
7Ba36	15-30	4-7	Sand and Gravel	Loam	0-2	Till	300-700	142	167
7Ba37	15-30	4-7	Sand and Gravel	Silty Loam	0-2	Till	300-700	140	162
7Ba38	15-30	4-7	Sand and Gravel	Silty Loam	2-6	Till	300-700	139	159
7Ba39	30-50	4-7	Sand and Gravel	Silty Loam	2-6	Till	300-700	129	149
7Ba40	15-30	4-7	Sand and Gravel	Peat	0-2	Till	700-1000	154	186

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Ba41	15-30	4-7	Sand and Gravel	Loam	6-12	Till	700-1000	143	156
7Ba42	5-15	4-7	Sand and Gravel	Loam	0-2	Till	700-1000	158	181
7Ba43	30-50	4-7	Sand and Gravel	Silty Loam	6-12	Till	700-1000	131	141
7Ba44	50-75	2-4	Sand and Gravel	Sandy Loam	2-6	Till	700-1000	117	141
7Ba45	75-100	2-4	Sand and Gravel	Sandy Loam	2-6	Till	700-1000	107	132
7Ba46	50-75	2-4	Sand and Gravel	Loam	6-12	Till	700-1000	111	124
7Ba47	75-100	2-4	Sand and Gravel	Loam	6-12	Till	700-1000	101	115
7Ba48	75-100	2-4	Sand and Gravel	Sandy Loam	12-18	Till	700-1000	101	114
7Ba49	50-75	2-4	Sand and Gravel	Sandy Loam	12-18	Till	700-1000	111	123
7Ba50	5-15	7-10	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	300-700	171	204
7Ba51	5-15	7-10	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	300-700	165	189
7Ba52	5-15	7-10	Sand and Gravel	Silty Loam	0-2	Sd&Gvl w/Sl&Cl	300-700	163	184
7Ba53	30-50	4-7	Sand and Gravel	Silty Loam	0-2	Till	700-1000	136	156
7Ba54	50-75	2-4	Sand and Gravel	Sandy Loam	6-12	Till	700-1000	113	129
7Ba55	30-50	4-7	Sand and Gravel	Peat	0-2	Till	700-1000	144	176
7Ba56	30-50	4-7	Sand and Gravel	Loam	0-2	Till	700-1000	141	164
7Ba57	15-30	4-7	Sand and Gravel	Loam	0-2	Till	700-1000	151	174
7Ba58	15-30	4-7	Sand and Gravel	Loam	2-6	Till	300-700	141	164
7Ba59	15-30	4-7	Sand and Gravel	Sandy Loam	2-6	Sd&Gvl w/Sl&Cl	300-700	148	173
7Ba60	30-50	4-7	Sand and Gravel	Loam	2-6	Till	300-700	131	154
7Ba61	50-75	2-4	Sand and Gravel	Loam	2-6	Till	300-700	109	132
7Ba62	30-50	4-7	Sand and Gravel	Loam	6-12	Till	300-700	127	142
7Ba63	50-75	2-4	Sand and Gravel	Loam	6-12	Till	300-700	100	116
7Ba64	30-50	4-7	Sand and Gravel	Peat	0-2	Till	300-700	138	172
7Ba65	15-30	4-7	Sand and Gravel	Muck	0-2	Till	300-700	136	152
7Ba66	15-30	4-7	Sand and Gravel	Peat	0-2	Till	300-700	148	182
7Ba67	5-15	4-7	Sand and Gravel	Peat	0-2	Till	300-700	158	192
7Ba68	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	300-700	138	157
7Ba69	15-30	4-7	Sand and Gravel	Loam	2-6	Till	100-300	135	160
7Ba70	15-30	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	134	158

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Ba71	15-30	4-7	Sand and Gravel	Silty Loam	2-6	Till	100-300	133	155
7Ba72	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	132	153
7Ba73	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	142	163
7Ba74	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	144	168
7Ba75	5-15	4-7	Sand and Gravel	Loam	0-2	Till	100-300	146	173
7Ba76	30-50	4-7	Sand and Gravel	Loam	6-12	Till	100-300	121	138
7Ba77	50-75	2-4	Sand and Gravel	Loam	2-6	Till	100-300	103	128
7Ba78	30-50	4-7	Sand and Gravel	Silty Loam	2-6	Till	100-300	123	145
7Ba79	5-15	4-7	Sand and Gravel	Peat	0-2	Till	100-300	152	188
7Ba80	15-30	4-7	Sand and Gravel	Peat	0-2	Till	100-300	142	178
7Ba82	30-50	4-7	Sand and Gravel	Loam	0-2	Till	300-700	132	157
7Ba83	15-30	4-7	Sand and Gravel	Loam	6-12	Till	100-300	131	148
7Ba84	15-30	4-7	Sand and Gravel	Loam	2-6	Till	100-300	135	160
7Ba85	30-50	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	121	145
7Ba86	15-30	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	131	155
7Ba87	15-30	4-7	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	700-1000	162	193
7Ba88	5-15	7-10	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	700-1000	180	211
7Ba89	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	152	168
7Ba90	15-30	4-7	Sand and Gravel	Silty Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	151	170
7Ba91	30-50	4-7	Sand and Gravel	Sandy Loam	6-12	Sd&Gvl w/Sl&Cl	1000-2000	149	162
7Ba92	15-30	7-10	Sand and Gravel	Sandy Loam	2-6	Sd&Gvl w/Sl&Cl	1000-2000	171	192
7Ba93	5-15	4-7	Sand and Gravel	Loam	0-2	Till	100-300	143	170
7Ba94	30-50	4-7	Sand and Gravel	Loam	2-6	Till	100-300	125	150
7Ba95	30-50	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	122	143
7Ba96	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	139	160
7Ba97	15-30	4-7	Sand and Gravel	Loam	2-6	Till	100-300	132	157
7Ba98	5-15	4-7	Sand and Gravel	Loam	2-6	Till	100-300	142	167
7Ba99	15-30	4-7	Sand and Gravel	Silty Loam	2-6	Till	100-300	130	152
7Ba100	15-30	4-7	Sand and Gravel	Loam	6-12	Till	300-700	137	152
7Ba101	30-50	4-7	Sand and Gravel	Loam	2-6	Till	100-300	122	147

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Ba102	15-30	4-7	Sand and Gravel	Sandy Loam	0-2	Till	700-1000	150	176
7Ba103	5-15	7-10	Sand and Gravel	Sandy Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	176	201
7Ba104	15-30	10+	Sand and Gravel	Gravel	2-6	Sand and Gravel	1000-2000	196	227
7Ba105	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	700-1000	134	153
7Ba106	30-50	4-7	Sand and Gravel	Clay Loam	0-2	Till	700-1000	124	143
7Ba107	5-15	4-7	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	700-1000	164	196
7Ba108	15-30	4-7	Sand and Gravel	Clay Loam	2-6	Till	300-700	127	146
7Ba109	30-50	4-7	Sand and Gravel	Loam	2-6	Till	300-700	121	146
7Ba110	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	154	171
7Ba111	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	161	180
7Ba112	15-30	4-7	Sand and Gravel	Loam	6-12	Till	700-1000	143	156
7Ba113	15-30	10+	Sand and Gravel	Clay Loam	0-2	Sand and Gravel	1000-2000	183	195
7Ba114	15-30	10+	Sand and Gravel	Loam	2-6	Sand and Gravel	1000-2000	186	202
7Ba115	15-30	7-10	Sand and Gravel	Nonshrinking and Nonaggregated Cl	0-2	Sand and Gravel	1000-2000	170	177
7Ba116	5-15	10+	Sand and Gravel	Loam	0-2	Sand and Gravel	1000-2000	197	215
7Ba117	5-15	4-7	Sand and Gravel	Nonshrinking and Nonaggregated Cl	0-2	Till	100-300	138	153

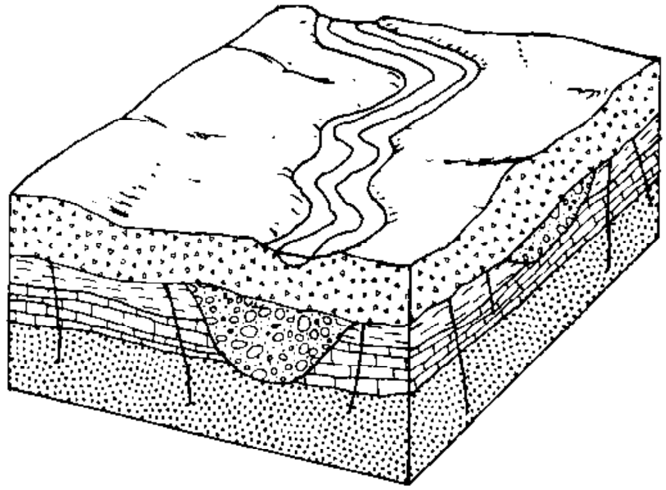


7Bb Outwash Over Bedded Sedimentary Rocks

This hydrogeologic setting is characterized by low to moderate relief and overlies fractured sandstone or interbedded sandstone and shale sequences. Deposits include both valley train outwash as well as kame fields. The outwash is composed of sand and gravel and includes some incorporated zones of till. The sands and gravels in this setting are generally not as coarse, clean, or as well sorted as those in the 7Ba Outwash setting. The depth to bedrock is also much shallower than in the 7D Buried Valley setting. Where the outwash deposits fine appreciably, a number of the wells may be developed in the underlying bedrock. Depth to water varies considerably with the high relief areas possessing greater depths to water and flat-lying stream valleys having shallow depths to water. Recharge is moderate and depends upon the amount of till cover. Soils range from clay loam to loam depending upon the thickness and nature of the till cover. These deposits may be in direct hydrologic connection with the underlying bedrock.

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Bb1	5-15	4-7	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	100-300	146	173
7Bb2	15-30	4-7	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	100-300	136	163
7Bb3	30-50	4-7	Sand and Gravel	Loam	2-6	Sd&Gvl w/Sl&Cl	100-300	125	150
7Bb4	30-50	4-7	Sand and Gravel	Clay Loam	6-12	Till	100-300	104	117
7Bb5	50-75	2-4	Sand and Gravel	Clay Loam	6-12	Till	100-300	82	95
7Bb6	75-100	2-4	Sand and Gravel	Clay Loam	2-6	Till	100-300	76	98
7Bb7	50-75	2-4	Sand and Gravel	Clay Loam	6-12	Till	300-700	91	102
7Bb8	50-75	2-4	Sand and Gravel	Loam	2-6	Till	300-700	104	128
7Bb9	30-50	4-7	Sand and Gravel	Loam	6-12	Till	300-700	127	142
7Bb10	15-30	4-7	Sand and Gravel	Silty Loam	0-2	Till	300-700	140	162

7Bb11	5-15	4-7	Sand and Gravel	Loam	6-12	Till	300-700	147	162
7Bb12	15-30	4-7	Sand and Gravel	Loam	2-6	Sd&Gvl w/Sl&Cl	300-700	146	168
7Bb13	15-30	10+	Sand and Gravel	Gravel	0-2	Sand and Gravel	1000-2000	189	223
7Bb14	15-30	4-7	Sand and Gravel	Loam	6-12	Till	300-700	137	152
7Bb15	15-30	4-7	Sand and Gravel	Loam	2-6	Sd&Gvl w/Sl&Cl	100-300	132	157
7Bb16	30-50	4-7	Sand and Gravel	Loam	2-6	Till	100-300	122	147



7D Buried Valley

This hydrogeologic setting is characterized by sand and gravel that has been deposited in a former topographic low (usually a pre-glacial or inter-glacial river valley) by glacial meltwaters. These outwash (valley train) deposits are capable of yielding large quantities of ground water. Commonly, the more continuous, thicker sands and gravels are located within the main "trunk" valleys; sands and gravels along valley margins and in tributary valleys may not be as productive. These deposits typically underlie present-day rivers; however, the degree of hydraulic connection between streams and the underlying aquifers is highly variable. Surficial sand and gravel outwash and ice-contact (kame) deposits associated with the Late Wisconsinan glaciations overlie major portions of the buried valleys, especially in southeastern Portage County. Recent alluvium, peat- and muck-filled bogs, and glacial till comprise the surficial cover overlying buried valleys elsewhere in Portage County. Usually, less permeable glacial till and lacustrine clays and silts separate the surficial deposits from the underlying sand and gravel aquifers in northern Portage County. In southwestern and central Portage County, soils and overlying deposits are more permeable and recharge is higher. These sand and gravel aquifers tend to be several times more permeable then the surrounding bedrock. Recharge within the buried valley setting is generally higher than in the surrounding till and bedrock uplands. Depth to water can be variable, but is usually within 40 feet of the surface and is often less then 15 feet, especially in the areas near bogs and modern streams.

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7D1	30-50	4-7	Sand and Gravel	Loam	2-6	Sd&Gvl w/Sl&Cl	1000-2000	151	169
7D2	15-30	4-7	Sand and Gravel	Loam	2-6	Sd&Gvl w/Sl&Cl	1000-2000	161	179
7D3	5-15	7-10	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	1000-2000	180	200
7D4	15-30	4-7	Sand and Gravel	Loam	0-2	Till	700-1000	151	174
7D5	5-15	4-7	Sand and Gravel	Loam	0-2	Till	700-1000	161	184
7D6	15-30	4-7	Sand and Gravel	Silty Loam	0-2	Till	700-1000	149	169
7D7	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Till	700-1000	159	179

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7D8	5-15	4-7	Sand and Gravel	Muck	0-2	Till	700-1000	155	169
7D9	30-50	4-7	Sand and Gravel	Loam	0-2	Till	700-1000	141	164
7D10	50-75	2-4	Sand and Gravel	Loam	0-2	Till	700-1000	119	142
7D11	75-100	2-4	Sand and Gravel	Sandy Loam	6-12	Till	700-1000	106	123
7D12	5-15	7-10	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	174	196
7D13	5-15	7-10	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	700-1000	180	211
7D14	5-15	7-10	Sand and Gravel	Silty Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	172	191
7D15	15-30	4-7	Sand and Gravel	Silty Loam	0-2	Sd&Gvl w/Sl&Cl	1000-2000	160	177
7D16	15-30	7-10	Sand and Gravel	Loam	2-6	Sd&Gvl w/Sl&Cl	1000-2000	169	187
7D17	30-50	4-7	Sand and Gravel	Sandy Loam	6-12	Sd&Gvl w/Sl&Cl	1000-2000	149	162
7D18	15-30	7-10	Sand and Gravel	Sandy Loam	2-6	Sd&Gvl w/Sl&Cl	1000-2000	171	192
7D19	15-30	7-10	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	1000-2000	176	205
7D20	5-15	7-10	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	1000-2000	186	215
7D21	15-30	4-7	Sand and Gravel	Loam	6-12	Till	1000-2000	152	163
7D22	30-50	4-7	Sand and Gravel	Loam	6-12	Till	1000-2000	142	153
7D23	30-50	4-7	Sand and Gravel	Peat	0-2	Till	1000-2000	153	183
7D24	50-75	2-4	Sand and Gravel	Loam	6-12	Till	1000-2000	120	131
7D25	50-75	2-4	Sand and Gravel	Loam	12-18	Till	1000-2000	118	125
7D26	15-30	4-7	Sand and Gravel	Silty Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	146	166
7D27	5-15	4-7	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	700-1000	164	196
7D28	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	144	161
7D29	5-15	7-10	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	700-1000	172	204
7D30	5-15	7-10	Sand and Gravel	Silty Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	164	184
7D31	15-30	4-7	Sand and Gravel	Clay Loam	2-6	Till	700-1000	138	154
7D32	15-30	4-7	Sand and Gravel	Shrink/Swell Clay	0-2	Till	300-700	141	173
7D33	30-50	4-7	Sand and Gravel	Clay Loam	2-6	Till	300-700	122	140
7D34	15-30	4-7	Sand and Gravel	Clay Loam	2-6	Till	300-700	132	150
7D35	5-15	7-10	Sand and Gravel	Sandy Loam	0-2	Sd&Gvl w/Sl&Cl	300-700	162	190
7D36	5-15	4-7	Sand and Gravel	Shrink/Swell Clay	0-2	Till	300-700	151	183
7D37	15-30	7-10	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	156	179
7D38	5-15	7-10	Sand and Gravel	Silty Loam	0-2	Sd&Gvl w/Sl&Cl	300-700	158	180
7D39	15-30	4-7	Sand and Gravel	Silty Loam	2-6	Till	300-700	139	159

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7D40	15-30	4-7	Sand and Gravel	Loam	2-6	Till	300-700	141	164
7D41	5-15	4-7	Sand and Gravel	Nonshrinking and Nonaggregated Cl	0-2	Till	300-700	139	153
7D42	15-30	4-7	Sand and Gravel	Silty Loam	0-2	Till	300-700	140	162
7D43	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Till	300-700	145	168
7D44	5-15	4-7	Sand and Gravel	Peat	0-2	Till	300-700	153	188
7D45	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Till	300-700	150	172
7D46	15-30	4-7	Sand and Gravel	Sandy Loam	2-6	Sd&Gvl w/Sl&Cl	700-1000	157	180
7D47	30-50	4-7	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	146	168
7D48	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	162	178
7D49	15-30	4-7	Sand and Gravel	Loam	0-2	Till	300-700	142	167
7D50	30-50	4-7	Sand and Gravel	Silty Loam	0-2	Till	300-700	130	152
7D51	5-15	7-10	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	300-700	160	185
7D52	15-30	7-10	Sand and Gravel	Peat	0-2	Till	300-700	156	190
7D53	30-50	4-7	Sand and Gravel	Silty Loam	2-6	Till	300-700	129	149
7D54	30-50	4-7	Sand and Gravel	Silty Loam	6-12	Till	300-700	125	137
7D55	15-30	4-7	Sand and Gravel	Clay Loam	2-6	Till	300-700	137	154
7D56	5-15	4-7	Sand and Gravel	Peat	0-2	Till	300-700	158	192
7D57	5-15	4-7	Sand and Gravel	Shrink/Swell Clay	0-2	Till	300-700	156	187
7D58	5-15	4-7	Sand and Gravel	Nonshrinking and Nonaggregated Cl	0-2	Till	300-700	144	157
7D60	15-30	4-7	Sand and Gravel	Silty Loam	2-6	Till	300-700	134	155
7D61	5-15	7-10	Sand and Gravel	Clay Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	170	186
7D62	15-30	4-7	Sand and Gravel	Shrink/Swell Clay	0-2	Sd&Gvl w/Sl&Cl	700-1000	155	184
7D63	15-30	4-7	Sand and Gravel	Nonshrinking and Nonaggregated Cl	0-2	Sd&Gvl w/Sl&Cl	700-1000	143	154
7D64	15-30	4-7	Sand and Gravel	Loam	2-6	Sd&Gvl w/Sl&Cl	700-1000	150	171
7D65	30-50	4-7	Sand and Gravel	Shrink/Swell Clay	0-2	Till	700-1000	140	170
7D66	15-30	4-7	Sand and Gravel	Shrink/Swell Clay	0-2	Till	700-1000	150	180
7D67	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Till	300-700	148	167
7D68	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	300-700	138	157
7D69	15-30	4-7	Sand and Gravel	Silty Loam	2-6	Till	700-1000	148	166
7D70	15-30	4-7	Sand and Gravel	Peat	0-2	Till	700-1000	157	189
7D71	5-15	4-7	Sand and Gravel	Peat	0-2	Till	700-1000	162	195

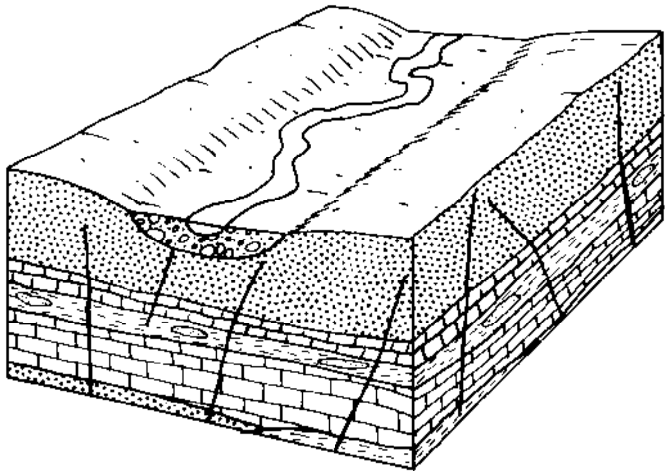
Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7D72	30-50	4-7	Sand and Gravel	Sandy Loam	6-12	Till	700-1000	138	154
7D73	30-50	4-7	Sand and Gravel	Loam	6-12	Till	700-1000	136	149
7D74	15-30	4-7	Sand and Gravel	Loam	6-12	Till	700-1000	146	159
7D75	15-30	4-7	Sand and Gravel	Loam	6-12	Till	300-700	137	152
7D76	30-50	4-7	Sand and Gravel	Loam	6-12	Till	300-700	127	142
7D77	5-15	4-7	Sand and Gravel	Loam	0-2	Till	300-700	152	177
7D78	30-50	4-7	Sand and Gravel	Loam	2-6	Till	700-1000	140	161
7D79	30-50	4-7	Sand and Gravel	Loam	2-6	Sd&Gvl w/Sl&Cl	2000+	160	176
7D80	15-30	4-7	Sand and Gravel	Loam	2-6	Sd&Gvl w/Sl&Cl	2000+	175	190
7D81	5-15	10+	Sand and Gravel	Loam	0-2	Sand and Gravel	2000+	198	215
7D82	5-15	10+	Sand and Gravel	Peat	0-2	Sand and Gravel	2000+	204	230
7D83	15-30	7-10	Sand and Gravel	Loam	0-2	Sand and Gravel	2000+	184	201
7D84	5-15	7-10	Sand and Gravel	Clay Loam	0-2	Sand and Gravel	2000+	190	201
7D85	30-50	4-7	Sand and Gravel	Loam	2-6	Till	300-700	131	154
7D86	5-15	7-10	Sand and Gravel	Sandy Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	176	201
7D87	15-30	4-7	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	156	178
7D88	15-30	4-7	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	700-1000	162	193
7D89	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	152	168
7D90	30-50	4-7	Sand and Gravel	Clay Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	142	158
7D91	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	300-700	128	149
7D92	30-50	4-7	Sand and Gravel	Clay Loam	0-2	Till	300-700	118	139
7D93	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Sd&Gvl w/Sl&Cl	300-700	143	163
7D94	15-30	4-7	Sand and Gravel	Clay Loam	6-12	Till	300-700	123	134
7D95	30-50	4-7	Sand and Gravel	Clay Loam	6-12	Till	300-700	113	124
7D96	30-50	4-7	Sand and Gravel	Sandy Loam	6-12	Till	300-700	124	143
7D97	15-30	4-7	Sand and Gravel	Clay Loam	2-6	Sd&Gvl w/Sl&Cl	700-1000	151	165
7D98	50-75	2-4	Sand and Gravel	Sandy Loam	6-12	Till	300-700	97	117
7D99	50-75	2-4	Sand and Gravel	Clay Loam	2-6	Till	300-700	95	114
7D100	75-100	2-4	Sand and Gravel	Clay Loam	2-6	Till	300-700	85	105
7D101	50-75	2-4	Sand and Gravel	Peat	0-2	Till	300-700	106	142
7D102	30-50	4-7	Sand and Gravel	Loam	0-2	Till	300-700	122	149
7D103	50-75	2-4	Sand and Gravel	Clay Loam	0-2	Till	300-700	96	117
7D104	75-100	2-4	Sand and Gravel	Peat	0-2	Till	300-700	96	133
7D105	75-100	2-4	Sand and Gravel	Clay Loam	0-2	Till	300-700	86	108
7D106	15-30	7-10	Sand and Gravel	Loam	0-2	Sand and Gravel	700-1000	169	190

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7D107	5-15	10+	Sand and Gravel	Loam	0-2	Sand and Gravel	700-1000	183	204
7D108	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Till	300-700	138	159
7D109	5-15	4-7	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	100-300	149	185
7D110	15-30	4-7	Sand and Gravel	Clay Loam	2-6	Till	100-300	118	139
7D111	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Sd&Gvl w/Sl&Cl	100-300	129	150
7D112	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	129	152
7D113	30-50	4-7	Sand and Gravel	Clay Loam	2-6	Till	100-300	108	129
7D114	15-30	4-7	Sand and Gravel	Peat	0-2	Till	300-700	143	178
7D115	15-30	4-7	Sand and Gravel	Clay Loam	6-12	Till	100-300	114	127
7D116	5-15	4-7	Sand and Gravel	Clay Loam	2-6	Till	100-300	128	149
7D117	5-15	4-7	Sand and Gravel	Nonshrinking and Nonaggregated Cl	0-2	Till	100-300	122	139
7D118	0-5	4-7	Sand and Gravel	Nonshrinking and Nonaggregated Cl	0-2	Till	100-300	127	144
7D119	0-5	7-10	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	100-300	159	195
7D120	0-5	7-10	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	100-300	153	180
7D121	0-5	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	131	154
7D122	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	126	149
7D123	5-15	4-7	Sand and Gravel	Clay Loam	2-6	Till	100-300	125	146
7D124	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	128	154
7D125	15-30	4-7	Sand and Gravel	Clay Loam	6-12	Till	100-300	111	124
7D126	30-50	4-7	Sand and Gravel	Clay Loam	2-6	Till	100-300	105	126
7D127	50-75	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	96	119
7D128	50-75	4-7	Sand and Gravel	Silty Loam	0-2	Till	300-700	113	137
7D129	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	116	139
7D130	15-30	4-7	Sand and Gravel	Peat	0-2	Sd&Gvl w/Sl&Cl	100-300	131	168
7D131	30-50	4-7	Sand and Gravel	Silty Loam	0-2	Till	300-700	123	147
7D132	5-15	7-10	Sand and Gravel	Gravel	0-2	Sd&Gvl w/Sl&Cl	700-1000	179	217
7D133	15-30	4-7	Sand and Gravel	Silty Loam	2-6	Till	300-700	132	154
7D134	5-15	7-10	Sand and Gravel	Loam	0-2	Silt/Clay	100-300	146	174
7D135	30-50	4-7	Sand and Gravel	Clay Loam	6-12	Till	100-300	104	117
7D136	50-75	2-4	Sand and Gravel	Clay Loam	2-6	Till	100-300	86	107
7D137	15-30	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	121	147
7D138	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	131	157
7D139	30-50	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	109	132

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7D140	5-15	4-7	Sand and Gravel	Nonshrinking and Nonaggregated Cl	0-2	Till	300-700	134	149
7D141	30-50	4-7	Sand and Gravel	Clay Loam	2-6	Till	100-300	111	132
7D142	15-30	4-7	Sand and Gravel	Clay Loam	2-6	Till	300-700	127	146
7D143	30-50	4-7	Sand and Gravel	Clay Loam	6-12	Till	700-1000	132	139
7D144	5-15	4-7	Sand and Gravel	Clay Loam	2-6	Till	700-1000	156	171
7D145	5-15	10+	Sand and Gravel	Silty Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	176	195
7D146	5-15	7-10	Sand and Gravel	Loam	2-6	Sand and Gravel	700-1000	178	197
7D147	5-15	7-10	Sand and Gravel	Loam	6-12	Sand and Gravel	700-1000	174	185
7D148	15-30	4-7	Sand and Gravel	Silty Loam	6-12	Till	300-700	130	143
7D149	15-30	4-7	Sand and Gravel	Sandy Loam	2-6	Till	300-700	136	164
7D150	5-15	7-10	Sand and Gravel	Sandy Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	171	197
7D151	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	300-700	131	152
7D152	30-50	4-7	Sand and Gravel	Clay Loam	0-2	Till	300-700	121	142
7D153	5-15	4-7	Sand and Gravel	Loam	0-2	Till	300-700	147	173
7D154	15-30	4-7	Sand and Gravel	Silty Loam	2-6	Till	100-300	130	152
7D155	5-15	4-7	Sand and Gravel	Loam	0-2	Till	100-300	138	166
7D156	5-15	4-7	Sand and Gravel	Peat	0-2	Silt/Clay	100-300	144	181
7D157	15-30	4-7	Sand and Gravel	Loam	0-2	Till	100-300	123	152
7D158	30-50	4-7	Sand and Gravel	Loam	6-12	Till	100-300	108	127
7D159	15-30	4-7	Sand and Gravel	Loam	6-12	Till	100-300	118	137
7D160	30-50	4-7	Sand and Gravel	Loam	6-12	Till	100-300	111	130
7D161	15-30	4-7	Sand and Gravel	Loam	0-2	Till	300-700	137	163
7D162	30-50	4-7	Sand and Gravel	Clay Loam	2-6	Till	300-700	114	133
7D163	15-30	4-7	Sand and Gravel	Loam	2-6	Till	300-700	131	156
7D164	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	136	161
7D165	0-5	7-10	Sand and Gravel	Sandy Loam	0-2	Sd&Gvl w/Sl&Cl	300-700	167	195
7D166	0-5	4-7	Sand and Gravel	Clay Loam	0-2	Sd&Gvl w/Sl&Cl	300-700	148	168
7D167	5-15	4-7	Sand and Gravel	Nonshrinking and Nonaggregated Cl	0-2	Till	100-300	125	142
7D168	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	129	152
7D169	0-5	7-10	Sand and Gravel	Sandy Loam	0-2	Sd&Gvl w/Sl&Cl	100-300	158	188
7D170	0-5	7-10	Sand and Gravel	Silty Loam	0-2	Sd&Gvl w/Sl&Cl	100-300	154	178
7D171	0-5	4-7	Sand and Gravel	Clay Loam	0-2	Silt/Clay	100-300	139	161
7D172	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	119	142

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7D173	15-30	4-7	Sand and Gravel	Shrink/Swell Clay	0-2	Till	100-300	127	162
7D174	15-30	4-7	Sand and Gravel	Shrink/Swell Clay	2-6	Till	100-300	126	159
7D175	15-30	4-7	Sand and Gravel	Shrink/Swell Clay	6-12	Till	100-300	122	147
7D176	15-30	4-7	Sand and Gravel	Shrink/Swell Clay	6-12	Sd&Gvl w/Sl&Cl	300-700	141	162
7D177	30-50	4-7	Sand and Gravel	Shrink/Swell Clay	2-6	Till	100-300	116	149
7D178	5-15	4-7	Sand and Gravel	Silty Loam	2-6	Till	100-300	135	158
7D179	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	141	165
7D180	15-30	4-7	Sand and Gravel	Silty Loam	2-6	Till	100-300	130	152
7D181	30-50	4-7	Sand and Gravel	Silty Loam	0-2	Till	300-700	125	148
7D182	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	124	146
7D183	30-50	4-7	Sand and Gravel	Shrink/Swell Clay	2-6	Till	300-700	130	160
7D184	30-50	4-7	Sand and Gravel	Shrink/Swell Clay	0-2	Till	300-700	131	163
7D185	15-30	4-7	Sand and Gravel	Nonshrinking and Nonaggregated Cl	0-2	Till	300-700	129	143
7D186	15-30	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	131	155
7D187	15-30	4-7	Sand and Gravel	Loam	6-12	Till	100-300	128	145
7D188	15-30	4-7	Sand and Gravel	Loam	2-6	Till	100-300	132	157
7D189	50-75	2-4	Sand and Gravel	Silty Loam	2-6	Till	700-1000	111	130
7D190	15-30	4-7	Sand and Gravel	Nonshrinking and Nonaggregated Cl	0-2	Till	700-1000	138	150
7D191	30-50	4-7	Sand and Gravel	Shrink/Swell Clay	2-6	Till	700-1000	149	175
7D192	30-50	4-7	Sand and Gravel	Shrink/Swell Clay	2-6	Till	300-700	135	164
7D193	30-50	4-7	Sand and Gravel	Shrink/Swell Clay	6-12	Till	300-700	126	148
7D194	30-50	4-7	Sand and Gravel	Clay Loam	0-2	Till	300-700	128	147
7D195	15-30	4-7	Sand and Gravel	Shrink/Swell Clay	6-12	Till	300-700	136	158
7D196	15-30	4-7	Sand and Gravel	Shrink/Swell Clay	6-12	Till	700-1000	145	165
7D197	30-50	4-7	Sand and Gravel	Shrink/Swell Clay	6-12	Till	300-700	126	148
7D198	5-15	7-10	Sand and Gravel	Loam	0-2	Sd&Gvl w/Sl&Cl	700-1000	174	196
7D199	15-30	4-7	Sand and Gravel	Shrink/Swell Clay	2-6	Till	700-1000	149	177
7D200	30-50	4-7	Sand and Gravel	Shrink/Swell Clay	6-12	Till	100-300	117	141
7D201	15-30	4-7	Sand and Gravel	Shrink/Swell Clay	2-6	Till	100-300	131	163

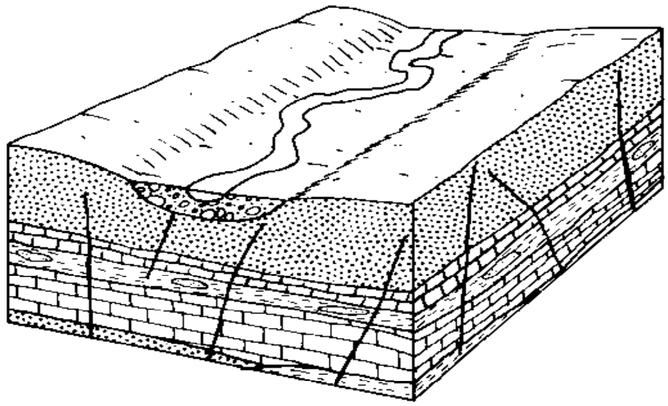
Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7D202	50-75	2-4	Sand and Gravel	Shrink/Swell Clay	2-6	Till	100-300	94	127
7D203	15-30	4-7	Sand and Gravel	Loam	0-2	Till	100-300	128	156
7D204	5-15	4-7	Sand and Gravel	Shrink/Swell Clay	0-2	Till	100-300	142	176
7D205	5-15	4-7	Sand and Gravel	Shrink/Swell Clay	2-6	Till	100-300	141	173
7D206	30-50	4-7	Sand and Gravel	Silty Loam	2-6	Till	100-300	120	142



7Eb Alluvium Without Overbank Deposits

This hydrogeologic setting is characterized by flat-lying topography along the floodplains of some moderate-sized streams in northern Portage County. Moderately thick, relatively coarse alluvium is found within these stream valleys. These valleys lack significant fine-grained overbank deposits. Recharge is relatively high and the depth to water is less then 15 feet. The coarse alluvium (sand and gravel) aquifer is commonly in direct hydrologic contact with the surface stream. The alluvium may also serve as a source of recharge to the underlying, fractured, sedimentary rocks.

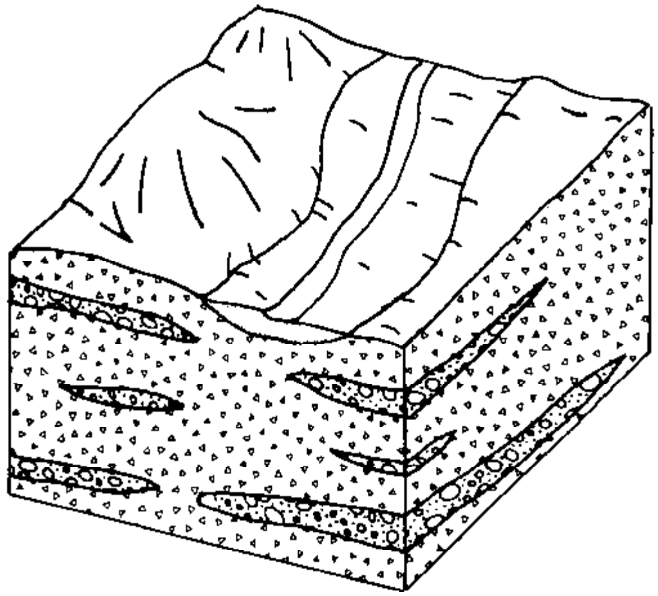
Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Eb1	5-15	7-10	Sand and Gravel	Silty Loam	0-2	Sd&Gvl w/Sl&Cl	300-700	155	177
7Eb2	5-15	7-10	Bedded Sandstone, Shale	Silty Loam	0-2	Sd&Gvl w/Sl&Cl	100-300	149	173
7Eb3	5-15	7-10	Sandstone	Clay Loam	0-2	Sd&Gvl w/Sl&Cl	300-700	153	172



7Ec Alluvium Over Bedded Sedimentary Rock

This hydrogeologic setting is characterized by minor, narrow, low relief tributary valleys, particularly in central and eastern Portage County. The silty alluvium associated with the floodplain of these minor streams is commonly more permeable then the surrounding till uplands. The alluvium overlies the fractured shales and sandstone which serve as the principal aquifer. Recharge may be slightly higher than in the surrounding uplands, but is generally much less than in the major valley systems due to the lack of sand and gravel deposits. Depth to the water table is usually less than in surrounding upland areas and is typically less then 15 feet in depth.

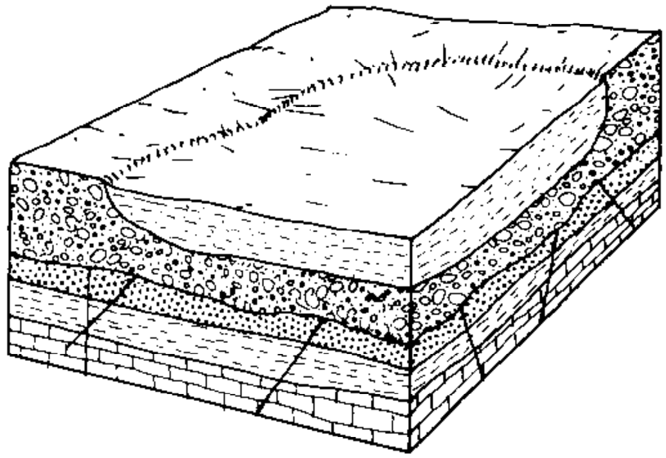
Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Ec1	5-15	7-10	Bedded Sandstone, Shale	Silty Loam	0-2	Till	100-300	149	173
7Ec2	5-15	4-7	Bedded Sandstone, Shale	Silty Loam	0-2	Silt/Clay	100-300	136	161
7Ec3	5-15	4-7	Bedded Sandstone, Shale	Clay Loam	0-2	Till	100-300	129	152
7Ec4	5-15	4-7	Bedded Sandstone, Shale	Loam	0-2	Till	100-300	143	170
7Ec5	15-30	4-7	Bedded Sandstone, Shale	Loam	0-2	Silt/Clay	100-300	128	156
7Ec6	5-15	4-7	Bedded Sandstone, Shale	Loam	0-2	Silt/Clay	100-300	138	166
7Ec7	5-15	4-7	Sandstone	Silty Loam	0-2	Till	300-700	142	165
7Ec8	5-15	7-10	Sandstone	Loam	0-2	Sd&Gvl w/Sl&Cl	300-700	152	178
7Ec9	5-15	7-10	Sandstone	Silty Loam	0-2	Sd&Gvl w/Sl&Cl	300-700	150	173
7Ec10	0-5	7-10	Sandstone	Sandy Loam	0-2	Sd&Gvl w/Sl&Cl	300-700	164	192
7Ec11	5-15	4-7	Bedded Sandstone, Shale	Silty Loam	0-2	Till	100-300	131	157
7Ec12	5-15	4-7	Bedded Sandstone, Shale	Loam	0-2	Till	100-300	133	162
7Ec13	5-15	4-7	Bedded Sandstone, Shale	Nonshrinking & Nonaggregated Cl	0-2	Till	100-300	125	142
7Ec14	5-15	4-7	Bedded Sandstone, Shale	Clay Loam	0-2	Till	100-300	139	160



7Ed Alluvium Over Glacial Till

This setting is characterized by relatively narrow, low relief, minor tributary valleys. The primarily silty alluvium associated with the floodplains of modern streams, overlies glacial till. The aquifer is comprised of sand and gravel lenses interbedded with or underlying till. These sand and gravel beds may be associated with the minor tributaries of buried valley systems, or with interfluvial areas between buried valley systems. The alluvial deposits are typically thin and do not constitute an aquifer. They are generally not in direct contact with the sand and gravel aquifer. The surficial, silty alluvium is generally more permeable then the surrounding uplands. The alluvial deposits serve as a source of recharge to the sand and gravel layers underlying the till. Depth to water is usually less than the surrounding upland areas and typically is less than 15 feet in depth.

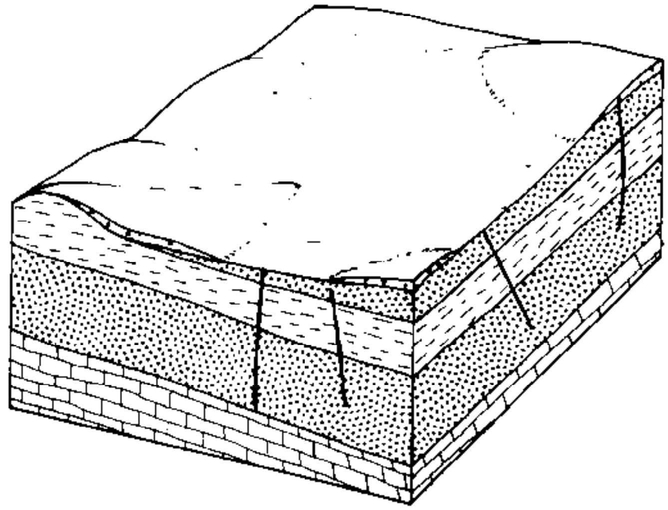
Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Ed1	5-15	4-7	Sand and Gravel	Loam	0-2	Till	100-300	143	170
7Ed2	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	139	160
7Ed3	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	141	165



7F Glacial Lake Deposits

This hydrogeologic setting was limited to a flat-lying, poorly drained portion of the Cuyahoga River floodplain in north-central Portage County. Stream drainage was blocked upstream during the Late Wisconsinan glaciation causing the valley to flood (pond). Fine silts and clays were deposited into the ponded valley. Recharge is moderate to low due to the fine-grained nature of the deposits. Soils are sandy loams due to the presence of coarse, surficial alluvium overlying the lacustrine (lake) sediments. Depth to water is within 30 feet; the fineness of the deposits may limit the degree of interconnection between the river and the underlying fractured, sedimentary bedrock aquifer.

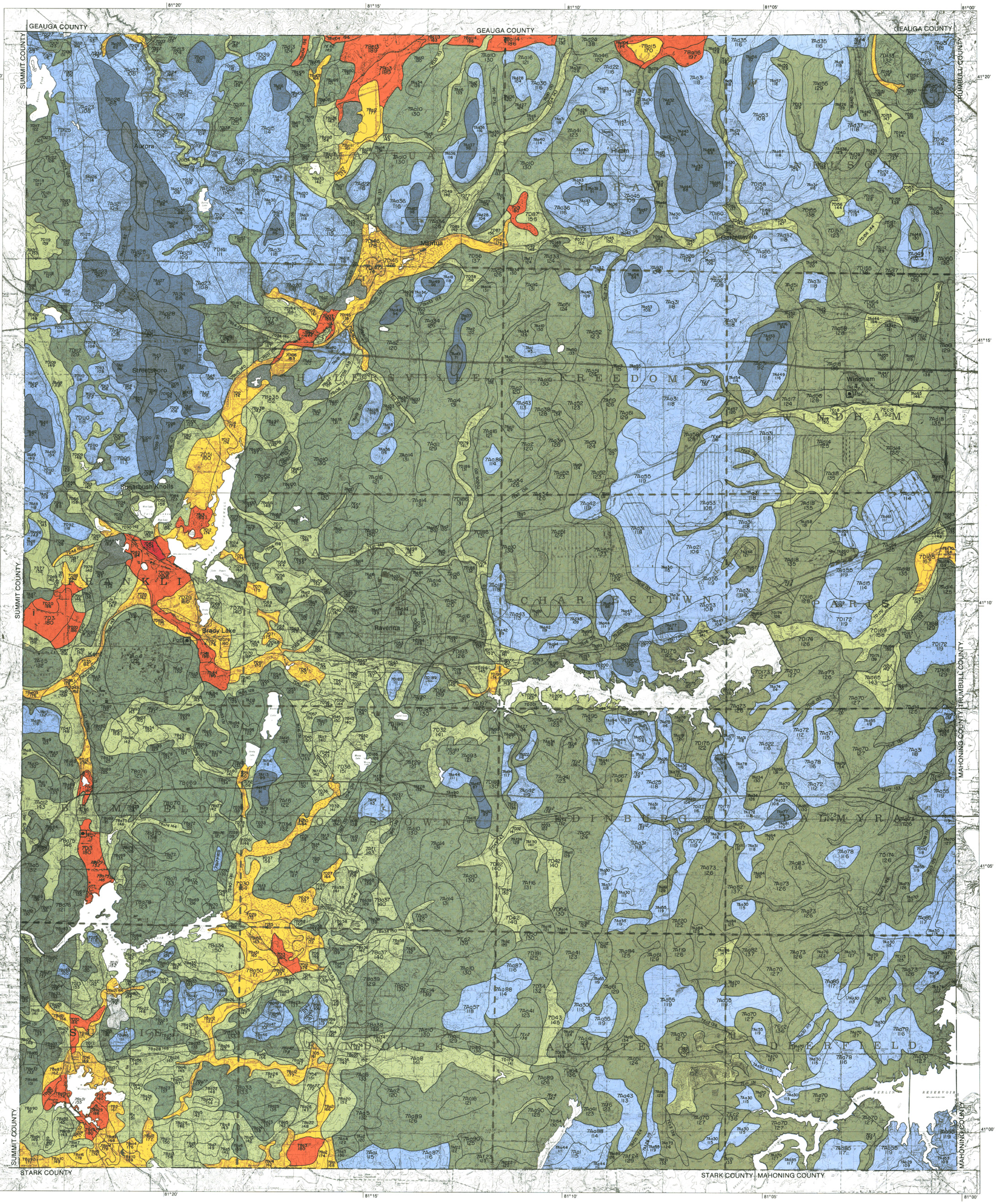
Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7F1	15-30	4-7	Bedded Sandstone, Shale	Sandy Loam	0-2	Silt/Clay	100-300	130	161



7G Thin Till Over Bedded Sedimentary Rock

This hydrogeologic setting is characterized by relatively flat-lying topography and by till (soil) being absent, or very thinly (<20 inches) overlying the sedimentary bedrock. This setting is used in this report to denote areas in southeastern Portage County which have been strip-mined. The soils and much of the vadose media have been either stripped away or highly altered; hence, recharge to the underlying, fractured bedrock is moderately high. Depth to water is quite shallow because much of the bedrock overlying the water table has been removed.

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7G1	0-5	4-7	Bedded Sandstone, Shale, Limestone	Thin or Absent	2-6	Interbedded SS, Shale, LS, and Coal	100-300	157	197
7G2	5-15	4-7	Bedded Sandstone, Shale, Limestone	Thin or Absent	2-6	Interbedded SS, Shale, LS, and Coal	100-300	152	192



Ground Water Pollution Potential of PORTAGE COUNTY

by

Michael P. Angle

CONTOUR INTERVAL 10 FEET

County Line
Township Line
Incorporated City Limit

Pollution Potential Index Range

Higher
200+
180 - 199
160 - 179
to 140 - 159
120 - 139
100 - 119
80 - 99
Lower <79

Description of Map Symbols

Hydrogeologic Region — 7Ad 6 — Hydrogeologic Setting
98 — Relative Pollution Potential

Observation Well Site**

Gravel Pit/Quarry

Hydrogeologic Settings

7Aa- Glacial Till Over Bedded Sedimentary Rock
7Ad- Glacial Till Over Sandstone
7Af - Sand and Gravel Interbedded in Glacial Till
7Ba- Outwash
7Bb- Outwash Over Bedded Sedimentary Rock
7D - Buried Valley
7Eb- Alluvium Without Over Bank Deposits
7Ec- Alluvium Over Bedded Sedimentary Rock
7Ed- Alluvium Over Glacial Till
7F - Glacial Lake Deposits
7G - Thin Till Over Bedded Sedimentary Rock

A more detailed description of the hydrogeologic settings and the evaluation of the pollution potential may be found in the publication "Ground-Water Pollution Potential of Portage County Ohio", GWPP Report No. 22 Ohio Department of Natural Resources, Division of Water.

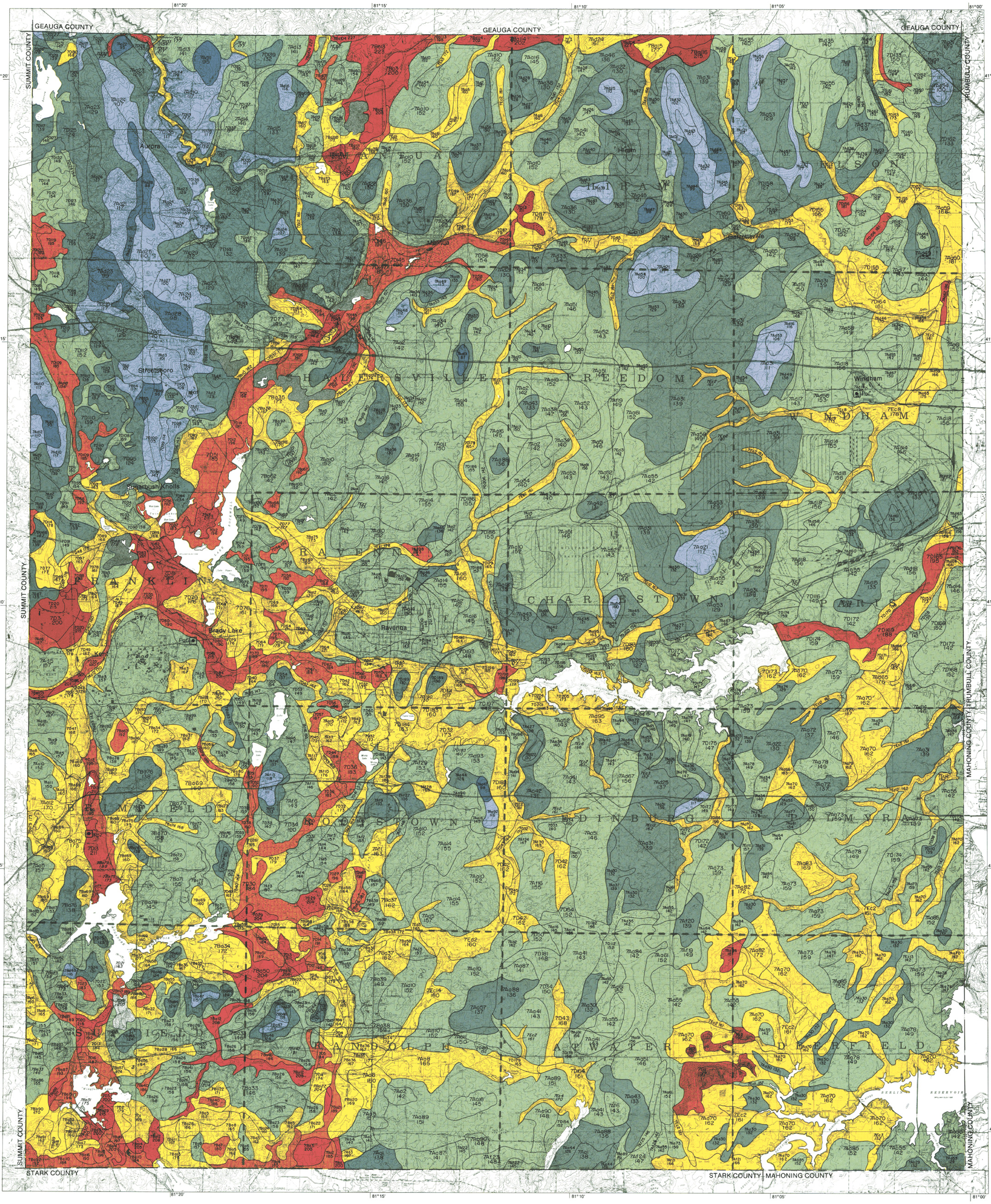
** Observation well sites indicate the location of wells used to collect ground-water level information. These wells are part of the State observation well network. Hydrographs of the water levels recorded in these and other State observation wells can be obtained through ODNR-Division of Water.

Published 1991
Ohio Department of Natural Resources
Division of Water
Ground-Water Resources Section
1939 Fountain Square
Columbus, Ohio 43224

Total copies printed: 500
Unit Cost: $4.27
Publication date: 5/91

ODNR Ohio Department of Natural Resources
George V. Voinovich Governor
Frances S. Buchholzer Director
Naturally OHIO the heart of it all!

David S. Orr, Cartographer



David S. Orr, Cartographer

(Pesticide) Ground Water Pollution Potential of PORTAGE COUNTY

by

Michael P. Angle

CONTOUR INTERVAL 10 FEET

Miles

Kilometers

County Line

Township Line

Incorporated City Limit

Pesticide Pollution Potential Index Range

Higher		200+
		180 - 199
		160 - 179
to		140 - 159
		120 - 139
		100 - 119
Lower		80 - 99

Description of Map Symbols

Hydrogeologic Region → **7Ad 6** ← Hydrogeologic Setting

98 ← Relative Pollution Potential

Observation Well Site**

Gravel Pit/Quarry

Hydrogeologic Settings

- 7Aa- Glacial Till Over Bedded Sedimentary Rock
- 7Ad- Glacial Till Over Sandstone
- 7Af - Sand and Gravel Interbedded in Glacial Till
- 7Ba- Outwash
- 7Bb- Outwash Over Bedded Sedimentary Rock
- 7D - Buried Valley
- 7Eb- Alluvium Without Over Bank Deposits
- 7Ec- Alluvium Over Bedded Sedimentary Rock
- 7Ed- Alluvium Over Glacial Till
- 7F - Glacial Lake Deposits
- 7G - Thin Till Over Bedded Sedimentary Rock

A more detailed description of the hydrogeologic settings and the evaluation of the pollution potential may be found in the publication "Ground-Water Pollution Potential of Portage County Ohio", GWPP Report No. 22 Ohio Department of Natural Resources, Division of Water.

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