GROUND WATER POLLUTION POTENTIAL OF GEAUGA COUNTY, OHIO

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ABSTRACT

A ground water pollution potential mapping program for Ohio has been developed under the direction of the Division of Water (now Division of Soil and Water Resources), Ohio Department of Natural Resources, 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 form the basis of the system and incorporate the major hydrogeologic factors that affect and 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. These factors, which form the acronym DRASTIC, are incorporated into a relative ranking scheme that uses a combination of weights and ratings to produce a numerical value called the ground water pollution potential index. Hydrogeologic settings are combined with the pollution potential indexes to create units that can be graphically displayed on a map.

Geauga County lies within the Southern New York Section of the Appalachian Plateau Province (Fenneman, 1938). The entire county is covered by a variable thickness of glacial till and outwash sand and gravel. These unconsolidated glacial deposits overlie Devonian, Mississippian and Pennsylvanian sandstones, conglomerates, and shales. Ground water yields are dependent on the type of aquifer and vary greatly throughout the county. Pollution potential indexes are relatively low to moderate in areas of till or lacustrine cover over bedrock, and moderate to moderately high in areas with alluvial cover. Buried valleys containing sand and gravel aquifers, and areas covered by outwash, have low to high vulnerabilities to contamination.

Ground water pollution potential analysis in Geauga County resulted in a map with symbols and colors which illustrate areas of varying ground water contamination vulnerability. Eight hydrogeologic settings were identified in Geauga County with computed ground water pollution potential indexes ranging from 81 to 207.

The ground water pollution potential mapping program optimizes the use of existing data to rank areas with respect to relative vulnerability to contamination. The ground water pollution potential map of Geauga County has 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, approximately 700,000 rural households depend on private wells; approximately 26,509 of these wells exist in Geauga 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 clean-up of a polluted aquifer. Based on these concerns for protection of the resource, staff of the Division of Soil and Water Resources 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 Soil and Water Resources, 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 map is to aid in the protection of our ground water resources. This protection can be enhanced 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 Geauga 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 clean-up efforts.

An important application of the pollution potential maps for many areas will be to assist in county land use planning and resource expenditure allocation 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.

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 clean-up 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.

Hydrogeologic Settings and Factors

To facilitate the designation of mappable units, the DRASTIC system used 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 Geauga 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

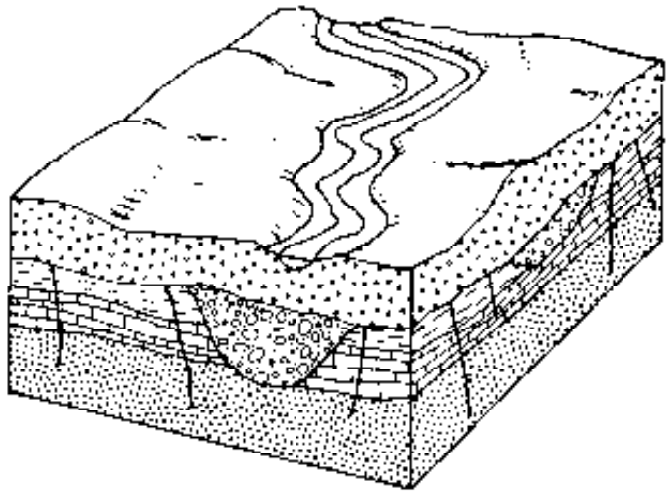
C - Conductivity (Hydraulic) of the Aquifer

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.

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.



7D Buried Valley

This hydrogeologic setting is characterized by thick deposits of sand and gravel that have been deposited in a former topographic low (usually a pre-glacial river valley) by glacial meltwaters. These deposits are capable of yielding large quantities of ground water. The deposits may or may not underlie a present-day river and may or may not be in direct hydraulic connection with a stream. Glacial till or recent alluvium often overlies the buried valley. Usually the deposits are several times more permeable than the surrounding bedrock. Soils are typically a sandy loam. Recharge to the sand and gravel is moderate and water levels are commonly relatively shallow, although they may be quite variable.

Figure 1. Format and description of the hydrogeologic setting - 7D Buried Valley

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 a higher DRASTIC index. 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 to be used 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. 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 significantly differs.

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	

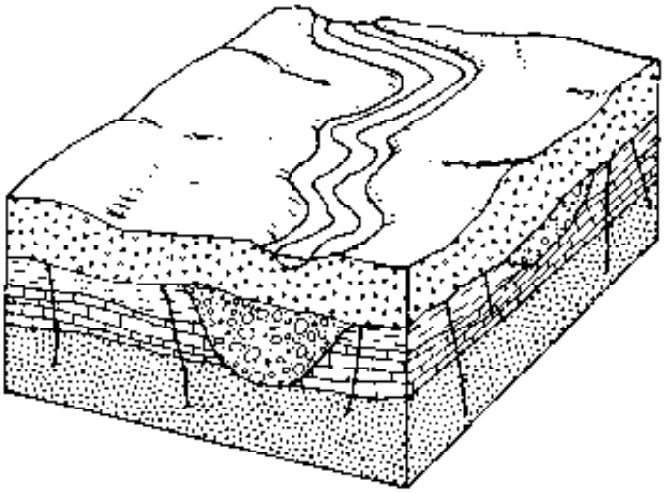
Table 8. Ranges and ratings for hydraulic conductivity

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 Geauga County, and the pollution potential index calculated for the setting. Based on selected ratings for this setting, the pollution potential index is calculated to be 87. 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 45 to 223. The diversity of hydrogeologic conditions in Geauga County produces settings with a wide range of vulnerability to ground water contamination. Calculated pollution potential indexes for the eight settings identified in the county range from 81 to 207.

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 analysis in Geauga County resulted in a map with symbols and colors that illustrate areas of ground water vulnerability. The map describing the ground water pollution potential of Geauga County is included with this report.



SETTING 7D1		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	NUMBER
Depth to Water	30-50	5	5	25
Net Recharge	2-4	4	3	12
Aquifer Media	Sand & Gravel	3	5	15
Soil Media	Silty Loam	2	4	8
Topography	18+	1	1	1
Impact Vadose Zone	Silt/Clay	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		DRASTIC	INDEX	87

Figure 2. Description of the hydrogeologic setting - 7D Buried Valley

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 a higher pollution potential index. This numeric value determined for one area can be compared to the pollution potential index calculated for another area.

The map accompanying this report displays 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
87 - defines the relative pollution potential

Here the first number (7D1) refers to the major hydrogeologic region and the upper case refers 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 (87) 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 map also includes 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 GEAUGA COUNTY

Geauga County occupies an area of approximately 404 square miles in northeastern Ohio (Figure 3). It is bounded on the north by Lake County, on the east by Ashtabula and Trumbull Counties, on the south by Portage County and on the west by Cuyahoga County.

The county seat is Chardon, located approximately 32 miles northeast of Cleveland. The 2010 estimate of the population of Lake County was 93,389 (Ohio Department of Development, 2012).

The average annual precipitation for the city of Chardon during the thirty year period starting in 1971 and ending in 2000 was 47.33 inches. The average annual temperature for the same period was 46.9 degrees Fahrenheit (U.S. Department of Commerce, 2002).

Physiography

Geauga County lies within the Glaciated Allegheny Plateaus Section of the Appalachian Plateaus Province. The majority of the county lies within the Killbuck-Glaciated Plateau Region, while portions of the central and south-central areas of the county are part of the Akron-Canton Interlobate Plateau. There is a limited area along the east-central border of the county that lies within the Grand River Low Plateau Region (Fenneman, 1938 and Brockman, 1998). Topography in the county ranges widely, from gently rolling to steeply sloping. The steepest slopes are found along valley walls where some cliffs are 100 feet or more in height. The dominant topographic features within the county are numerous sandstone knobs and ridges, many surrounded by deep narrow valleys (Totten, 1988).

The vast majority of Geauga County lies within the Lake Erie drainage basin. The principal streams flowing through the county include the Chagrin River and the Cuyahoga River. Only one small area in southeastern Troy Township lies within the Ohio River basin.

Glacial Geology

During the Pleistocene Epoch (2 million to 10,000 years ago), at least four episodes of glaciation occurred in North America. In Ohio, evidence exists for three of these periods: the Wisconsinan, which occurred between 70,000 and 10,000 years ago; the Illinoian, which occurred at least 120,000 years ago, and the pre-Illinoian (Kansan). Approximately two thirds of the state is covered by a mantle of glacial material deposited during these periods.

The majority of the glacial materials in Ohio were deposited by the Wisconsinan glaciers. Less extensive Illinoian-age deposits are found in the southwestern counties of the state along most of the glacial boundary. Pre-Illinoian (Kansan) deposits are evident at the surface only in

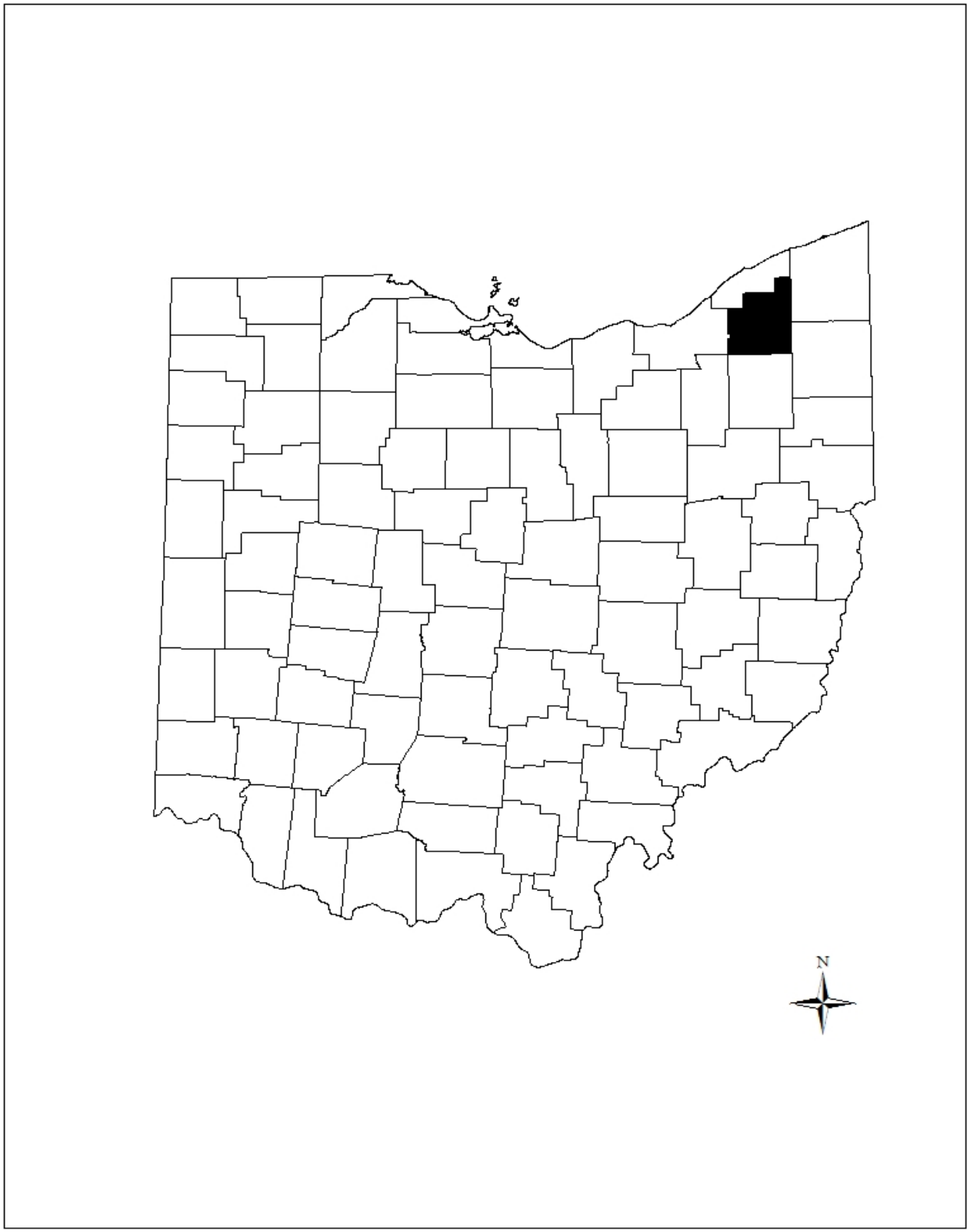


Figure 3. Location of Geauga County in Ohio

Hamilton County. Glacial deposits in Ohio average 35 to 40 feet in thickness. However, thicknesses range from less than a foot to more than 500 feet (Stout et al., 1943).

Glacial till (Wisconsinan age) covers most of Geauga County. Till, by definition, is deposited directly by glacial ice and is typically a poorly sorted mixture of clay, silt, sand, and gravel. The total thickness of all till layers in Geauga County ranges from less than 2 feet on the crest of some knobs and ridges, to several hundred feet in the deeper buried valleys (Totten, 1988).

The Defiance Moraine (a glacial end moraine) virtually surrounds the county on three sides: east, west, and north. This feature is composed primarily of glacial till with some gravel. Totten (1988), described the Defiance Moraine in Geauga County as "...a more or less continuous belt of hummocky topography, typically 1 to 2 miles wide with 10 to 30 feet of relief...". Other smaller end moraines or segments of end moraines can be found in Russell, Chester, Claridon, Middlefield, and Parkman Townships (Totten, 1988). The end moraines in Geauga County have been interpreted as indicating the furthest extent of the advance of a glacier.

As glacial ice melts, a tremendous volume of water is released. This melt water carries with it sand, gravel, silt, and clay previously trapped within the glacial ice. The moving water sorts these materials by size, depositing the coarse sand and gravel near the source of the melt water and carrying away the silt and clay downstream. If the sand and gravel is deposited directly on the land surface in front of glacial ice the resulting formation is referred to as an "outwash deposit". If the sand and gravel was deposited in holes or depressions on the ice, and then laid down on the land surface as the ice melted, the resulting deposit is referred to as a "kame". In areas where ice remained in the valleys while the uplands were ice-free, meltwater often deposited sand and gravel that would sometimes accumulate in bands along the margins between the ice and the uplands. Deposits of this type are called "kame terraces".

Outwash deposits, kames and kame terraces are common in Geauga County. Outwash deposits found near the surface in the county are primarily confined to the valleys currently occupied by the larger streams which flow through the county (Totten, 1988).

Kames and kame terraces are also found within the valleys of the major streams. However, a large area (approximately 10 miles long and 5 miles wide) of kames and kame terraces covered by a layer of glacial till occurs in Auburn, Newbury, Munson, Burton, and Troy Townships (Totten, 1988).

Lacustrine (lake bottom) deposits are the surficial deposits within most of the Cuyahoga River valley and large parts of many of the other large river valleys. Layers of silt and fine sand are the primary components of these deposits. Surface runoff washed these sediments into lakes which occupied the valleys when glacial ice blocked the flow in the rivers. Over a period of time the silt and sand settled to the bottom of the lakes and accumulated into thick deposits. Lacustrine deposits also occur where kettle lakes have been filled in with sediments.

Buried Valleys

Streams that flowed either prior to or between periods of glaciation cut deep valleys into the bedrock underlying Geauga County. The largest and deepest of these valleys form a network which trends northeast to southwest and northwest to southeast through the center of the county.

As glacial ice advanced through the county, flow in the streams ceased and the bedrock valleys were partially, and in some areas totally, filled with glacial drift. This material consists primarily of till but does contain some significant layers of outwash sand and gravel in many areas.

Bedrock Geology

Bedrock underlying Geauga County belongs to the Devonian, Mississippian and Pennsylvanian Systems (See Table 9). These formations are predominantly sandstones, conglomerates, and shale.

The Sharon Sandstone (Pennsylvanian System) is the predominant formation capping the numerous bedrock ridges and knobs in the northern third of the county (Hanson, unpublished). Most ridges and knobs in the southern two-thirds are capped by either the Massillon Sandstone (Pennsylvanian System) or the Sharon Sandstone. Some ridges in the southwest corner of the county are capped by the Mercer Shale. Sugarloaf Mountain, the highest point in Geauga County, is capped by the Homewood Sandstone (Pennsylvanian System).

Bedrock within the buried stream channels are predominantly shales belonging to the Mississippian and Devonian Systems (Hanson, unpublished). The lowermost units in the shallower valleys are typically the Mississippian-age Meadville Shale and Orangeville Shale, while the lowermost unit in the deeper valleys is the Ohio Shale (Devonian System).

Hydrogeology

Geauga County lies within the Glaciated Central hydrogeologic region of the DRASTIC system (Aller et al. 1987). The entire county is covered by variable thicknesses of glacial till and outwash sand and gravel. The thickest deposits are found in the areas underlain by buried valleys. The coarser-grained deposits constitute the major ground-water resource; yields from the till are variable but generally low. The glacial deposits also serve as the source of recharge to the underlying bedrock aquifers.

Table 9. Generalized bedrock stratigraphy of Geauga County, Ohio (Modified from Bower 1951; Fuller 1965a; Pedry 1951; Szmuc, 1957; and Slucher et al., 2006).

System (Age)	Group/Formation (Symbol)	Significant Members or Beds	Lithologic Description

PENNSYLVANIAN	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	Logan and Cuyahoga Formations, undivided (Mlc)	Meadville Shale Sharpsville Sandstone Orangeville Shale	The Logan Formation is not found in Geauga County. The members of the Cuyahoga Formation consist of alternating, thin-bedded, gray silty shales, sandy shales, siltstones and fine-grained sandstones.
DEVONIAN	Berea Sandstone and Bedford Shale, undivided (Dbb)	Berea Sandstone Bedford Shale	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.
	Ohio Shale (Doh)	Cleveland Member Chagrin Member Huron Member	Consists of three members, Cleveland, Chagrin, and Huron Shales. Cleveland member is absent in northeastern Ohio. Chagrin consists of shale, siltstone, and very fine-grained sandstone, gray to greenish gray. Huron is black, carbonaceous shale with calcareous concretions common in the lower portion.

Aquifers within Geauga County are divided into two general groups: consolidated sandstone and shale formations within the bedrock, and unconsolidated glacial deposits. Of these two, the most wide-spread aquifers are the various bedrock formations. Bedrock aquifers on the ridges and hills are primarily the Sharon Conglomerate and the Massillon Sandstone. Yields from these formations may be as high as 100 gallons per minute in some locations (Walker, 1978). In the valleys and lowlands the principal bedrock aquifers are the interbedded sandstones and shales of the Mississippian System (See Table 9). Devonian-age shale is the uppermost aquifer in a small band along the northern edge of the county. Yields from this formation are typically small, usually barely enough for domestic needs.

Unconsolidated aquifers are found primarily within the buried valley areas. Outwash sand and gravel deposits in these valleys may yield more than 500 gallons per minute to large diameter wells (Walker, 1978). Other sand and gravel aquifers within the county include widely scattered kame deposits and alluvial deposits underlying the floodplains of some of the larger streams.

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APPENDIX A

DESCRIPTION OF THE LOGIC IN FACTOR SELECTION

Depth to Water

Water level information was obtained by using located water well log and drilling reports available at the Ohio Department of Natural Resources, Division of Soil and Water Resources. All located wells were plotted and data were interpreted with respect to geology and topography.

Water levels in the county are extremely variable. However, in general, water levels average 15 to 30 feet (7) or 30 to 50 feet (5) throughout the county. Water levels along the rivers in the River Alluvium setting along the central portion of the Geauga-Ashtabula county line east and northeast of Montville and southeast of Huntsburg, south of East Branch Reservoir in an area adjacent to the Cuyahoga River, and in areas adjacent to the East Branch of the Chagrin and Chagrin Rivers average 5 to 15 feet (9). In the southwestern corner of the county and in the northeastern corner bordering on Lake County, water levels are typically deeper than average and generally range between 50 to 75 feet (3). Isolated areas of the county along the Chagrin River east of Welshefield and in northern Thompson Township have water levels that average 75 to 100 feet (2).

Net Recharge

Published references for net recharge were not located during reference-searching for this county. Net recharge rates were estimated based on precipitation and predicted infiltration due to geology, soils, and topography. Values of 4 to 7 inches per year (6) were assigned to the majority of the county recognizing that recharge most likely is in the lower portion of this range where glacial till deposits are thick. Where more permeable outwash deposits were delineated, values of 10+ inches per year (9) were chosen. River alluvium was assigned a value of 7 to 10 inches per year (8). Values of 4 to 7 inches per year (6), 7 to 10 inches per year (8), and 10+ inches per year (9) were chosen in the Buried Valleys based on the character of the overlying surficial deposits. Values of 2 to 4 inches per year (3) were assigned to areas of Glacial Till Over Shale and Buried Valleys adjacent to Cuyahoga County based on information obtained from Barber (1994).

Aquifer Media

Information on aquifer media was primarily derived from: Totten (1988), Walker (1978), Rau (1969), Sedam (1973), and well log and drilling reports from the Ohio Department of Natural Resources, Division of Soil and Water Resources. Additional information was gleaned from Fuller (1965a and b), Ohio Department of Natural Resources (1959), Pedry (1951), Szmuc (1957), Bower (1951), Tague (1953), Moody and Associates (1973a, 1973b, 1976), the Ohio Drilling Company (1971), Cummins (1959), Bownocker (1965), and Goldthwait et al. (1967).

Although the county is covered by variable thicknesses of unconsolidated deposits, the aquifer chosen for the majority of the county is the underlying bedrock. In Glacial Till Over Bedded Sedimentary Rocks, the underlying sequences of sandstone and shale were chosen as the aquifer and assigned a value of (6). In Glacial Till Over Sandstone, the underlying sandstone was chosen as the aquifer and assigned a value of (6). Glacial Till Over Shale occurs in a small band along the northern edge of the county. In these areas, the underlying shale was chosen as the aquifer where the unconsolidated deposits are thin and assigned a value of (2). Where the unconsolidated deposits are thicker than 25 feet, thin sand and gravel layers within the glacial till were chosen as the aquifer and assigned a value of (5). Where Glacial Lake Deposits were designated, the underlying sandstone bedrock and sandstone/shale sequences were chosen as the aquifer. In outwash areas where the deposits were noted as kames, a value of (9) was assigned because of the abundance of coarser-grained material; a value of (8) was assigned in the terrace deposit areas. In the alluvium along the rivers, sand and gravel was chosen as the aquifer and assigned a typical value of (8). In areas where alluvium occurs along tributaries, the underlying bedrock was chosen as the aquifer. In these areas, bedded sandstone, limestone, and shale sequences as well as sandstone were assigned a value of (6). Along the Chagrin River flowing into Cuyahoga County, the underlying sandstone was assigned a value of (4) based on information found in Barber (1994). Sand and gravel was chosen as the aquifer in the Buried Valleys; typical values of (8) were assigned to the majority of the areas. Where kame deposits were indicated, a value of (9) was assigned because of the abundance of coarse-grained material. In buried valley areas adjacent to Cuyahoga County, sand and gravel was assigned a value of (5) based on information found in Barber (1994). In buried valley areas adjacent to Lake County, sand and gravel was assigned a value of (6) based on information found in Aller and Ballou (1991).

Soil Media

Soils were mapped based on the soil survey of Geauga County (Williams and McCleary, 1982). The soil media were assigned using the general soil association map in approximately 80 percent of the county; the remainder was re-mapped using DRASTIC-based parameters. Soils formed in glacial till are predominantly silty loam (4) with areas of clay loam (3) in the southeastern corner, east-central, and north-central parts of the county. Gravel (10) predominates along the rivers and creeks, with loam (5) soils directly adjacent to the gravel soils. Shrinking clay (7) soils occur in the southeastern corner of the county, along the Geauga-Trumbull County line. Soils found northeast of Bass Lake, surrounding and between Snow Lake and Lake Kelso, and along the northeastern branch of the Cuyahoga River are designated as muck (2).

Topography

Percent slope was estimated by using 7 1/2 minute USGS topographic quadrangle maps. Contour intervals on the topographic maps are 10 feet on all quadrangles. Topography averages 2 to 6 percent (9) in the majority of the county, although areas of 0 to 2 percent (10) are also common. One area of 6 to 12 percent (5) slope occurs in northeastern Russell Township adjacent to the Chagrin River and another occurs in southwestern Bainbridge Township. Slopes of 12 to 18 percent (3) and 18+ percent (1) occur along river valleys, primarily in the northern and western parts of the county.

Vadose Zone Media

Information on the vadose zone media was primarily obtained from: Totten (1988), Rau (1969), Sedam (1973), and well log and drilling reports form the Ohio Department of Natural Resources. Additional information was gleaned from Tague (1953), Bower (1951), Szmuc (1957), Pedry (1951), and Fuller (1965a).

Thicknesses of unconsolidated deposits are extremely variable throughout the county. Where till-rich deposits are significant from a pollution potential standpoint, the till designation was chosen as the vadose zone media in the Glacial Till Over Bedded Sedimentary Rocks, Glacial Till Over Sandstone, and Glacial Till Over Shale settings. Where the surficial deposits were designated Hiram Till, a value of (4) was assigned; where Kent Till was indicated in the central portion of the county, value of (6) was assigned to reflect the higher sand content; where Lavery Till was designated adjacent to Lake County a value of (5) was assigned. The designation of sand and gravel with significant silt and clay was assigned a value of (4) and used in Glacial Till Over Sandstone areas adjacent to Cuyahoga County based on information found in Barber (1994). Where glacial deposits are thin and/or water levels deeper, bedded sandstone, limestone, and shale sequences (6); sandstone (6); and shale (2) were chosen as the vadose zone media. In areas where surficial deposits were designated as lake plains, the designation of silt/clay was chosen and assigned a value of (5). Sand and gravel was chosen as the vadose zone media in the outwash areas. A value of (9) was assigned where kames were designated and a value of (8) was assigned in the terrace areas. The vadose zone media in the river alluvium was designated as sand and gravel with significant silt and clay and assigned a typical value of (6) based on the amount of fines usually found in those deposits. Along the Chagrin River where it flows into Cuyahoga County, the sand and gravel with significant silt and clay designation was assigned a value of (5) based on information found in Barber (1994). In the buried valley areas, the vadose zone media was chosen based on the type of overlying deposit. The vadose zone media ranged from sand and gravel (8) and (9) in areas of terrace deposits and kames respectively to till (4) and silt/clay (5) in Hiram Till and lake plains respectively to sand and gravel with significant silt and clay (4), (6) and (7) representing various fractions of fines in the deposits.

Hydraulic Conductivity

Only limited published data on the hydraulic conductivity of the sandstone bedrock were found for this county in Sedam (1973). Values of hydraulic conductivity were primarily estimated by reading descriptions in Walker (1978), referring to unpublished values in Moody and Associates (1973a, 1973b and 1976) and Eagon (No date (a) and (b)) and referring to the

appropriate values referenced by Freeze and Cherry (1979). Values of 300 to 700 gallons per day per square foot (4) were assigned to the sandstone bedrock based on information in Sedam (1973) except along the Cuyahoga border where values of 1 to 100 gallons per day per square foot (1) were assigned based on information found in Barber (1994). Values of 100 to 300 gallons per day per square foot (2) were assigned to the bedded sandstone/shale areas based on anticipated yields in Walker (1978). In areas where shale bedrock was designated as the aquifer, values of 1 to 100 gallons per day per square foot (1) were assigned. Values of 100 to 300 gallons per day per square foot (2), 300 to 700 gallons per day per square foot (4), 700 to 1000 gallons per day per square foot (6) and 1000 to 2000 gallons per day per square foot (8) were assigned in the buried valley areas based on anticipated yields in Walker (1978) and the character of the aquifer. Outwash deposits were estimated to have values of 1000 to 2000 gallons per day per square foot (8) based on their coarser nature. River alluvium was estimated to have values of 700 to 1000 gallons per day per square foot (6) except along the Chagrin River adjacent to Cuyahoga County where 1 to 100 gallons per day per square foot (1) was assigned based on information found in Barber (1994).

APPENDIX B

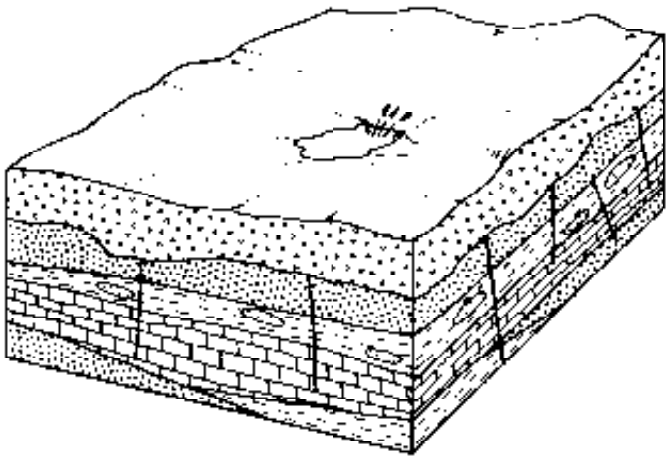
DESCRIPTION OF HYDROGEOLOGIC SETTINGS AND CHARTS

Ground water pollution potential mapping in Geauga County resulted in the identification of eight hydrogeologic settings within the Glaciated Central Region. The list of these settings, the range of pollution potential index calculations, and the number of index calculations for each setting are provided in Table 10. Pollution potential indexes computed for Geauga County range from 81 to 207.

Table 10. Hydrogeologic settings mapped in Geauga County, Ohio

Hydrogeologic Settings	Range of GWPP Indexes	Number of Index Calculations
7Aa - Glacial Till Over Bedded Sedimentary Rock	89 - 153	34
7Ad - Glacial Till Over Sandstone	95 - 148	23
7Ae - Glacial Till Over Shale	81 - 129	16
7Ba - Outwash	155 - 206	10
7Bb - Outwash Over Bedded Sedimentary Rock	179 - 189	2
7D - Buried Valley	87 - 207	30
7Eb - River Alluvium Without Overbank Deposits	129 - 179	16
7F - Glacial Lake Deposits	116 - 144	5

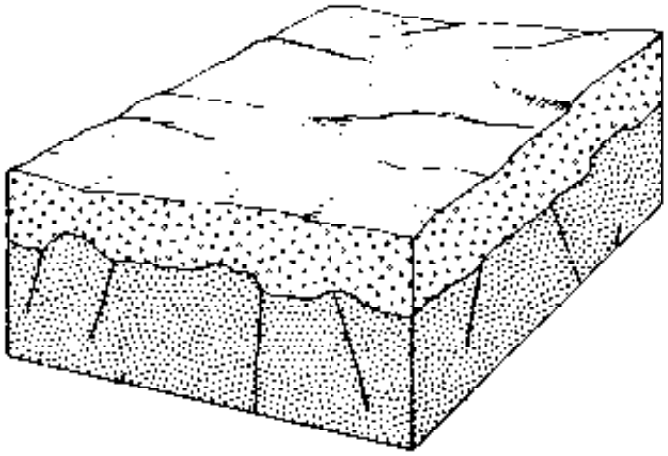
The following information provides a description of each hydrogeologic setting identified in the county, a block diagram illustrating the characteristics of the setting, and a listing of the charts for each unique combination of pollution potential indexes calculated for each setting. The charts provide 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.



7Aa Glacial Till Over Bedded Sedimentary Rock

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 with thin, inter-layered coals and shales which are covered by varying thicknesses of glacial till. 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 high 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.

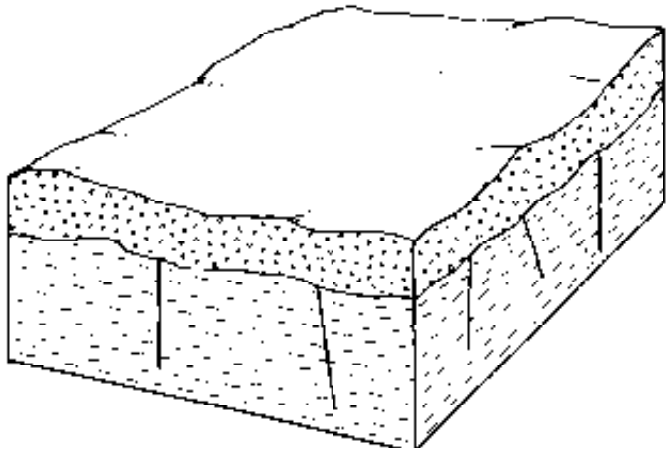
GWPP index values for the hydrogeologic setting of Glacial Till over Bedded Sedimentary Rock range from 89-153 with the total number of GWPP index calculations equaling 34.



7Ad Glacial Till Over Sandstone

This hydrologic setting is characterized by low topography and relatively flat-lying, fractured sandstones which are covered by varying thicknesses of glacial till. The till is principally unsorted deposits which may be interbedded with loess or localized deposits of sand and gravel. Although ground water occurs in both the glacial deposits and in the intersecting bedrock fractures, the bedrock is typically 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 because of the glacial tills which typically weather to clay loam. Depth to water is extremely variable, depending in part on the thickness of the glacial till, but averages around 40 feet.

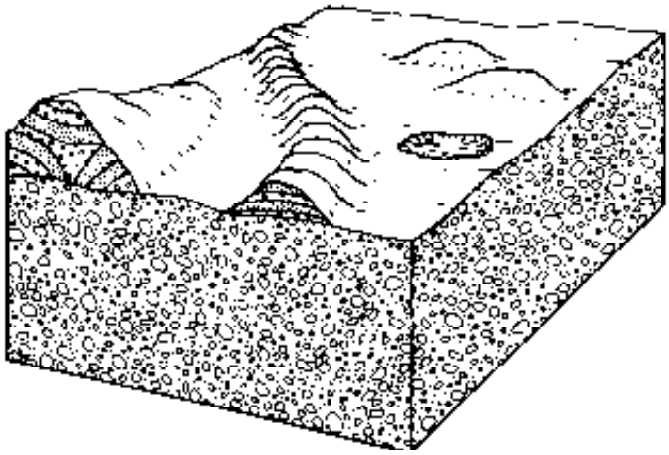
GWPP index values for the hydrogeologic setting of Glacial Till over Sandstone range from 95-148 with the total number of GWPP index calculations equaling 23.



7Ae Glacial Till over Shale

This hydrogeologic setting is similar to 7Ad - Glacial Till Over Sandstone except that varying thicknesses of till overlie fractured, flat-lying shales. The till is principally unsorted deposits with interbedded lenses of loess and sand and gravel. Ground water is derived from either localized sources in the overlying till or from deeper, more permeable formations. The shale is relatively impermeable and does not serve as a source of ground water. Although precipitation is abundant, recharge is minimal from the till to deeper formations and occurs only by leakage of water through the fractures.

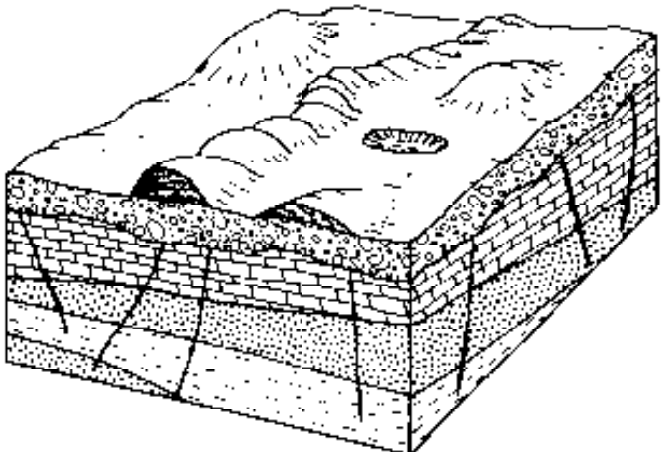
GWPP index values for the hydrogeologic setting of Glacial Till over Shale range from 81-129 with the total number of GWPP index calculations equaling 16.



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. 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.

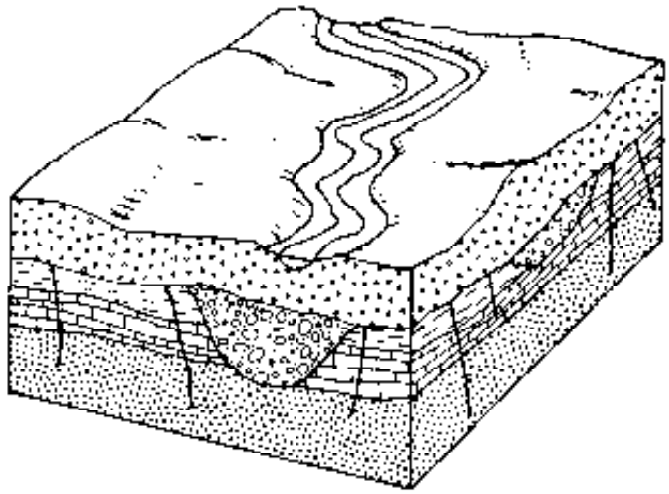
GWPP index values for the hydrogeologic setting of Outwash range from 155-206 with the total number of GWPP index calculations equaling 10.



7Bb Outwash over Bedded Sedimentary Rock

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.

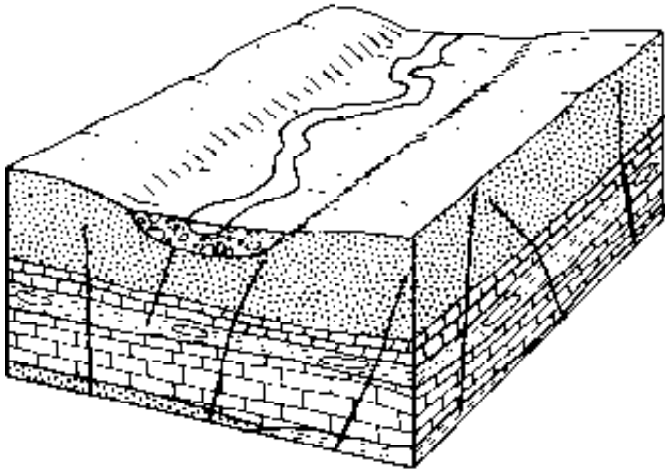
GWPP index values for the hydrogeologic setting of Outwash over Bedded Sedimentary Rock range from 179-189 with the total number of GWPP index calculations equaling 2.



7D Buried Valley

This hydrogeologic setting is characterized by thick deposits of sand and gravel that have been deposited in a former topographic low (usually a pre-glacial river valley) by glacial meltwaters. These deposits are capable of yielding large quantities of ground water. The deposits may or may not underlie a present-day river and may or may not be in direct hydraulic connection with a stream. Glacial till or recent alluvium often overlies the buried valley. Usually the deposits are several times more permeable than the surrounding bedrock. Soils are typically a sandy loam. Recharge to the sand and gravel is moderate and water levels are commonly relatively shallow, although they may be quite variable.

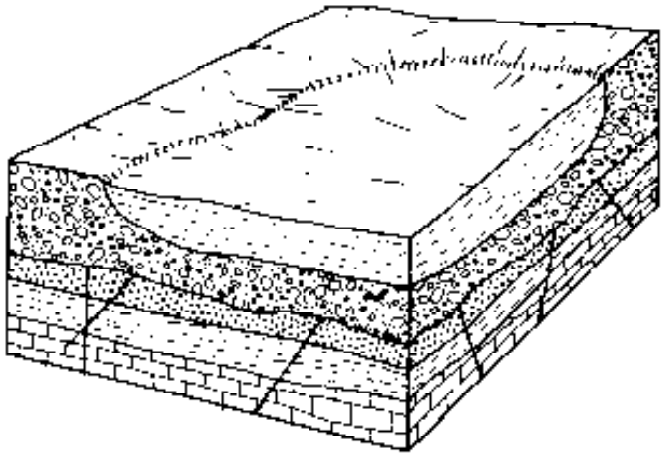
GWPP index values for the hydrogeologic setting of Buried Valley range from 87-207 with the total number of GWPP index calculations equaling 30.



7Eb River Alluvium Without Overbank Deposits

This hydrogeologic setting is characterized by flat-lying topography along the floodplains of some moderate-sized streams. Moderately thick, relatively coarse alluvium is found within these stream valleys. Theses valleys lack significant fine-grained overbank deposits. Recharge is relatively high and the depth to water is generally less than 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.

GWPP index values for the hydrogeologic setting of River Alluvium Without Overbank deposits range from 129-179 with the total number of GWPP index calculations equaling 16.



7F Glacial Lake Deposits

This hydrogeologic setting is characterized by flat topography and varying thicknesses of fine-grained sediments that overlie sequences of fractured sedimentary rocks. The deposits are composed of fine-grained silts and clays interlayered with fine sand that settled out in glacial lakes and exhibit alternating layers relating to seasonal fluctuations. As a consequence of the thin, alternating layers there is a substantial difference between the vertical and horizontal permeability with the horizontal commonly two or more orders of magnitude greater than the vertical. Due to their fine-grained nature, these deposits typically weather to organic-rich sandy loam with a range of permeabilities reflecting variations in sand content. Underlying glacial deposits or bedrock serve as the major source of ground water in the region. Although precipitation is abundant, recharge is controlled by the permeability of the surface clays; however, in all instances recharge is moderately high because of the impact of the low topography. Water levels are variable, depending on the thickness of the lake sediments and the underlying materials.

GWPP index values for the hydrogeologic setting of Glacial Lake Deposits range from 116-144 with the total number of GWPP index calculations equaling 5.

Table 11. Hydrogeologic settings, DRASTIC factors, and ratings

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Aa1	15-30	4-7	Interbedded sandstone & shale	Silty Loam	2-6	Till	100-300	120	144
7Aa2	15-30	4-7	Interbedded sandstone & shale	Clay Loam	2-6	Interbedded sandstone & shale	100-300	128	147
7Aa3	30-50	4-7	Interbedded sandstone & shale	Silty Loam	2-6	Till	100-300	110	134
7Aa4	15-30	4-7	Interbedded sandstone & shale	Gravel	6-12	Till	100-300	128	162
7Aa5	50-75	4-7	Interbedded sandstone & shale	Silty Loam	6-12	Interbedded sandstone & shale	100-300	106	120
7Aa6	15-30	4-7	Interbedded sandstone & shale	Thin/Absent	2-6	Interbedded sandstone & shale	100-300	142	182
7Aa7	30-50	4-7	Interbedded sandstone & shale	Clay Loam	6-12	Interbedded sandstone & shale	100-300	114	125
7Aa8	5-15	4-7	Interbedded sandstone & shale	Silty Loam	6-12	Interbedded sandstone & shale	100-300	136	150
7Aa9	50-75	4-7	Interbedded sandstone & shale	Clay Loam	6-12	Interbedded sandstone & shale	100-300	104	115
7Aa10	30-50	4-7	Interbedded sandstone & shale	Silty Loam	2-6	Interbedded sandstone & shale	100-300	120	142
7Aa11	75-100	4-7	Interbedded sandstone & shale	Silty Loam	2-6	Interbedded sandstone & shale	100-300	105	127
7Aa12	5-15	4-7	Interbedded sandstone & shale	Sandy Loam	2-6	Till	100-300	134	164
7Aa13	30-50	4-7	Interbedded sandstone & shale	Silty Loam	6-12	Till	100-300	106	122
7Aa14	30-50	4-7	Interbedded sandstone & shale	Gravel	2-6	Till	100-300	122	164
7Aa15	50-75	4-7	Interbedded sandstone & shale	Silty Loam	2-6	Interbedded sandstone & shale	100-300	110	132
7Aa16	30-50	4-7	Interbedded sandstone & shale	Sandy Loam	2-6	Till	100-300	114	144
7Aa17	30-50	4-7	Interbedded sandstone & shale	Sandy Loam	2-6	Interbedded sandstone & shale	100-300	124	152
7Aa18	15-30	4-7	Interbedded sandstone & shale	Clay Loam	2-6	Till	100-300	118	139

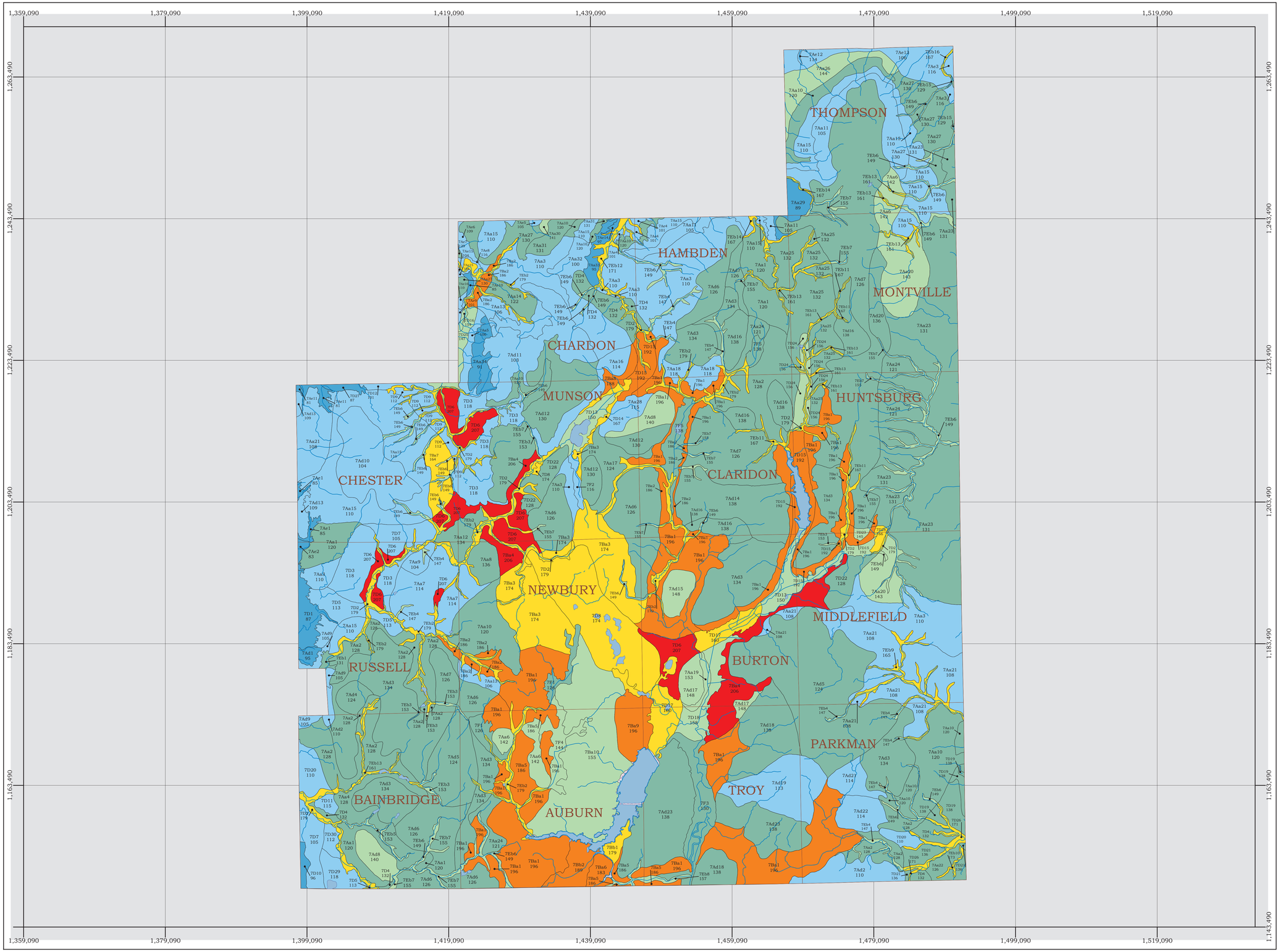
Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Aa19	5-15	4-7	Interbedded sandstone & shale	Thin or Absent	0-2	Interbedded sandstone & shale	100-300	153	195
7Aa20	5-15	4-7	Interbedded sandstone & shale	Gravel	0-2	Till	100-300	143	187
7Aa21	30-50	4-7	Interbedded sandstone & shale	Clay Loam	2-6	Till	100-300	108	129
7Aa22	15-30	4-7	Interbedded sandstone & shale	Shrink/Swell Clay	2-6	Till	100-300	126	159
7Aa23	5-15	4-7	Interbedded sandstone & shale	Silty Loam	0-2	Till	100-300	131	157
7Aa24	15-30	4-7	Interbedded sandstone & shale	Silty Loam	0-2	Till	100-300	121	147
7Aa25	15-30	4-7	Interbedded sandstone & shale	Gravel	2-6	Till	100-300	132	174
7Aa26	5-15	4-7	Interbedded sandstone & shale	Sandy Loam	2-6	Interbedded sandstone & shale	100-300	144	172
7Aa27	15-30	4-7	Interbedded sandstone & shale	Silty Loam	2-6	Interbedded sandstone & shale	100-300	130	152
7Aa28	15-30	4-7	Sand & gravel	Silty Loam	0-2	Till	1-100	115	142
7Aa29	100+	2-4	Interbedded sandstone & shale	Silty Loam	0-2	Interbedded sandstone & shale	100-300	89	113
7Aa30	5-15	4-7	Interbedded sandstone & shale	Silty Loam	0-2	Interbedded sandstone & shale	100-300	141	165
7Aa31	15-30	4-7	Interbedded sandstone & shale	Silty Loam	0-2	Interbedded sandstone & shale	100-300	131	155
7Aa32	50-75	4-7	Interbedded sandstone & shale	Silty Loam	2-6	Till	100-300	100	124
7Aa33	75-100	4-7	Interbedded sandstone & shale	Silty Loam	2-6	Till	100-300	95	119
7Aa34	75-100	4-7	Interbedded sandstone & shale	Silty Loam	6-12	Till	100-300	91	107
7Ad1	30-50	4-7	Sandstone	Clay Loam	0-2	Till	1-100	95	129
7Ad2	15-30	4-7	Sandstone	Clay Loam	0-2	Till	1-100	110	134
7Ad3	15-30	4-7	Sandstone	Clay Loam	2-6	Sandstone	300-700	134	151
7Ad4	15-30	4-7	Sandstone	Clay Loam	2-6	Till	300-700	124	143
7Ad5	30-50	4-7	Sandstone	Clay Loam	2-6	Sandstone	300-700	124	141
7Ad6	30-50	4-7	Sandstone	Silty Loam	2-6	Sandstone	300-700	126	146
7Ad7	15-30	4-7	Sandstone	Silty Loam	2-6	Till	300-700	126	148

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Ad8	15-30	4-7	Sandstone	Sandy Loam	2-6	Sandstone	300-700	140	166
7Ad9	15-30	4-7	Sandstone	Clay Loam	6-12	Sand & Gravel w/sig Silt/Clay	1-100	105	119
7Ad10	50-75	4-7	Sandstone	Clay Loam	2-6	Till	300-700	104	123
7Ad11	50-75	4-7	Sandstone	Silty Loam	2-6	Till	300-700	103	125
7Ad12	30-50	4-7	Sandstone	Sandy Loam	2-6	Sandstone	300-700	130	156
7Ad13	15-30	4-7	Sandstone	Clay Loam	2-6	Till	1-100	109	131
7Ad14	30-50	4-7	Sandstone	Thin/Absent	2-6	Sandstone	300-700	138	176
7Ad15	15-30	4-7	Sandstone	Thin/Absent	2-6	Sandstone	300-700	148	186
7Ad16	15-30	4-7	Sandstone	Gravel	2-6	Sand & Gravel w/sig Silt/Clay	300-700	138	178
7Ad17	5-15	4-7	Sandstone	Loam	2-6	Sandstone	300-700	148	171
7Ad18	15-30	4-7	Sandstone	Loam	2-6	Sandstone	300-700	138	161
7Ad19	75-100	4-7	Sandstone	Loam	2-6	Sandstone	300-700	113	136
7Ad20	5-15	4-7	Sandstone	Silty Loam	2-6	Till	300-700	136	158
7Ad21	30-50	4-7	Sandstone	Clay Loam	2-6	Till	300-700	114	133
7Ad22	50-75	4-7	Sandstone	Clay Loam	2-6	Sandstone	300-700	114	131
7Ad23	15-30	4-7	Sandstone	Loam	2-6	Till	300-700	138	161
7Ae1	15-30	2-4	Shale	Silty Loam	18+	Till	1-100	85	94
7Ae2	15-30	2-4	Shale	Clay Loam	18+	Till	1-100	83	89
7Ae3	5-15	4-7	Shale	Silty Loam	0-2	Till	1-100	116	143
7Ae4	30-50	4-7	Sand & gravel	Silty Loam	18+	Till	1-100	101	109
7Ae5	5-15	4-7	Shale	Silty Loam	2-6	Shale	1-100	105	132
7Ae6	5-15	4-7	Shale	Sandy Loam	2-6	Shale	1-100	109	142
7Ae7	15-30	4-7	Sand & gravel	Sand	2-6	Till	1-100	129	168
7Ae8	15-30	4-7	Sand & gravel	Sand	18+	Sand & Gravel w/sig Silt/Clay	1-100	116	140
7Ae9	15-30	4-7	Shale	Silty Loam	6-12	Till	1-100	101	118
7Ae10	30-50	4-7	Shale	Silty Loam	2-6	Shale	1-100	85	112
7Ae11	75-100	4-7	Sand & gravel	Silty Loam	18+	Till	1-100	81	90
7Ae12	5-15	4-7	Shale	Loam	18+	Till	1-100	114	125
7Ae13	5-15	4-7	Shale	Silty Loam	0-2	Shale	1-100	106	135
7Ae14	5-15	4-7	Shale	Silty Loam	18+	Shale	1-100	97	108
7Ae15	15-30	4-7	Shale	Loam	18+	Till	1-100	104	115
7Ae16	15-30	4-7	Shale	Silty Loam	2-6	Till	1-100	110	134
7Ba1	15-30	10+	Sand & Gravel	Gravel	2-6	Sand & Gravel	1000-2000	196	227
7Ba2	30-50	10+	Sand & Gravel	Gravel	2-6	Sand & Gravel	1000-2000	186	217
7Ba3	30-50	10+	Sand & Gravel	Silty Loam	2-6	Sand & Gravel	1000-2000	174	187

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Ba4	5-15	10+	Sand & Gravel	Gravel	2-6	Sand & Gravel	1000-2000	206	237
7Ba5	15-30	10+	Sand & Gravel	Loam	2-6	Sand & Gravel	1000-2000	186	202
7Ba6	15-30	10+	Sand & Gravel	Clay Loam	0-2	Sand & Gravel	1000-2000	183	195
7Ba7	50-75	10+	Sand & Gravel	Silty Loam	2-6	Sand & Gravel	1000-2000	164	177
7Ba8	15-30	10+	Sand & Gravel	Sandy Loam	2-6	Sand & Gravel	1000-2000	188	207
7Ba9	5-15	10+	Sand & Gravel	Loam	2-6	Sand & Gravel	1000-2000	196	212
7Ba10	30-50	10+	Sandstone	Loam	2-6	Sand & Gravel	300-700	155	175
7Bb1	15-30	10+	Sand & Gravel	Loam	0-2	Sand & Gravel	1000-2000	179	198
7Bb2	15-30	10+	Sand & Gravel	Gravel	0-2	Sand & Gravel	1000-2000	189	223
7D1	30-50	2-4	Sand & Gravel	Silty Loam	18+	Till	100-300	87	95
7D2	5-15	7-10	Sand & Gravel	Gravel	0-2	Sand & Gravel w/sig Silt/Clay	700-1000	179	217
7D3	30-50	4-7	Sand & Gravel	Silty Loam	6-12	Till	300-700	118	132
7D4	15-30	4-7	Sand & Gravel	Silty Loam	2-6	Till	300-700	132	154
7D5	50-75	4-7	Sand & Gravel	Silty Loam	0-2	Till	300-700	113	137
7D6	5-15	10+	Sand & Gravel	Gravel	0-2	Sand & Gravel	1000-2000	207	240
7D7	75-100	4-7	Sand & Gravel	Clay Loam	2-6	Till	300-700	105	124
7D8	30-50	10+	Sand & Gravel	Silty Loam	2-6	Sand & Gravel	1000-2000	174	187
7D9	50-75	4-7	Sand & Gravel	Silty Loam	2-6	Till	300-700	112	134
7D10	50-75	4-7	Sand & Gravel	Clay Loam	0-2	Sand & Gravel w/sig Silt/Clay	100-300	96	119
7D11	75-100	4-7	Sand & Gravel	Gravel	6-12	Till	300-700	115	147
7D12	50-75	4-7	Sand & Gravel	Silty Loam	0-2	Till	100-300	101	127
7D13	5-15	4-7	Sand & Gravel	Muck	0-2	Till	700-1000	150	165
7D14	30-50	10+	Sand & Gravel	Silty Loam	0-2	Sand & Gravel	1000-2000	167	183
7D15	15-30	7-10	Sand & Gravel	Gravel	2-6	Sand & Gravel	1000-2000	192	223
7D16	5-15	7-10	Sand & Gravel	Silty Loam	0-2	Sand & Gravel w/sig Silt/Clay	100-300	154	177
7D17	5-15	4-7	Sand & Gravel	Silty Loam	0-2	Till	1000-2000	160	179
7D18	5-15	4-7	Sand & Gravel	Sandy Loam	0-2	Till	700-1000	158	185
7D19	15-30	4-7	Sand & Gravel	Shrink/Swell Clay	2-6	Till	300-700	138	169
7D20	50-75	4-7	Sand & Gravel	Clay Loam	2-6	Till	300-700	110	129

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7D21	15-30	4-7	Sand & Gravel	Sandy Loam	2-6	Till	300-700	136	164
7D22	30-50	4-7	Sand & Gravel	Silty Loam	2-6	Till	700-1000	128	148
7D23	5-15	4-7	Sand & Gravel	Muck	0-2	Till	700-1000	145	161
7D24	15-30	4-7	Sand & Gravel	Gravel	0-2	Till	700-1000	156	195
7D25	30-50	10+	Sand & Gravel	Silty Loam	2-6	Sand & Gravel	100-300	147	166
7D26	5-15	7-10	Sand & Gravel	Sandy Loam	0-2	Sand & Gravel w/sig Silt/Clay	700-1000	171	197
7D27	75-100	4-7	Sand & Gravel	Silty Loam	18+	Till	100-300	87	95
7D28	5-15	4-7	Sand & Gravel	Gravel	0-2	Till	700-1000	166	205
7D29	50-75	4-7	Sand & Gravel	Silty Loam	0-2	Sand & Gravel w/sig Silt/Clay	300-700	118	141
7D30	75-100	4-7	Sand & Gravel	Silty Loam	2-6	Sand & Gravel w/sig Silt/Clay	300-700	112	133
7Eb1	5-15	4-7	Sandstone	Sandy Loam	0-2	Sand & Gravel w/sig Silt/Clay	1-100	131	163
7Eb2	5-15	7-10	Sand & Gravel	Gravel	0-2	Sand & Gravel w/sig Silt/Clay	700-1000	179	217
7Eb3	5-15	7-10	Sandstone	Clay Loam	0-2	Sand & Gravel w/sig Silt/Clay	300-700	153	172
7Eb4	5-15	7-10	Interbedded sandstone & shale	Clay Loam	0-2	Sand & Gravel w/sig Silt/Clay	100-300	147	168
7Eb5	5-15	7-10	Interbedded sandstone & shale	Sandy Loam	0-2	Sand & Gravel w/sig Silt/Clay	100-300	153	183
7Eb6	5-15	7-10	Interbedded sandstone & shale	Silty Loam	0-2	Sand & Gravel w/sig Silt/Clay	100-300	149	173
7Eb7	5-15	7-10	Sandstone	Silty Loam	0-2	Sand & Gravel w/sig Silt/Clay	300-700	155	177
7Eb8	5-15	7-10	Sandstone	Loam	0-2	Sand & Gravel w/sig Silt/Clay	300-700	157	182
7Eb9	5-15	7-10	Sand & Gravel	Clay Loam	0-2	Sand & Gravel w/sig Silt/Clay	700-1000	165	182
7Eb10	5-15	7-10	Sand & Gravel	Shrink/Swell Clay	0-2	Sand & Gravel w/sig Silt/Clay	700-1000	173	202
7Eb11	5-15	7-10	Sandstone	Gravel	0-2	Sand & Gravel w/sig Silt/Clay	300-700	167	207
7Eb12	5-15	7-10	Sand & Gravel	Sandy Loam	0-2	Sand & Gravel w/sig Silt/Clay	700-1000	171	197

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography (% slope)	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Eb13	5-15	7-10	Interbedded sandstone & shale	Gravel	0-2	Sand & Gravel w/sig Silt/Clay	100-300	161	203
7Eb14	5-15	7-10	Sand & Gravel	Silty Loam	0-2	Sand & Gravel w/sig Silt/Clay	700-1000	167	187
7Eb15	5-15	7-10	Shale	Silty Loam	0-2	Sand & Gravel w/sig Silt/Clay	1-100	129	155
7Eb16	5-15	4-7	Sand & Gravel	Silty Loam	0-2	Sand & Gravel w/sig Silt/Clay	700-1000	167	179
7F1	15-30	4-7	Interbedded sandstone & shale	Silty Loam	0-2	Silt/Clay	100-300	126	151
7F2	30-50	4-7	Interbedded sandstone & shale	Silty Loam	0-2	Silt/Clay	100-300	116	141
7F3	15-30	4-7	Interbedded sandstone & shale	Sandy Loam	0-2	Silt/Clay	100-300	130	161
7F4	15-30	4-7	Sandstone	Gravel	0-2	Silt/Clay	300-700	144	185
7F5	15-30	4-7	Interbedded sandstone & shale	Gravel	0-2	Silt/Clay	100-300	138	181



Ground Water Pollution Potential of Geauga County

by
Linda Aller and Karen L. Ballou, 1994
Revised by
Kathy Sprowls, 2013
Ohio Department of Natural Resources
Division of Soil and Water Resources

Ground Water Pollution Potential maps are designed to evaluate the susceptibility of ground water to contamination from surface sources. These maps are based on the DRASTIC system developed for the USEPA (Aller et al., 1987). The DRASTIC system consists of two major elements: the designation of mappable units, termed hydrogeologic settings, and a relative rating system for determining the ground water pollution potential within a hydrogeologic setting. The application of DRASTIC to an area requires the recognition of a set of assumptions made in the development of the system. The evaluation of pollution potential of an area assumes that a contaminant with the mobility of water is introduced at the surface and is flushed into the ground water by precipitation. DRASTIC is not designed to replace specific on-site investigations.

In DRASTIC mapping, hydrogeologic settings form the basis of the system and incorporate the major hydrogeologic factors that affect and control ground water movement and occurrence. The relative rating system is based on seven hydrogeologic factors: Depth to water, net Recharge, Aquifer media, Soil media, Topography, Impact of the vadose zone media, and hydraulic Conductivity. These factors form the acronym DRASTIC. The relative rating system uses a combination of weights and ratings to produce a numerical value called the ground water pollution potential index. Higher index values indicate higher susceptibility to ground water contamination. Polygons (outlined in black on the map at left) are regions where the hydrogeologic setting and the pollution potential index are combined to create a mappable unit with specific hydrogeologic characteristics, which determine the region's relative vulnerability to contamination. Additional information on the DRASTIC system, hydrogeologic settings, ratings, and weighting factors is included in the report.

Description of Map Symbols

Hydrogeologic Region → 7D24 ← Hydrogeologic Setting
170 ← Relative Pollution Potential

Legend

Colors are used to depict the ranges in the pollution potential indexes shown below. Warm colors (red, orange, yellow) represent areas of higher vulnerability (higher pollution potential indexes), while cool colors (green, blue, violet) represent areas of lower vulnerability to contamination (lower pollution potential indexes).

Roads
Streams
Lakes
Townships

N

Index Ranges
Not Rated
Less Than 79
80 - 99
100 - 119
120 - 139
140 - 159
160 - 179
180 - 199
Greater Than 200

Black grid represents the State Plane South Coordinate System (NAD27, feet).

0 1 2 3 4 5
Miles

0 2 4 6 8
Kilometers

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Cartography by Rachel Pohnan