GROUND WATER POLLUTION POTENTIAL OF ASHLAND COUNTY, OHIO

BY

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ABSTRACT

A ground water pollution potential map of Ashland 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 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. 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.

Ground water pollution potential analysis in Ashland County resulted in a map with symbols and colors, which illustrate areas of varying ground water pollution potential indexes ranging from 66 to 176.

Most of Ashland County lies within the Glaciated Central hydrogeologic setting. Central and east-central Hanover Township in southern Ashland County contains a small area within the Non-Glaciated Central hydrogeologic setting. A complex network of buried valley systems crosses the county. Valleys that were flowing south prior to the advance of ice typically contain fairly coarse, thick sand and gravel outwash deposits that can have maximum yields exceeding 500 gallons per minute (gpm). These coarse deposits may be interbedded with finer-grained alluvial or lacustrine deposits or glacial till particularly in the upper "headwaters" portion of the valleys. Yields from these finer-grained materials occupying buried valleys seldom exceed 100 gpm. Yields of less than 5 up to 25 gpm are obtained from thin lenses of sand and gravel interbedded with glacial till and lacustrine sediments along the margins of the buried valleys and in upland areas containing moderately thick drift. The upland areas of northern Ashland County include both ground moraine and end moraine.

Thin interbedded sandstones, shales, siltstones, and limestones of the Pennsylvanian System are limited to ridge tops in the southern tip of the county. These rocks commonly have yields of 0 to 5 gpm. Wells developed from highly fractured, coarse-grained sandstones of the Mississippian Logan and Black Hand Formations can yield up to 100 gpm in parts of southwestern Ashland County. Wells developed in the interbedded shales, fine-grained sandstones, and siltstones of the Mississippian Cuyahoga Group typically yield from 5 to 25 gpm. These units are widespread throughout the county, especially in northern and eastern Ashland County. Deeper wells in the extreme northwestern corner of the county may encounter low-yielding shales belonging to the Mississippian Sunbury Shale, or fine-grained Berea Sandstone. The Berea Sandstone typically yields 5 to 25 gpm, while the Sunbury Shale yields less than 5 gpm.

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 Ashland 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. Approximately 42 percent of Ohio citizens rely on ground water for drinking and household use from both municipal and private wells. Industry and agriculture also utilize significant quantities of ground water for processing and irrigation. In Ohio, approximately 750,000 rural households depend on private wells; 7,914 of these wells exist in Ashland 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 remediation 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, Water Resources Section to implement the ground water pollution potential mapping program on a countywide 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 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 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 Ashland 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 assisting 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 suitable for 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 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 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 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.

Individuals in the county who are familiar with specific land use and management problems will recognize other beneficial uses of the pollution potential maps. Planning commissions and zoning boards can use these maps to help make informed decisions about the development of areas within their jurisdiction. Developers proposing projects 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

DRASTIC was developed by the National Ground Water Association for the United States Environmental Protection Agency. This system was chosen for implementation of a ground water pollution potential mapping program in Ohio. 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. Vulnerability 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 that 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 under the assumption that a contaminant with the mobility of water is introduced at the surface and flushed into the ground water by precipitation. Most important, DRASTIC cannot be applied to areas smaller than 100 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 15 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 Ashland County. Inherent within each hydrogeologic setting are the physical characteristics that 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

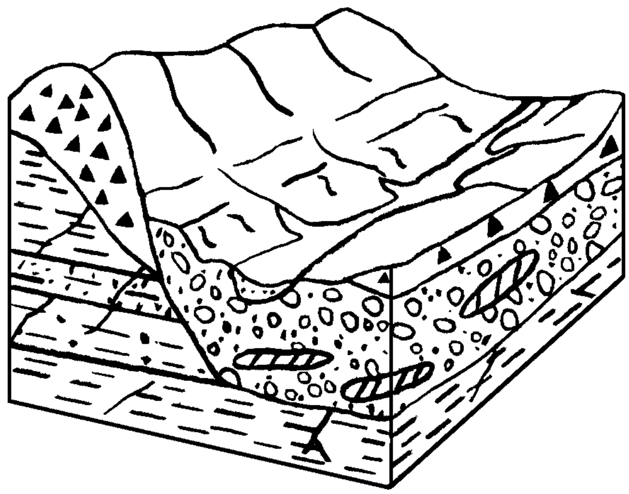
These factors incorporate concepts and mechanisms such as attenuation, retardation, and time or distance of travel of a contaminant with respect to the physical characteristics of the hydrogeologic setting. Broad consideration of these factors and mechanisms coupled with existing conditions in a setting 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 the aquifer measured in inches per year. Recharge water is available to transport a contaminant from the surface into the aquifer and 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 influences 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.



7D Buried Valleys

This hydrogeologic setting is widespread throughout Ashland County. An extensive network of pre-glacial and interglacial rivers created the buried valleys that downcut into the bedrock. The block diagram above shows the typical form of buried valley deposits, which is exemplified by Jerome Fork from Clear Creek Township southeast to Mohican Township, and Black Fork near Charles Mill Lake in Mifflin Township. These valleys are occupied by a modern river and floodplain and contain abundant outwash and kame deposits. The upper portion of these valleys contains 50 to 100 feet of sand and gravel interbedded with alluvium. Depth to water is typically less than 30 feet. Yields over 100 gpm are obtainable from large diameter wells developed in the sand and gravel deposits. Soils are typically sandy loams or silt loams. The streams are in direct connection with the aquifer and recharge is typically high. GWPP index values for these settings are usually over 125 in the main channel of the buried valley, and somewhat lower in the tributary channels.

GWPP index values for the hydrogeologic setting of Buried Valley range from 75 to 176, with the total number of GWPP index calculations equaling 156.

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

Topography refers to the slope of the land expressed as percent slope. The slope of an area affects the likelihood that a contaminant will 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 has a significant impact on 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. As the DRASTIC index increases, the vulnerability to contamination increases. 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/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	

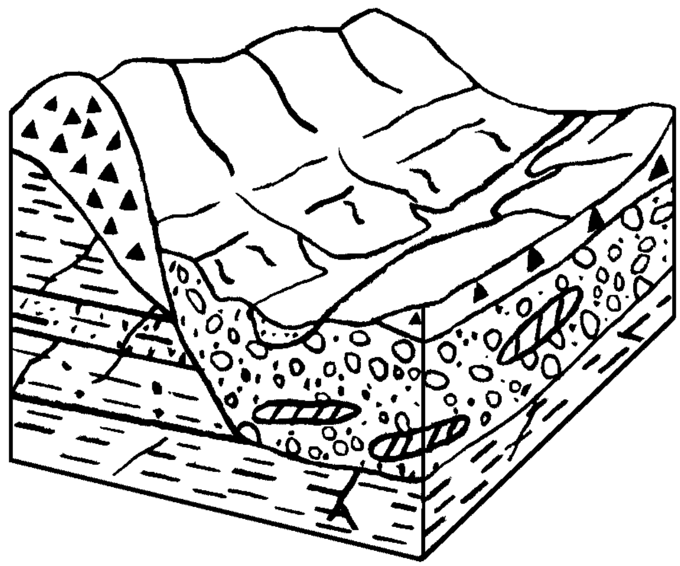
Table 8. Ranges and ratings for hydraulic conductivity

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 Ashland 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 144. 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 Ashland County produces settings with a wide range of vulnerability to ground water contamination. Calculated pollution potential indexes for the 10 settings identified in the county range from 66 to 176.

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 Ashland 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 Ashland County is included with this report.



SETTING 7D1		GENERAL		
FEATURE	**RANGE**	**WEIGHT**	**RATING**	**NUMBER**
Depth to Water	15-30	5	7	35
Net Recharge	4-7	4	6	24
Aquifer Media	Sand & Gravel	3	7	21
Soil Media	Sandy Loam	2	6	12
Topography	0-2%	1	10	10
Impact of Vadose Zone	Sand & gvl w/slt & cl	5	6	30
Hydraulic Conductivity	300-700	3	4	12
		DRASTIC	INDEX	144

Figure 2. Description of the hydrogeologic setting - 7D1 Buried Valley.

INTERPRETATION AND USE OF GROUND WATER POLLUTION POTENTIAL MAPS

The application of the DRASTIC system to evaluate an area's vulnerability to contamination produces hydrogeologic settings with corresponding pollution potential indexes. The susceptibility to contamination becomes greater as the pollution potential index increases. 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
144 - defines the relative pollution potential

Here the first number (**7**) refers to the major hydrogeologic region and the upper case letter (**D**) refers to a specific hydrogeologic setting. The following number (**1**) references a certain set of DRASTIC parameters that are unique to this setting and are described in the corresponding setting chart. The second number (**144**) 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.

The map is 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 delineate large man-made and natural features such as lakes, landfills, quarries, and strip mines, but these areas are not rated and therefore are not color-coded.

GENERAL INFORMATION ABOUT ASHLAND COUNTY

Demographics

Ashland County occupies approximately 424 square miles in north central Ohio (Figure 3). It is bounded to the west by Richland County, to the north by Huron and Lorain Counties, to the east by Medina and Wayne Counties, and to the south by Holmes and Knox Counties.

The approximate population of Ashland County, based upon year 2006 census estimates, is 54,727 (Department of Development, Ohio County Profiles, 2007). Ashland is the largest community and the county seat. Agriculture accounts for roughly 59 percent of the land usage in Ashland County. Woodlands account for approximately 37 percent of the land usage. Urban, industrial, and residential are the other major land uses in the county. There are numerous lakes and reservoirs, especially in the southern part of the county. More specific information on land usage can be obtained from the Ohio Department of Natural Resources, Division of Real Estate and Land Management (REALM), Resource Analysis Program.

Climate

The *Hydrologic Atlas for Ohio* (Harstine, 1991) reports an average annual temperature of approximately 49 degrees Fahrenheit for Ashland County. Harstine (1991) shows that precipitation averages approximately 36 inches per year for the county, with rainfall increasing towards the southeast. The normal annual precipitation at Ashland is 38.97 inches per year based upon a thirty-year (1971-2000) period (National Oceanic and Atmospheric Administration (NOAA), 2002). The mean annual temperature at Ashland for the same thirty-year period is 48.4 degrees Fahrenheit (NOAA, 2002).

Physiography and Topography

The northern third of Ashland County lies within the Central Lowland Till Plains Province (Frost, 1931; Fenneman, 1938, and Bier, 1956); while the central and southern portion of the county lies within the Glaciated Allegheny Plateau Section of the Appalachian Plateau Province (Frost, 1931; Fenneman, 1938, and Bier, 1956). Brockman (1998) and

Figure 3. Location map of Ashland County, Ohio.

Schiefer (2002) indicate that the extreme southwest corner of the county is part of the Illinoian Glaciated Allegheny Plateau, while the southeast corner is part of the Muskingum-Pittsburgh Plateau. Highly variable topography and relief are found in Ashland County. The southern, central, and eastern portions of the county feature steep, bedrock-controlled ridges separated by broad, flat stream valleys. Relief becomes steeper towards the non-glaciated southeast corner. Gently rolling ground moraine and hummocky end moraines characterize the northern and western portions of the county.

Modern Drainage

The drainage divide between the Ohio River Basin and the Lake Erie Basin extends across the northern third of Ashland County. The northwestern corner of the county is a source of headwaters for the Vermillion River, which drains into Lake Erie. Just north and west of Ashland are the headwaters of the Jerome Fork, a tributary of the Mohican River, which drains central Ashland County. Muddy Fork drains northeastern Ashland County, and ultimately joins Jerome Fork at the Wayne County border. Black Fork drains the southwestern corner of Ashland County and joins the Mohican River in eastern Hanover Township. These Mohican River tributaries and the Mohican River itself all drain toward the Ohio River.

Pre- and Inter-Glacial Drainage Changes

The drainage patterns of Ashland County have changed significantly as a result of the multiple glaciations. The drainage changes are complex and not yet fully understood. More research and data are necessary in both Ashland County and adjacent counties. Particularly, well log data for deeper wells that penetrate the entire drift thickness would be helpful in making interpretations.

Prior to glaciation, the drainage in Ohio is referred to as the Teays Stage. The Teays River drained the southern and western two thirds of the state and was the master stream for what is now the upper Ohio River Valley. Other drainages of that age are referred to as Teays Stage even if they did not drain into the Teays or its tributaries. Stout et al. (1943) proposed that part of the headwaters of the Groveport River, a major tributary of the Teays River, were located near Polk and Ashland. The drainage divide between the southwest-flowing Groveport River and northward drainage into Lake Erie was located along the southern borders of New London, Nova, and Sullivan Townships.

As ice advanced through Ohio during the pre-Illinoian (Kansan) glaciations, the northerly drainage ways were blocked. Flow backed-up these numerous tributaries forming several large lakes. These lakes over-topped, creating spillways and cutting new channels. New drainage systems began to evolve (Stout et al., 1943). This downcutting by these new streams was believed to be relatively rapid and, in many places, the new channels were cut over 100 feet deeper than the previous Teays River System valleys. The new drainage system is referred to as the Deep Stage due to this increased downcutting. Most of Ashland County was now drained by the headwaters of the Utica River, which had a course similar to that of the Groveport River (Stout et al., 1943). The Illinoian- and Wisconsinan-age glaciations have left modern-day drainage divides similar to that of the Deep Stage drainage.

Glacial Geology

During the Pleistocene Epoch (2 million to 10,000 years before present (Y.B.P.)) several episodes of ice advance occurred in northeastern Ohio. Table 9 summarizes the Pleistocene deposits found in Ashland County. Older ice advances that predate the most recent (Brunhes) magnetic reversal (about 730,000 Y.B.P.) are now commonly referred to as pre-Illinoian (formerly Kansan).

The majority of the glacial deposits fall into four main types: (glacial) till, lacustrine, outwash, and ice-contact sand and gravel (kames). Drift is an older term that collectively refers to the entire sequence of glacial deposits. Buried valleys may contain a mix of all of these types of deposits. Ancestral stream channels filled with glacial/alluvial sediments are referred to as buried valleys. The buried valleys are filled with differing sequences of coarse sand and gravel outwash, glacial till, ice-contact deposits, finer-grained lacustrine (lake) and modern, silty alluvial or floodplain deposits. These deposits vary with the energy level of the streams at that time. Streams leading away from melting glaciers are high energy and deposit coarser outwash. Streams that are blocked by ice or by thick channel deposits tend to be ponded and filled with finer-grained sediments. Such valleys are also typically filled with till from the advancing ice sheets. Both outwash and ice-contact features may be deposited as the ice sheets melt within the valleys. Modern tributaries, which lead into streams overlying the buried valleys, tend to contain variable thicknesses of sand, gravel, and silty alluvium.

Till is an unsorted, non-stratified (non-bedded) mixture of sand, gravel, silt, and clay deposited directly by the ice sheet. There are two main types or facies of glacial till. Lodgement till is "plastered-down" or "bulldozed" at the base of an actively moving ice sheet. Lodgement till tends to be relatively dense and compacted and pebbles typically are angular, broken, and have a preferred direction or orientation. "Hardpan" and "boulder-clay" are two common terms used for lodgement till. Ablation or "melt-out" till occurs as the ice sheet melts or stagnates away. Debris bands are laid down or stacked as the ice between the bands melts. Ablation till tends to be less dense, less compacted, and slightly coarser as meltwater commonly washes away some of the fine silt and clay.

Till has relatively low inherent permeability. Permeability in till is in part dependent upon the primary porosity of the till which reflects how fine-textured the particular till is. Vertical permeability in till is controlled largely by factors influencing the secondary porosity such as fractures (joints), worm burrows, root channels, sand seams, etc. (Brockman and Szabo, 2000).

At the land surface, till accounts for two primary landforms: ground moraine and end moraine. Ground moraine (till plain) is relatively flat to gently rolling. End moraines are ridge-like, with terrain that is steeper and more rolling or hummocky. Goldthwait et al. (1961) and Pavey et al. (1999) mapped end moraines regionally across the state. The ODNR,

Table 9. Generalized Pleistocene stratigraphy of Ashland County, Ohio

Age In years before present (Y.B.P.)	**Epoch**	**Stage**	**Killbuck Lobe** Northern, central, and south-central Ashland Co.	**Scioto Lobe** Extreme southwestern Ashland Co.
25,000 to 70,000		Wisconsinan	Hiram Till Hayesville Till Navarre Till	
70,000 to 120,000	Pleistocene	Sangamonian	Weathered soil	Weathered soil
120,000 to 730,000		Illinoian	Millbrook Till Butler Till	Jelloway Till Butler Till
			Kame deposits	
>730,000		Pre-Illinoian	Deep buried valley deposits	

Division of Water Open File, Glacial State Aquifer Map (2000) and White (1977) depict a generalized version of the more prominent moraines across Ashland County. In Ashland County, moraines are identifiable north of Ashland, which approximately equates to being north of the Allegheny Escarpment (Brockman, 1998). South of the Allegheny Escarpment, the steep topography is bedrock controlled and moraines would not be identifiable. Also, once past the Escarpment, the nature of the ice flow may not have been conducive to the formation of end moraines. Among the major end moraines mapped in Ashland County by White (1977) are (south to north), the Broadway Moraine, Mississinewa Moraine, St. Johns Moraine, Wabash Moraine, Fort Wayne Moraine, New Washington Moraine, and the Defiance Moraine. The end moraines have a tendency to bunch together at places, making separating and naming the ridges difficult.

Illinoian till deposits in Ashland County are found in the extreme southwestern corner of Hanover Township. Butler Till is exposed at the surface in a limited area of about one square mile, and may possibly exist in some of the deeper buried valleys in the county (White, 1977 and Pavey et al., 1999). Butler Till was named for the village of Butler in Richland County where the deposits are more extensive (Totten, 1973).

During the Wisconsinan (most recent) ice advance, ice advanced into north central Ohio in two distinct lobes. These lobes extended from the main ice sheet crossing the Lake Erie basin much like fingers extending from a hand. The Killlbuck Lobe extended from the western margin of Summit County through Wayne County into the east-central portion of Ashland County. The Scioto Lobe extended from western Richland County westward to Bellefontaine and southward to Chillicothe and Hillsboro, and to southern Ashland County to the east. Ice movement in the Killbuck Lobe was primarily due south, whereas ice movement in the Scioto Lobe was primarily due east in this region. The boundary between the two lobes passes through southwestern Richland County and is transitional and indistinct (Totten, 1973).

White (1977) initially reported that the Millbrook Till and the Jelloway Till were the oldest Wisconsinan-age tills in the Killbuck Lobe and Scioto Lobe, respectively. Current thinking (Totten, 1987 and Eyles and Westgate, 1987) suggests that the Millbrook Till and

Jelloway Till are Illinoian in age. Surface exposures of these tills are limited to the southwestern corner of Hanover Township in Ashland County. The Millbrook Till is olive brown in color, dense, calcareous, sandy, and stony. The Jelloway Till is also olive brown in color, sandy, and pebbly in texture (White, 1977).

The Navarre Till of the Killbuck Lobe is the oldest of the Late Wisconsinan Woodfordian tills (Totten, 1973 and White, 1982). The Navarre Till is found in northern Hanover Township and the majority of Green Township in southern Ashland County. The Navarre Till is yellow brown in color, calcareous, friable (loose), non-compact, sandy, and stony. Sand and gravel lenses are common in this till (Totten, 1973 and White, 1977).

Following the deposition of the Navarre Till, the late Wisconsinan Woodfordian ice sheet withdrew into the Lake Erie Basin. This local ice-free interval is referred to as the Erie Interstade. Approximately 19,000 YBP, ice began to re-advance into northern Ohio along both lobes. The tills this time are typically much more clayey and silty, contain less rock fragments, and most of the rock fragments are shaley in nature. It is believed that when the ice re-advanced into the Lake Erie basin, it eroded a significant amount of fine shales and previous lacustrine deposits (White, 1982).

The Hayesville Till of the Killbuck Lobe, named for exposures near Hayesville in Ashland County, is the surficial till that forms a band through the central portion of the county. The Hayesville Till is dark brown in color, moderately compact, dense, sparingly to moderately pebbly, and has a silty texture. The till is commonly thin, patchy, and discontinuous in its southernmost 4 to 6 miles. It is typically highly weathered (Totten, 1973 and White, 1977).

The Hiram Till is the youngest till encountered in Ashland County (Totten, 1973 and White, 1982). It is the surficial till found across the northern third of Ashland County. The Hiram Till caps most of the end moraines found in the county. The Hiram Till is chocolate brown in color, relatively soft, non-compact, and sparingly pebbly and has a silty-clay to clayey texture. The fine texture is probably due to the till eroding and incorporating lacustrine deposits or shale bedrock. The Hiram Till may have been deposited in a fairly wet environment transitional between lacustrine and an ablational environment. The Hiram Till is typically thin; however, it is thicker in areas of lower relief (Totten, 1973 and White, 1977).

Outwash deposits are created by active deposition of sediments by meltwater streams. These deposits are generally bedded or stratified and are sorted. Outwash deposits in Ashland County are commonly associated with buried valleys and are usually adjacent to modern streams. Outwash deposits associated with stream valleys were referred to in earlier literature as valley trains. Sorting and degree of coarseness depend upon the nature and proximity of the melting ice sheet. Braided streams usually deposited the outwash. Such streams have multiple channels, which migrate across the width of the valley floor, leaving behind a complex record of deposition and erosion. As modern streams downcut, the older, now higher elevation, remnants of the original valley floor are called terraces. White (1977) has shown the only major terraces in the county to be located along Muddy Fork in Perry Township at the border with Wayne County.

Kames and eskers are ice contact features. They are composed of masses of generally poorly sorted sand and gravel with minor till, deposited in depressions, holes, tunnels, or other cavities in the ice. As the surrounding ice melts, a mound of sediment remains behind. Typically, these deposits may collapse or flow as the surrounding ice melts. These deposits may display high angle, distorted or tilted beds, faults, and folds. Kame terraces are a linear belt of kames that have a similar appearance and a fairly uniform elevation. They represent deposition of materials between the melting ice sheet and the bedrock and till slopes flanking the ice-filled valleys. Eskers are elongate, sinuous deposits that marked deposition by drainage channels beneath the iced sheet. Crevasse fills are similar except that they occurred at the top of the ice sheet or within the ice sheet.

The kame deposits in some areas are immediately adjacent to outwash deposits. In these areas, the outwash deposits are commonly lower elevation and are flat-lying whereas the kame deposits have their characteristic rolling to hummocky nature. Surficial kame deposits generally lie above the water table whereas the outwash deposits are typically saturated. Although not saturated, the kame deposits are commonly highly permeable and provide conduits for water movement. Buried or lower elevation kames may be saturated.

Abundant kames and kame terraces flank Black Fork, particularly near Charles Mill Reservoir, Jerome Fork southeast of Nankin to the county line, and Muddy Fork south of Redhaw to the Wayne County line. The kames flanking these major stream valleys tend to be at higher elevations and further up the headwaters of tributaries than do outwash deposits. There are also a number of isolated, individual kames that are not obviously associated with streams. Most of these kames are found in north central Hanover Township and in southeastern Mohican Township (White, 1977).

Peat and muck are organic-rich deposits associated with low-lying depression areas, bogs, kettles, and swamps. Muck is dense, fine silt with a high content of organics and a dark black color. Peat is typically brownish and contains pieces of plant fibers, decaying wood, and mosses. The two deposits commonly occur together, along with lacustrine or slack water clays and silts. The majority of these deposits are found along lower-lying portions of valley floors including margins of floodplains and terraces. Promising areas for peat deposits are found in the Jerome Fork valley near Ashland and southeast of Jeromesville (White, 1977).

Bedrock Geology

Most of the bedrock exposed at the surface in Ashland County belongs to the Mississippian System. Interbedded sandstones, shales, siltstones, and limestones of the Pennsylvanian Allegheny and Pottsville Groups are exposed in the southeastern corner of Ashland County. Table 10 summarizes the bedrock stratigraphy found in Ashland County.

Table 10. Bedrock stratigraphy of Ashland County, Ohio

System	Group/Formation (Symbol)	Lithologic Description
Pennsylvanian	Allegheny-Upper Pottsville (Pap)	Thin brown to gray sandstones, siltstones, shale, limestone, and coal. Local thickness <100 feet. Poor aquifer yielding 0-5 gpm. Limited to southern border of county.
Mississippian	Logan and Black Hand Formations (Mlb)	The Logan consists of reddish-brown fine-grained sandstones interbedded with siltstones and shales. The Black Hand is massive, coarse-grained sandstone, yellow to brown in color. Primary aquifers in southwestern Ashland County. Thickness exceeds 100 feet. Yields range from 5 to 100 gallons per minute.
	Cuyahoga Formation (Mcg)	Gray to brown shale with thin sandstone and siltstone interbeds. Thickness commonly greater than 100 feet, except in the northwestern part of the county. Yields range from 5 to 25 gpm, except in the northwest corner of the county, where they range from 0 to 5 gpm. Widespread aquifer in central and eastern Ashland County.
	Sunbury Shale (Ms)	The Sunbury Shale is a brownish-black to greenish-gray thin-bedded fissile shale. Encountered at depth in northwestern Ashland County except where uppermost formation in Vermillion River valley. Formation typically <100 feet thick, with yields less than 5 gpm.
	Berea Sandstone (Mb)	Fine- to medium-grained, light greenish-gray to brown sandstone. Thickness is typically <100 feet, with yields ranging from 5 to 25 gpm. Uppermost bedrock formation in northwestern Ashland County in a portion of the Vermillion River valley, found at depth elsewhere in the northwestern part of the county.

The ODNR, Division of Geological Survey, has Open-File Reconnaissance Bedrock Geological Maps done on a 1:24,000 scale USGS topographic map base available for the entire county. The ODNR, Division of Water, has Open File Bedrock State Aquifer mapping available for the county also.

The Mississippian Berea Sandstone is the uppermost bedrock unit beneath the buried valley underlying the Vermillion River in the northwestern corner of the county (ODNR, Division of Water, Bedrock State Aquifer Map, 2000). The Berea is found at depth through the northwestern third of the county. It is a fine- to medium-grained, light greenish-gray to brown sandstone that may contain minor shale interbeds. The thickness does not exceed 100 feet. The Berea Sandstone consisted of river channel and bank sediments deposited along the proximal or near-shore edge of a broad delta. The upper part of the Berea Sandstone appears to have been formed as encroaching marine waters submerged the sediments. The sediments were then re-deposited along adjacent shorelines (Rau, 1969).

The Sunbury Shale is a brownish black to greenish gray thin-bedded carbonaceous shale. It is commonly found with carbonate/siderite concretions in the lowermost 50 feet of the formation. The Sunbury Shale is typically fractured and contains a high degree of organic matter, pyrite, petroleum, and is also very mildly radioactive. The Sunbury Shale was deposited in deep oceans that had limited circulation of fresher waters and sediments. Organic material was slow to decompose in the oxygen-starved, stagnant water. The Sunbury Shale is not known to crop out at the surface in Ashland County. This unit is common at depth in the subsurface of Ashland and covers roughly the same portions of the county that the underlying Berea Sandstone does. The Sunbury Shale is also the uppermost bedrock unit beneath a portion of the buried valley overlain by the Vermillion River.

The Mississippian Cuyahoga Formation is found across most of Ashland County except for the southwestern third of the county. It crops out along ridges and valleys and is the uppermost bedrock unit in these areas of the county. The Cuyahoga Formation consists of interbedded sandstones, siltstones, and shales that represent deltaic to fluvial sediments deposited in a rapidly fluctuating, shoreline environment. The Cuyahoga Formation is more shale-rich in the north central and northeast portions of the county.

The Mississippian Logan and Black Hand Formation are found in the southwestern third of Ashland County. The Logan formation consists of brown to reddish-brown sandstones interbedded with siltstones and shales; in some areas, siltstones and shales may predominate. The Black Hand formation is massive, coarse-grained sandstone, yellow to brown in color. The transition between shales and sandstones reflects the transition between coarser and finer stream deposition. The gradation also reflects the relative position of the shoreline over time, with coarser deposition closer to land and finer-grained sediments more distal from the shore. Drillers commonly refer to these sandstones as the “Big Injun”. These units reflect deposition in a high-energy, near-shore, deltaic environment.

Rocks of the Pennsylvanian System are limited to interbedded dirty sandstones, shales, siltstones, and limestones of the Pottsville and Allegheny Groups. These typically thin units occupy steep ridge tops in Hanover Township (ODNR, Division of Water, Bedrock State Aquifer Map, 2000). These rocks were deposited in highly transitional environments including both terrestrial ("land-based") and marine-derived sediments.

Ground Water Resources

Ground water in Ashland County is obtained from both unconsolidated (glacial-alluvial) and consolidated (bedrock) aquifers. Glacial aquifers are primarily associated with the buried valleys and thicker upland outwash and kame field deposits. In upland areas where the drift is primarily thick till, water is obtained from sand and gravel lenses interbedded in the glacial till. Such areas include the ground moraine and end moraines of northern Ashland County.

Yields exceeding 500 gpm are obtainable from the coarse, well-sorted sand and gravel outwash deposits along Jerome Fork near Ashland and for Black Fork in the vicinity of Charles Mill Reservoir (ODNR, Division of Water Open File, Glacial State Aquifer Map, 2000 and Schmidt, 1979). These aquifers have modern, overlying streams that provide recharge to sustain these high yields. Test drilling or geophysical methods are recommended to help locate the higher yielding zones. Proper well construction and development is also needed to insure the high sustainable yields capable from these larger diameter wells. Smaller diameter wells should be suitable for serving domestic/farm needs within this aquifer. Yields of 100 to 500 gpm are obtained from wells completed in coarse, well-sorted outwash deposits. These deposits are found along Black Fork northwest of Loudonville (ODNR, Division of Water Open File, Glacial State Aquifer Map, 2000 and Schmidt, 1979). These high yielding deposits commonly are nearby modern overlying streams or are overlain by permeable kame fields.

Yields of 25 to 100 gpm are obtained from wells drilled in outwash, lacustrine, alluvial, or kame deposits. Typically, these deposits are thinner, less coarse, and are not as clean or well-sorted as the above, higher-yielding aquifers. They also may not have nearby overlying streams. The sand and gravel units may be interbedded with finer-grained silty to clayey lacustrine or alluvial deposits or till. Aquifers yielding 25 to 100 gpm are commonly found along the margins, in the headwaters, or along tributaries leading toward the higher-yielding buried valley deposits in the county (ODNR, Division of Water Open File, Glacial State Aquifer Map, 2000 and Schmidt, 1979).

Yields of 5 to 25 gpm are obtained from thin lenses of sand and gravel interbedded with glacial till where the drift is of adequate thickness. This includes areas of ground moraine and end moraine in northern Ashland County. In many portions of central and southern Ashland County, the drift is too thin to be utilized as an aquifer and the presence of good, underlying sandstone aquifers helps minimize the number of wells completed in the drift found in these locales (ODNR, Division of Water Open File, Glacial State Aquifer Map, 2000 and Schmidt, 1979).

Yields from the consolidated, bedrock aquifers throughout the county are variable. The highest-yielding bedrock aquifers are the coarse, highly fractured zones of the Mississippian Logan and Black Hand Formations (ODNR, Division of Water, Bedrock State Aquifer Map, 2000 and Schmidt, 1979). These erosion-resistant units form the steep, higher-relief ridges in the southwestern third of the county and typically yield 25 to 100 gpm (ODNR, Division of Water Open File, Bedrock State Aquifer Map, 2000 and Schmidt, 1979). Yields ranging from 5 to 25 gpm are associated with the interbedded shales, fine-grained sandstones, and siltstones of the Cuyahoga Formation. These aquifers are widespread across northern, central, and eastern Ashland County. Wells drilled into the sandstones and shales of the Cuyahoga Group in the northern third of the county may encounter brackish water or water with high concentrations of calcium sulfate (ODNR, Division of Water Open File, Bedrock State Aquifer Map, 2000 and Schmidt, 1979).

The dirty sandstones, shales, and siltstones of the Pennsylvanian Allegheny-Pottsville Groups in southern Hanover Township are too thin and fine-grained to be good aquifers. Wells typically are drilled through these formations and are completed in the underlying sandstones (ODNR, Division of Water, Open File, Bedrock State Aquifer Map, 2000 and Schmidt, 1979).

The yield in any particular area is dependent upon the number and type of formations through which the well is drilled. Wells drilled in bedrock often encounter several aquifers or water-producing zones. Sandstones and conglomerates tend to be better water-bearing units than shales or siltstones. Water tends to "perch" or collect on top of lower permeability units (e.g. shale) and move laterally along the base of an overlying unit with higher permeability (e.g. sandstone). Springs and seeps mark where these contacts meet the slope or land surface. The number of fractures and bedding planes intersected by the well also influences yields. The amount of fracturing tends to increase along hill slopes and valleys. Fracturing is also an influence on the direction of ground water flow (Schubert, 1980) and affects the amount of recharge.

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APPENDIX A
DESCRIPTION OF THE LOGIC IN FACTOR SELECTION

Depth to Water

This factor was primarily evaluated using information from water well log records on file at the Ohio Department of Natural Resources (ODNR), Division of Soil and Water Resources, Water Resources Section (WRS). Approximately 7,914 water well log records are on file for Ashland County. Data from roughly 3,245 located water well log records were analyzed and plotted on U.S.G.S. 7-1/2 minute topographic maps during the course of the project. Static water levels and information as to the depths at which water was encountered were taken from these records. The *Ground Water Resources of Ashland County* (Schmidt, 1979) provided generalized depth to water information throughout the county. Depth to water trends mapped in adjoining Lorain County (Barber, 1989), Huron County (Powers, et al., 2003), Knox County (Aller and Ballou, 1990), Richland County (Angle, 2003), Holmes and Wayne Counties (Angle and Akins, 2002), and Medina County (Angle, 1994) were used as a guideline.

Depths to water of 5 to 15 feet (9) were typical of areas associated with floodplains of major streams. Depths of 5 to 15 feet (9) were also chosen for certain areas of ground moraine and end moraine in northern Ashland County. Depths of 15 to 30 feet (7) were used for stream terraces adjacent to major streams and along smaller tributaries. Depths to water of 15 to 30 feet were also common in areas of ground moraine and end moraine in northern Ashland County. Depths of 30 to 50 feet (5) were utilized for upland areas with lower relief and for margins of buried valleys that are not in close proximity to modern streams. Depths to water of 50 to 75 feet (3) were utilized for steeper slopes and moderate ridge tops in the uplands and in deeper buried valleys, which lack modern surficial streams. Depths to water of 75 to 100 feet (2) and greater than 100 feet (1) were selected for steep slopes and ridge tops associated with the resistant sandstones of southern Ashland County.

Net Recharge

This factor was evaluated using many criteria, including depth to water, topography, soil type, surface drainage, vadose zone material, aquifer type, and annual precipitation. General estimates of recharge provided by Pettyjohn and Henning (1979) and Dumouchelle and Schiefer (2002) proved to be helpful. Recharge is the precipitation that reaches the aquifer after evapotranspiration and run-off. Recharge ratings from adjoining Lorain County (Barber, 1989), Huron County (Powers, et al., 2003), Knox County (Aller and Ballou, 1990), Richland County (Angle, 2003), Holmes and Wayne Counties (Angle and Akins, 2002), and Medina County (Angle, 1994) were used as a guideline.

Recharge values of 7 to 10 inches per year (8) were assigned to floodplains adjacent to modern streams overlying outwash buried valley deposits. These areas contain highly permeable soils, vadose, and aquifer materials, have shallow depths to water, gentle slopes, and surficial streams. These areas are limited to terraces and floodplains underlain by coarse-grained outwash deposits. Values of 4 to 7 inches per year (6) were used for areas with moderate recharge. These areas include margins of buried valleys and uplands. Such areas also tend to have moderately shallow depths to water and lower permeability soils, or areas with moderate depths to water and moderately permeable soils, vadose, and aquifers. Values of 2 to 4 inches per year (3) were utilized for steep slopes and ridge tops in uplands associated with resistant sandstone bedrock. Greater depths to water, lower permeability soils, and steep slopes with high runoff characterize these areas of lower recharge. Values less than 2 inches per year (1) were used in some of the 7G-Thin Till over Bedded Sedimentary Rock hydrogeologic setting. These areas tend to lack soil and have very high run-off rates, steep slopes, and fairly great depths to water.

Aquifer Media

Information on evaluating aquifer media was obtained from the reports and maps of Schmidt (1979), Totten (1973), White (1977), ODNR, Division of Water, Glacial State Aquifer Map (2000) and Bedrock State Aquifer Map (2000). Open File Bedrock Reconnaissance Maps and Open File Bedrock Topography Maps, based upon U.S.G.S. 7-1/2 minute topographic maps from the ODNR, Division of Geological Survey proved helpful. Aquifer media data from adjoining Lorain County (Barber, 1989), Huron County (Powers, et al., 2003), Knox County (Aller and Ballou, 1990), Richland County (Angle, 2003), Holmes and Wayne Counties (Angle and Akins, 2002), and Medina County (Angle, 1994) were used as a guideline. Water well log records on file at the ODNR, Division of Water, were the primary source of aquifer information.

An aquifer rating of (8) was designated for the high-yielding sand and gravel outwash deposits underlying portions of Jerome Fork and and Black Fork in the vicinity of Charles Mill Reservoir. An aquifer rating of (7) was assigned to thinner, less continuous sand and gravel outwash deposits associated with portions of Jerome Fork, Black Fork, and Muddy Fork. These outwash deposits also tend to be somewhat finer-grained and less well sorted. An aquifer rating of (7) was also utilized for ice-contact deposits such as kames and eskers. An aquifer rating of (6) was used for some thinner sand and gravel deposits associated with tributaries and margins of the major buried valleys. An aquifer rating of (5) was used for the thin sand and gravel lenses interbedded with thick sequences of fined-grained glacial till in uplands and areas of ground moraine and end moraine in northern Ashland County. An aquifer rating of (5) was used for thin sand and gravel lenses interbedded with fine-grained till or lacustrine materials found in the headwaters of tributaries to buried valleys

Sandstone was designated for the aquifer primarily in wells in which sandstone was encountered. These areas are associated with the Mississippian Logan and Black Hand Formations throughout southwestern Ashland County. An aquifer rating of (5) was used for these aquifers. Wells that encounter both sandstone and shale were common in eastern and northern Ashland County. The aquifer in these areas was evaluated as being interbedded sandstone and shale even if the majority of the yield was probably derived from the sandstone. These areas are associated with the Mississippian Cuyahoga Formation. An aquifer rating of (5) was utilized for portions of the Cuyahoga Formation in eastern and north-central Ashland County. In these areas the Cuyahoga Formation contained a higher proportion of sandstone or was associated with steeper ridge tops that are more extensively fractured. An aquifer rating of (4) was assigned to more shaley portions of the Cuyahoga

Formation in northeastern Ashland County. Shale was evaluated as the aquifer for wells completed in shale in which sandstone was absent or not encountered in nearby well logs. Shale aquifers were limited to areas adjacent to Huron, Lorain, and Medina Counties where relatively thin, clayey end moraine deposits overlie very shale-rich units of the Cuyahoga Formation. An aquifer rating of (2) was utilized for shale aquifers.

Soils

Soils were mapped using the data obtained from the United States Department of Agriculture, Natural Resource Conservation Service Soil Data Mart for Ashland County. Each soil type was evaluated and given a rating for soil media. Evaluations were based upon the texture, permeability, and shrink-swell potential for each soil material. The soils of Ashland County showed a high degree of variability. This is a reflection of the parent material. Table 11 is a list of the soils, parent materials, setting, and corresponding DRASTIC values for Ashland County.

Soils were considered to be Thin/Absent (10) along many steep, prominent ridge tops and slopes where bedrock was exposed in south-central and east-central Ashland County. These soils are also common in the non-glaciated area of Hanover Township in southern Ashland County. Shrink-swell (aggregated) clays (7) were evaluated for limited shale-rich ridge tops associated with Pennsylvanian Allegheny-upper Pottsville Formations in the southwestern corner of Ashland County. Locally, these fine-grained shales weather into thin, very clay-rich soils. Sandy loams (6) were selected for soils overlying outwash terraces, plains, and kames overlying buried valleys. Sandy loam soils (6) were also selected for steep, residual sandstone ridges that flank buried valleys in the southwestern portion of the county. Loam soils (5) were designated for soils derived from coarser, ablational glacial till that caps portions of end moraines along the Huron County border. Silt loam (4) soils were evaluated for loamy glacial till-covered areas of the county. Silt loam (4) was also selected for silty alluvial and lacustrine deposits on floodplains. Clay loam (3) soils were evaluated for areas with clay-rich glacial till, primarily in central and northern Ashland County.

The Rittman-Wadsworth soils, the Ravenna-Canfield-Frenchtown-Wooster soils, and the Gresham-Hanover-Titusville soils, 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 (Ritchie et al., 1974 and Williams, 1991). 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 evaluated as a silt loam (4), and a soil with a silt loam (4) texture would be evaluated as a clay loam (3) due to the presence of a fragipan (see Table 11).

Table 11. Ashland County soils

Soil Name	Parent Material or Setting	DRASTIC Rating	Soil Media
Alexandria	Silty till	3	Clay loam
Algiers	Alluvium, floodplain	4	Silt loam
Amanda	Loamy till	4	Silt loam
Bennington	Clayey till	3	Clay loam
Berks	Shale-fine sandstone	10	Thin/Absent
Bogart	Outwash, kames	6	Sandy loam
Brownsville	Sandstone, shale	10	Thin/Absent
Canfield*	Loamy till	4	Silt loam
Cardington	Silty till	3	Clay loam
Carlisle	Bogs, depressions	8	Peat
Chili	Outwash, kames	6	Sandy loam
Cidermill	Allluvium over outwash terraces	6	Sandy loam
Conotton	Coarse outwash	10	Gravel
Condit	Clayey till	3	Clay loam
Coshocton	Shale/siltstone bedrock	3	Clay loam
Ellsworth	Till	3	Clay loam
Fitchville	Silty lacustrine terrace	4	Silt loam
Frenchtown*	Loamy till	4	Silt loam
Gilpin	Sandstone/siltstone bedrock	10	Thin/Absent
Glenford	Silty lacustrine	4	Silt loam
Haskins	Thin outwash over till	4	Silt loam
Holly	Coarse alluvium	6	Sandy loam
Jimtown	Outwash	6	Sandy loam
Killbuck	Alluvium, floodplain	4	Silt loam
Latham	Shale/siltstone	7	Shrink-swell clay
Linwood	Bogs, depressions	2	Muck
Lobdell	Alluvium, floodplain	4	Silt loam
Lordstown	Sandstone	10	Thin/Absent
Loudonville	Sandstone bedrock	10	Thin/Absent
Luray	Silty lacustrine	4	Silt loam
Lykens	Thin outwash over till	4	Silt loam
Mahoning	Till	3	Clay loam
Mechanicsburg	Thin till over sandstone/siltstone	4	Silt loam
Orrville	Alluvium, floodplain	4	Silt loam
Oshtemo	Outwash	6	Sandy loam
Pewamo	Clayey till	3	Clay loam
Ravenna*	Loamy till	4	Silt loam
Rawson	Thin outwash over till	6	Sandy loam
Riddles	Loess over till	3	Clay loam
Rigley	Thick sandstone residuum	6	Sandy loam
Rittman*	Silty till	3	Clay loam
Schaffenaker	Sandstone outcrops	10	Thin/Absent
Sebring	Lacustrine over till	3	Clay loam
Shoals	Alluvium, floodplain	4	Silt loam
Sloan	Alluvium, floodplain	4	Silt loam
Tiro	Lacustrine over till	3	Clay loam
Titusville*	Illinoian till	3	Clay loam
Trumbull	Till	3	Clay loam

Soil Name	Parent Material or Setting	DRASTIC Rating	Soil Media
Wadsworth*	Silty till	3	Clay loam
Walkill	Kettle, depression	8	Peat
Westmoreland	Sandstone/siltstone bedrock	4	Silt loam
Wheeling	High lacustrine terraces	4	Silt loam
Wooster*	Loamy till	4	Silt loam

* denotes soils containing a fragipan

Topography

Topography, or percent slope, was evaluated using U.S.G.S. 7-1/2 minute quadrangle maps. Slopes of 0 to 2 percent (10) and 2 to 6 percent (9) were selected for flat-lying floodplains, valley floors, and terraces. Slopes of 0 to 2 (10) and 2 to 6 percent (9) were also used for flat lying ground moraine or till plain areas on the uplands. Slopes of 6 to 12 percent (5) were used for less steep bedrock-controlled topography, for steeper kame features, and for areas of end moraines. Slopes of 12 to 18 percent (3) and greater than 18 percent (1) were selected for steeper slopes in higher relief, upland areas. These areas have bedrock-controlled topography and drift is thin or absent. These steep areas are common in southern Ashland County and along isolated ridge tops in east-central Ashland County.

Impact of the Vadose Zone Media

Information on evaluating vadose zone media was obtained from the reports and maps of Schmidt (1979), Totten (1973), and White (1977). Vadose zone media data from adjoining Lorain County (Barber, 1989), Huron County (Powers, et al., 2003), Knox County (Aller and Ballou, 1990), Richland County (Angle, 2003), Holmes and Wayne Counties (Angle and Akins, 2002), and Medina County (Angle, 1994) proved useful as a guideline for evaluating vadose zone materials. Open File Bedrock Reconnaissance Maps based upon U.S.G.S. 7-1/2 minute topographic maps from the ODNR, Division of Geological Survey proved helpful. The ODNR, Division of Water, Glacial State Aquifer Map and Bedrock State Aquifer Map were important sources of vadose zone media data. Water well log records on file at the ODNR, Division of Water, were the primary source of information on vadose zone media for the county.

Vadose zone media was given ratings of (6) and (7) for sand and gravel interbedded with silt and clay layers for outwash terraces, kames, and coarse alluvium overlying buried valleys. Vadose zone media ratings of (5) and (6) were selected for sand and gravel interbedded with silt and clay layers for deposits overlying buried valleys and alluvium. These ratings depend upon the proportion of coarse, well-sorted outwash to the finer-grained alluvial and lacustrine deposits. Silt and clay with ratings of (4) and (5) were selected for vadose zone media for fine-grained alluvial deposits associated with minor tributaries and the headwaters of streams throughout Ashland County. Silt and clay (3) was also chosen as the vadose zone media for some areas of moraines found in northern Ashland County that contain highly clayey Hiram Till.

Till with a rating of (5) was utilized for loamy glacial tills associated with the Navarre Till in Green and Hanover Townships. Till was also given a rating of (5) where the till was relatively thin, weathered, and presumably fractured through much of its extent. Till with a rating of (5) was also used in some areas where till had incorporated large amounts of sand from sandstone outcrops. Till with a rating of (4) was used for more clayey-textured tills and for tills of significant thickness in which the majority of the till would be unweathered and fractured to a lower degree. Till with a rating of (4) was used for silty to clayey tills associated with the Hayesville Till and Hiram Till in central and northern Ashland County. Till with a rating of (3) was also used for till which had incorporated large amounts of fine-grained shale in the northern part of the county.

A vadose zone media rating of (5) was selected for sandstone associated with the Mississippian Black Hand Sandstone and Logan Formation and some sandstone-rich units of the Cuyahoga Formation. Vadose zone media ratings of (4), (5), or (6) were chosen for interbedded sandstone and shale of the Cuyahoga Formation that capped uplands in central and eastern Ashland County, with the rating based on the absence or presence of till over the bedrock, and the degree of fracturing of the bedrock. The interbedded sandstone, shales, and limestones in the non-glaciated portion of Hanover Township were also given a vadose rating of (5) due to the absence of a till covering and weathered nature of the bedrock. A rating of (4) was selected for interbedded sandstone and shale for a shale-rich area of the Cuyahoga Formation in northern Ashland County.

Hydraulic Conductivity

Mapping in adjoining Lorain County (Barber, 1989), Huron County (Powers, et al., 2003), Knox County (Aller and Ballou, 1990), Richland County (Angle, 2003), Holmes and Wayne Counties (Angle and Akins, 2002), and Medina County (Angle, 1994) were used as a guideline for determining the range of hydraulic conductivity values. The ODNR, Division of Water, Glacial State Aquifer Map (2000) and Bedrock State Aquifer Map (2000) proved valuable. Water well log records on file at the ODNR, Division of Water, were the primary sources of information. Textbook tables (Freeze and Cherry, 1979, Fetter, 1980, and Driscoll, 1986) were useful in obtaining estimated values for hydraulic conductivity in a variety of sediments.

Values for hydraulic conductivity correspond to aquifer ratings; i.e., the more highly rated aquifers have higher values for hydraulic conductivity. For sand and gravel aquifers with an aquifer rating of (8), 700-1,000 gpd/ft^2 (6) were selected. These high values were limited to the clean outwash and kame deposits associated with buried valleys underlying Jerome Fork and Black Fork. For sand and gravel deposits associated with buried valleys with an aquifer media rating of (7), hydraulic conductivities of 700-1000 gpd/ft^2 (6) and 300-700 gpd/ft^2 (4) were chosen. These ratings vary upon how coarse, clean (free of fines), and well-sorted the permeable deposits are. For sand and gravel deposits with an aquifer rating of (6), hydraulic conductivity values ranged from 300-700 gpd/ft^2 (4). For sand and gravel deposits with an aquifer rating of (5), hydraulic conductivity values ranged from 300-700 gpd/ft^2 (4) or 100-300 gpd/ft^2 (2). In these deposits, thin sand and gravel lenses are interbedded with thicker sequences of finer-grained materials.

Sandstone aquifers with an aquifer rating of (5) have been assigned a hydraulic conductivity rating 100-300 gpd/ft^2 (2). These rocks tend to be relatively coarse-grained, porous, and highly fractured. Interbedded sandstone and shales with aquifer ratings of (5) or (4) were given hydraulic conductivity ratings of 1-100 gpd/ft^2 (1). All of the shale aquifers with an aquifer rating of (2) were given a hydraulic conductivity rating of 1-100 gpd/ft^2 (1) due to the low permeability of these rocks.

APPENDIX B

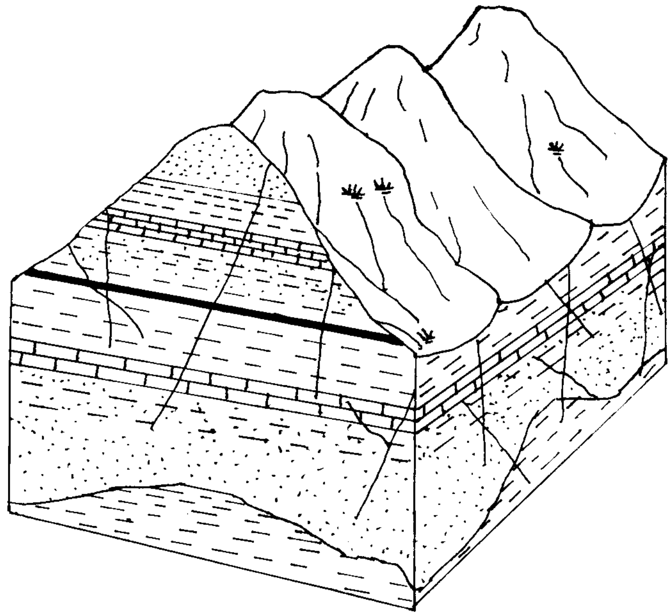
DESCRIPTION OF HYDROGEOLOGIC SETTINGS AND CHARTS

Ground water pollution potential mapping in Ashland County resulted in the identification of 10 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 12. Pollution potential indexes computed for Ashland County range from 66 to 176.

Table 12. Hydrogeologic settings mapped in Ashland County, Ohio

Hydrogeologic Settings	Range of GWPP Indexes	Number of Index Calculations
6Da-Alternating sandstone, limestone, shale-thin regolith	66-93	23
7Aa-Glacial till over bedded sedimentary rock	70-134	81
7Ad-Glacial till over sandstone	70-122	33
7Ae-Glacial till over shale	81-111	29
7Af-Sand and gravel interbedded in glacial till	112-129	11
7Bb-Outwash over bedded sedimentary rock	106-121	4
7C-Moraine	71-134	37
7D-Buried valley	75-176	156
7Ec-Alluvium over bedded sedimentary rock	111-133	9
7G-Thin glacial till over bedded sedimentary rock	74-131	31

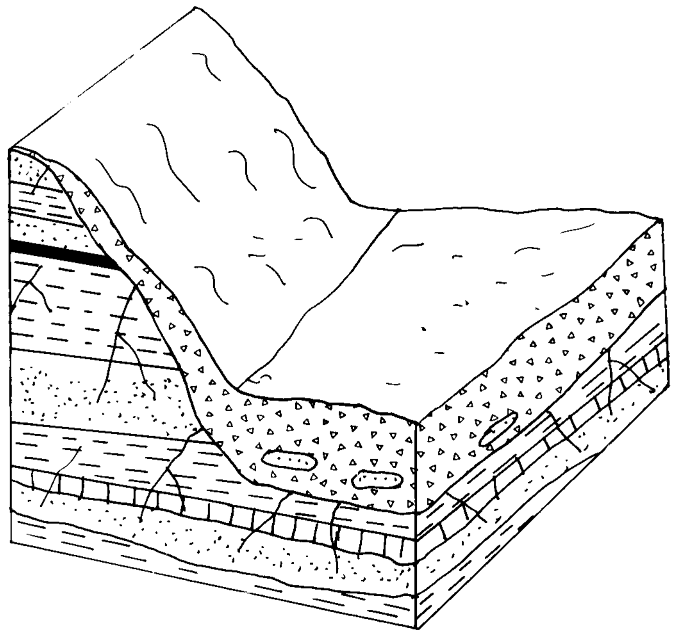
The following information provides a description of each hydrogeologic setting identified in the county, a block diagram illustrating the characteristics of the setting, and a listing of the charts for each unique combination of pollution potential indexes calculated for each setting. The charts provide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



6Da Alternating Sandstone, Limestone, Shale – Thin Regolith

This hydrogeologic setting is limited to the unglaciated region of Hanover Township in southern Ashland County. The area is characterized by high relief with broad, steep slopes and narrow, somewhat flatter ridge tops. The vadose zone and aquifers consist of slightly dipping, fractured, alternating sequences of dirty sandstones, shales, thin limestones, clays, and coals of the Mississippian Cuyahoga Group and Pennsylvanian Allegheny and Pottsville Groups, as well as the sandstone, shale, and siltstone of the Mississippian Logan and Black Hand Formations. Multiple aquifers are typically present. Depth to water is generally deep; shallower perched zones may overlie low permeability shales, limestones, and clays. Soils are generally thin to absent on steeper slopes. On gentler slopes, soils vary with the bedrock lithology. Variable supplies of ground water are obtained from intersecting bedding planes or vertical fractures. Ground water yields average 0 to 5 gpm for the Allegheny and Pottsville Group, 5 to 25 gpm for the Cuyahoga Group, and 25 to 100 gpm for the Logan and Black Hand Formations. Recharge is limited due to the steep slopes, deep aquifers, and layers of impermeable bedrock.

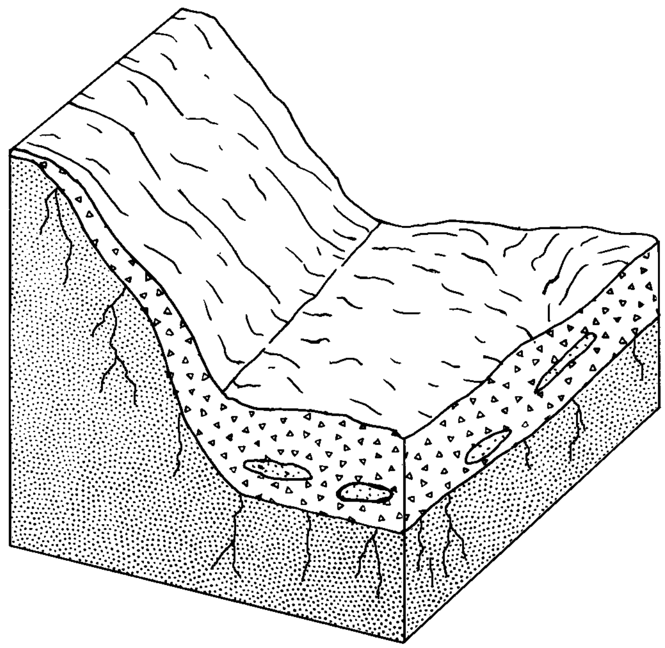
GWPP index values for the hydrogeologic setting of Alternating Sandstone, Limestone, Shale – Thin Regolith range from 66 to 93 with the total number of GWPP index calculations equaling 23.



7Aa Glacial Till over Bedded Sedimentary Rock

This hydrogeologic setting is common over much of Ashland County. This setting is associated with upland areas and commonly features bedrock-controlled topography. Topography varies from rolling, moderate relief areas with moderately thick till cover to steeper, higher relief areas associated with bedrock ridges. Well log data indicates that wells in this setting encounter both sandstone and shale sequences. The aquifer typically consists of thin interbedded shales, sandstones, and siltstones of the Mississippian Cuyahoga Group; however, in the southwestern portion of the county, the aquifer consists of the sandstones of the Logan and Black Hand Formations. Yields for wells completed in the Cuyahoga Group range from 5 to 25 gpm, while yields in the Logan and Black Hand Formations range from 25 to 100 gpm. The thickness of glacial till typically overlying the aquifer is highly variable. The various till units commonly weather into either silty loams or clay loams. Where the till is thin and depths to water greater, the interbedded sandstone and shale are inferred as being the vadose zone media. The depth to water is variable, ranging from 15 feet to up to 100 feet. The depth to water is significantly higher for the steeper ridge tops. Recharge is typically low to moderated due to low permeability soils, thickness of the till cover, and depth to water.

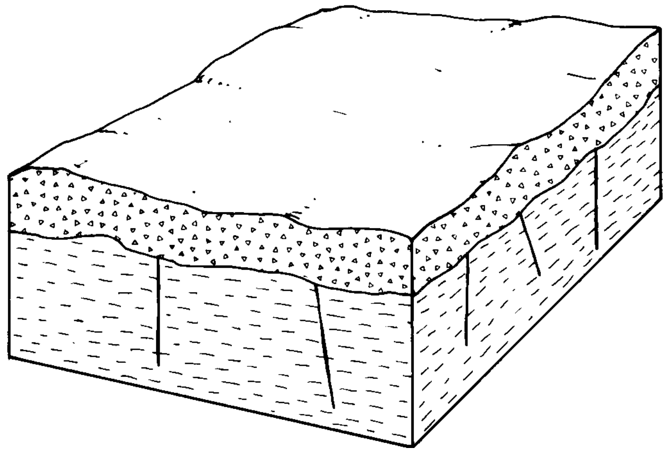
GWPP index values for the hydrogeologic setting of Glacial Till over Bedded Sedimentary Rock range from 70 to 134, with the total number of GWPP index calculations equaling 81.



7Ad Glacial Till over Sandstone

This hydrogeologic setting is found in southwestern Ashland County. It is typically associated with resistant, steep-sided ridges with moderately broad, flat ridge tops. The topography varies from gently rolling to relatively steep. Depths to water vary from moderate to deep. Soils are clay loams or silt loams derived from tills. The vadose zone is composed primarily of glacial till. The aquifer consists of the Mississippian Logan and Black Hand Formations. Yields range from 25 to 100 gpm depending upon the various sandstone units present. Recharge is commonly moderate to low due to low permeability soils and vadose, variable depths to water, and moderately steep slopes.

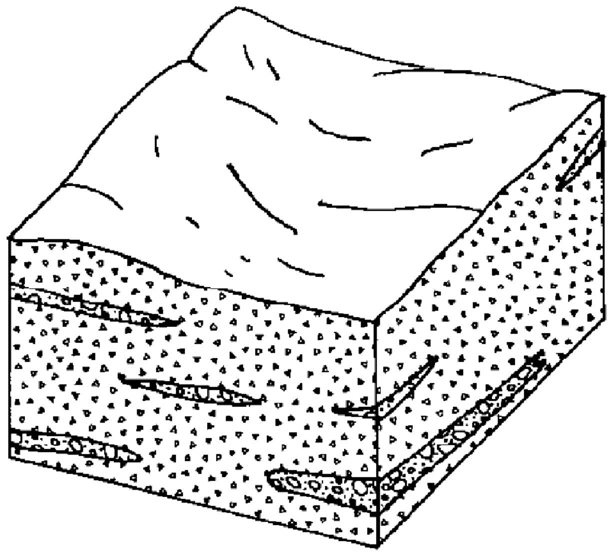
GWPP index values for the hydrogeologic setting of Glacial Till over Sandstone ranges from 70 to 122, with the total number of GWPP index calculations equaling 33.



7Ae Glacial Till over Shale

This hydrogeologic setting is common in northern Ashland County. This setting is characterized by relatively flat-lying to gently rolling topography. The setting is associated with clayey glacial till overlying shaley bedrock of the Mississippian Cuyahoga Group. Wells are completed in the shale and siltstone bedrock which, in the northern half of Ruggles, Troy, and Sullivan Townships, may produce brackish water. Yields are commonly less than 5 gpm. Soils are clay loams, loams, or silt loams derived from the underlying tills. The vadose zone is till or fractured till, which was denoted as sand and gravel with significant silt and clay or as silt and clay depending upon the texture of the till. Depths to water are commonly shallow, averaging less than 20 feet. Recharge is moderate to low due to the low permeability of the soils, vadose, and aquifer media itself and the very shallow depth to water.

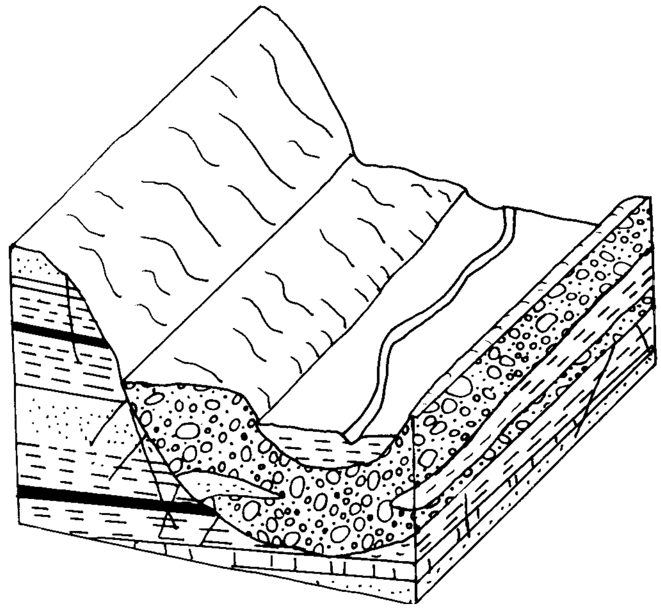
GWPP index values for the hydrogeologic setting of Glacial Till over Shale ranges from 81 to 111, with the total number of GWPP index calculations equaling 29.



7Af Sand and Gravel Interbedded in Glacial Till

This hydrogeologic setting occurs mainly in the northeast corner of Jackson Township, and in scattered locations along the western border of the county. The setting encompasses areas where sand and gravel lenses interbedded within till are the aquifer. It is associated with relatively thick sequences of glacial till associated with areas of ground moraine. The setting is characterized by relatively flat-lying to rolling topography. Drift is commonly thicker than in adjacent settings with bedrock aquifers. Soils are usually clay loams or silt loams derived from the weathering of glacial tills. The sand and gravel aquifers are typically thin, discontinuous, lenses. Yields average from 5 to 25 gpm and are adequate for domestic purposes. Till is the vadose zone media. Depth to water is commonly shallow to moderate depending upon how deep the sand and gravel lenses are. Recharge is moderate due to the low relief, moderate depths to the water table, moderate thickness of the till, and low permeability soils.

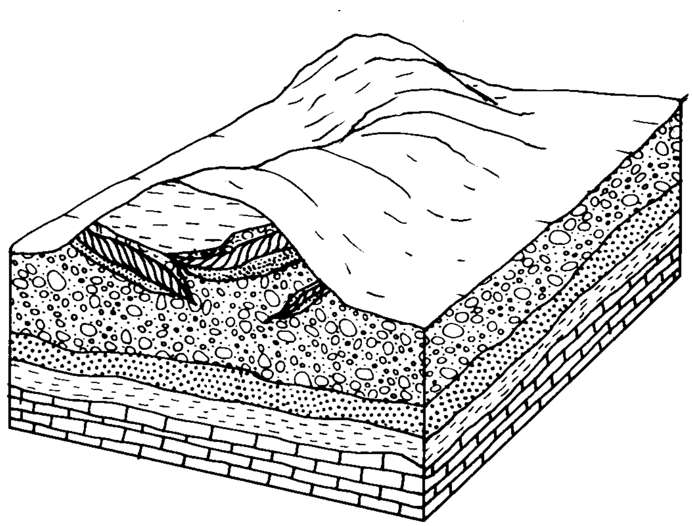
GWPP index values for the hydrogeologic setting of Sand and Gravel Interbedded in Glacial Till range from 112 to 129, with the total number of GWPP index calculations equaling 11.



7Bb Outwash over Bedded Sedimentary Rock

This hydrogeologic setting consists of relatively small, high-level outwash terraces that set on top of bedrock benches located in a limited area east of a buried valley underlying current day Muddy Fork. The total thickness of drift is not adequate to be considered buried valleys. Relief is rolling to moderately steep depending upon the amount of local stream dissection. Vadose zone media consists of sandy to gravelly outwash interbedded with silt and clay. Soils are sandy or silty loams. The outwash terraces are not thick enough to comprise the aquifer; underlying fractured sandstone and shale interbeds serve as the aquifer. Yields average 5 to 25 gpm. The overlying terraces are typically in direct contact with the underlying bedrock aquifer. Depth to water is shallow to moderate and is usually less than 50 feet. Recharge is moderately high due to the relatively permeable soils and vadose, moderate to shallow depth to water, and the moderately steep topography.

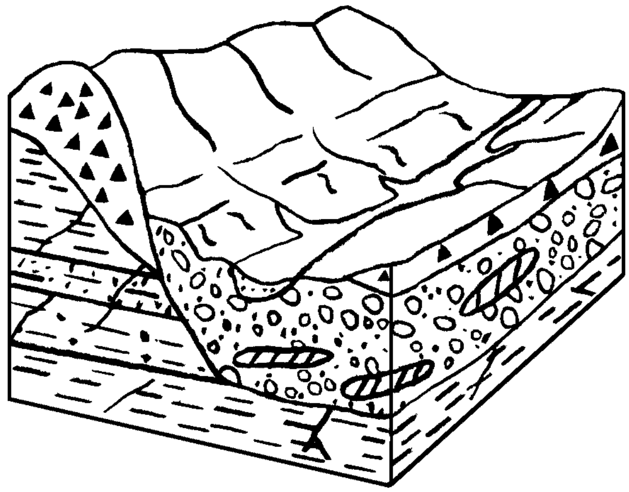
GWPP index values for the hydrogeologic setting of Outwash over Bedded Sedimentary Rock range from 106 to 121, with the total number of GWPP index calculations equaling 4.



7C-Moraine

This hydrogeologic setting consists of segments of the end moraines that cross Ashland County. This setting is characterized by hummocky to rolling topography. Relief tends to become steeper near the margins of the moraine, especially if enhanced by the downcutting of an adjacent stream. The aquifer consists of relatively thin sand and gravel lenses interbedded with glacial till within the moraine. These sand and gravel deposits differ as to lateral extent and thickness and are found at variable depths. Yields range from the 5 to 25 gpm. If sand and gravel lenses are not encountered or if they are too thin, wells are completed in the underlying sandstone, shale, or interbedded sandstone and shale bedrock. The vadose zone is composed of loamy to clayey glacial till, or sand and gravel with significant silt and clay. The till may be fractured or jointed, particularly in areas where it is predominantly thin and weathered. Depth to water is variable and depends primarily upon how deep the underlying aquifer is. Soils are commonly clay loams. Recharge is moderately high due to the proximity of sand and gravel lenses to the surface and the amount of weathering and fracturing in the till. The end moraines are the primary local sources of recharge.

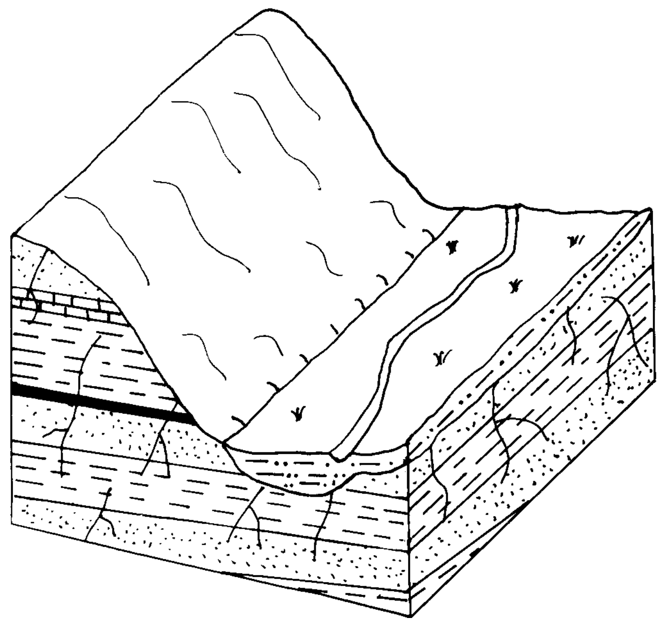
GWPP index values for the hydrogeologic setting of Moraine range from 71 to 134, with the total number of GWPP index calculations equaling 37.



7D Buried Valley

This hydrogeologic setting is widespread through Ashland County. An extensive network of pre-glacial and interglacial rivers created the buried valleys that downcut into the bedrock. The block diagram above shows the typical form of buried valley deposit, which is exemplified by Jerome Fork from Clear Creek Township southeast to Mohican Township, and Black Fork near Charles Mill Lake in Mifflin Township. These valleys are occupied by a modern river and floodplain and contain abundant outwash and kame deposits. The upper portion of these valleys contains 50 to 100 feet of sand and gravel interbedded with alluvium. Depth to water is typically less than 30 feet. Yields over 100 gpm are obtainable from large diameter wells developed in the sand and gravel deposits. Soils are typically sandy loams or silt loams. The streams are in direct connection with the aquifer and recharge is typically high. GWPP index values for these settings are usually over 125 in the main channel of the buried valley, and somewhat lower in the tributary channels.

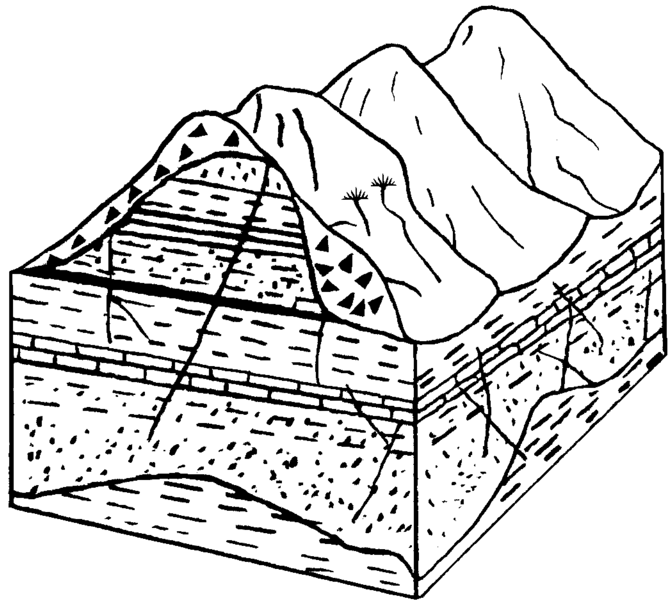
GWPP index values for the hydrogeologic setting of Buried Valley range from 75 to 176, with the total number of GWPP index calculations equaling 156.



7Ec Alluvium Over Bedded Sedimentary Rock

This hydrogeologic setting is found in upland areas throughout Ashland County. This setting consists of the headwaters of small tributary streams in upland areas with thin glacial cover. The setting is characterized by narrow, flat-bottomed stream valleys, which are flanked by rolling to steep bedrock-controlled uplands. The aquifer consists of fractured, interbedded sandstone and shale of the Mississippian Cuyahoga Group or sandstones of the Mississippian Logan and Black Hand Formations. Yields developed from wells intersecting fractures and bedding planes of the bedrock range from 5 to 25 gpm. Soils vary but are usually silty loams. Vadose zone media is typically silty, fine-grained alluvium. The depth to water is commonly shallow, averaging from 10 to 35 feet. The alluvium is commonly in direct hydraulic connection with the underlying aquifer. Recharge is moderately high due to the shallow depth to water, flat-lying topography, proximity of modern streams, and the moderately low permeability of the soils, alluvium, and bedrock.

GWPP index values for the hydrogeologic setting of Alluvium over Bedded Sedimentary Rocks ranges from 111 to 133, with the total number of GWPP index calculations equaling 9.



7G Thin Glacial Till Over Bedded Sedimentary Rock

This hydrogeologic setting is found in upland areas of southern Ashland County. The setting is characterized by rolling to steep bedrock-controlled topography and deposits of thin, patchy glacial till overlying layers of fractured sedimentary rock. The rock is typically resistant sandstone, but also includes shale. The till is commonly less than 5 feet thick and consists of varying amounts of unsorted clay, silt, and sand with minor pebbles and cobbles. Due to its thin nature, the till is probably weathered and fractured. The till may be absent in some areas along steep slopes. Due to the thin nature of the tills and soil, fractured bedrock is the vadose zone media. The majority of the area covered with Illinoian-age till falls within this hydrogeologic setting. Ground water is obtained from the underlying, fractured Mississippian bedrock. Depth to water is usually relatively deep, especially along ridge tops. Soils are evaluated as Thin/Absent, especially along steeper slopes and rock outcrops. Recharge is low due to depth to water, relatively steep slopes, and the high runoff due to the lack of a thick, permeable soil layer.

GWPP index values for the hydrogeologic setting of Thin Glacial Till over Bedded Sedimentary Rock range from 74 to 131, with the total number of GWPP index calculations equaling 31.

Table 13. Hydrogeologic Settings, DRASTIC Factors, and Ratings

Setting	Depth to Water	Recharge	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
6Da1	75-100	0-2	Interbedded ss/sh/ls	Thin/Absent	18+	Interbedded ss/sh/ls	100-300	81	106
6Da2	100+	2-4	Interbedded ss/sh/ls	Silty Loam	6-12	Interbedded ss/sh/ls	100-300	84	98
6Da3	50-75	0-2	Interbedded ss/sh/ls	Thin/Absent	6-12	Interbedded ss/sh/ls	100-300	90	123
6Da4	50-75	0-2	Sandstone	Thin/Absent	6-12	Sandstone	100-300	90	123
6Da5	100+	2-4	Sandstone	Silty Loam	6-12	Sandstone	100-300	84	98
6Da6	50-75	0-2	Sandstone	Silty Loam	6-12	Sandstone	100-300	78	93
6Da7	50-75	0-2	Sandstone	Thin/Absent	18+	Sandstone	100-300	86	111
6Da8	50-75	0-2	Sandstone	Silty Loam	18+	Sandstone	100-300	74	81
6Da9	75-100	0-2	Sandstone	Thin/Absent	18+	Sandstone	100-300	81	106
6Da10	75-100	2-4	Sandstone	Thin/Absent	6-12	Sandstone	100-300	93	126
6Da11	75-100	2-4	Interbedded ss/sh/ls	Thin/Absent	6-12	Interbedded ss/sh/ls	100-300	93	126
6Da12	100+	0-2	Sandstone	Thin/Absent	0-2	Sandstone	100-300	85	128
6Da13	100+	0-2	Sandstone	Thin/Absent	12-18	Sandstone	100-300	78	107
6Da14	100+	0-2	Sandstone	Silty Loam	12-18	Sandstone	100-300	66	77
6Da15	100+	0-2	Sandstone	Thin/Absent	18+	Sandstone	100-300	76	101
6Da16	100+	2-4	Sandstone	Thin/Absent	6-12	Sandstone	100-300	88	121
6Da17	100+	0-2	Sandstone	Thin/Absent	6-12	Sandstone	100-300	80	113
6Da18	100+	2-4	Sandstone	Thin/Absent	2-6	Sandstone	100-300	92	133
6Da19	100+	2-4	Sandstone	Thin/Absent	0-2	Sandstone	100-300	93	136
6Da20	50-75	0-2	Sandstone	Clay Loam	6-12	Sandstone	100-300	76	88
6Da21	50-75	0-2	Sandstone	Sandy Loam	6-12	Sandstone	100-300	82	103
6Da22	50-75	2-4	Sandstone	Silty Loam	6-12	Silt & clay	100-300	81	97
6Da23	50-75	2-4	Sandstone	Silty Loam	0-2	Silt & clay	100-300	86	112
7Aa1	75-100	2-4	Interbedded ss/sh/ls	Silty Loam	6-12	Interbedded ss/sh/ls	100-300	81	96
7Aa2	75-100	2-4	Interbedded ss/sh/ls	Silty Loam	6-12	Till	100-300	81	96
7Aa3	75-100	2-4	Interbedded ss/sh/ls	Sandy Loam	6-12	Interbedded ss/sh/ls	100-300	85	106
7Aa4	75-100	0-2	Interbedded ss/sh/ls	Sandy Loam	18+	Interbedded ss/sh/ls	100-300	73	86
7Aa5	100+	2-4	Interbedded ss/sh/ls	Sandy Loam	6-12	Till	1-100	72	95
7Aa6	100+	2-4	Interbedded ss/sh/ls	Silty Loam	6-12	Till	1-100	68	85
7Aa7	100+	2-4	Interbedded ss/sh/ls	Silty Loam	2-6	Till	1-100	72	97
7Aa8	50-75	4-7	Interbedded ss/sh/ls	Silty Loam	2-6	Till	1-100	99	123
7Aa9	50-75	4-7	Interbedded ss/sh/ls	Sandy Loam	2-6	Till	1-100	103	133

Setting	Depth to Water	Recharge	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Aa10	100+	2-4	Interbedded ss/sh/ls	Sandy Loam	2-6	Till	1-100	76	107
7Aa11	50-75	4-7	Interbedded ss/sh/ls	Clay Loam	2-6	Till	1-100	97	118
7Aa12	50-75	4-7	Interbedded ss/sh/ls	Silty Loam	6-12	Till	1-100	95	111
7Aa13	50-75	4-7	Interbedded ss/sh/ls	Sandy Loam	6-12	Till	1-100	99	121
7Aa14	50-75	4-7	Interbedded ss/sh/ls	Silty Loam	0-2	Till	1-100	100	126
7Aa15	15-30	4-7	Interbedded ss/sh/ls	Sandy Loam	2-6	Till	1-100	123	153
7Aa16	15-30	4-7	Interbedded ss/sh/ls	Silty Loam	2-6	Till	1-100	119	143
7Aa17	75-100	4-7	Interbedded ss/sh/ls	Silty Loam	2-6	Interbedded ss/sh/ls	1-100	94	118
7Aa18	75-100	2-4	Interbedded ss/sh/ls	Sandy Loam	0-2	Till	100-300	90	121
7Aa19	50-75	2-4	Interbedded ss/sh/ls	Silty Loam	6-12	Interbedded ss/sh/ls	100-300	86	101
7Aa20	30-50	2-4	Interbedded ss/sh/ls	Silty Loam	2-6	Till	100-300	100	123
7Aa21	50-75	2-4	Interbedded ss/sh/ls	Silty Loam	6-12	Till	100-300	86	101
7Aa22	50-75	2-4	Interbedded ss/sh/ls	Silty Loam	0-2	Till	100-300	91	116
7Aa23	50-75	2-4	Interbedded ss/sh/ls	Silty Loam	2-6	Till	100-300	90	113
7Aa24	50-75	2-4	Interbedded ss/sh/ls	Sandy Loam	2-6	Till	100-300	98	127
7Aa25	50-75	2-4	Interbedded ss/sh/ls	Silty Loam	2-6	Till	1-100	79	104
7Aa26	100+	2-4	Interbedded ss/sh/ls	Silty Loam	0-2	Till	1-100	73	100
7Aa27	50-75	2-4	Interbedded ss/sh/ls	Silty Loam	0-2	Till	1-100	80	107
7Aa28	50-75	2-4	Interbedded ss/sh/ls	Sandy Loam	0-2	Till	1-100	84	117
7Aa29	50-75	2-4	Interbedded ss/sh/ls	Clay Loam	0-2	Till	1-100	78	102
7Aa30	50-75	2-4	Interbedded ss/sh/ls	Clay Loam	2-6	Till	1-100	77	99
7Aa31	50-75	2-4	Interbedded ss/sh/ls	Sandy Loam	2-6	Till	1-100	83	114
7Aa32	50-75	2-4	Interbedded ss/sh/ls	Clay Loam	0-2	Interbedded ss/sh/ls	1-100	78	102
7Aa33	50-75	2-4	Interbedded ss/sh/ls	Clay Loam	2-6	Interbedded ss/sh/ls	1-100	77	99
7Aa34	50-75	2-4	Interbedded ss/sh/ls	Silty Loam	0-2	Interbedded ss/sh/ls	1-100	80	107
7Aa35	50-75	2-4	Interbedded ss/sh/ls	Silty Loam	2-6	Interbedded ss/sh/ls	1-100	79	104
7Aa36	30-50	4-7	Interbedded ss/sh/ls	Silty Loam	2-6	Till	1-100	109	133

Setting	Depth to Water	Recharge	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Aa37	5-15	4-7	Interbedded ss/sh/ls	Silty Loam	2-6	Till	1-100	129	153
7Aa38	5-15	4-7	Interbedded ss/sh/ls	Silty Loam	0-2	Till	1-100	130	156
7Aa39	5-15	4-7	Interbedded ss/sh/ls	Sandy Loam	0-2	Till	1-100	134	166
7Aa40	15-30	4-7	Interbedded ss/sh/ls	Silty Loam	0-2	Till	1-100	120	146
7Aa41	15-30	4-7	Interbedded ss/sh/ls	Sandy Loam	0-2	Till	1-100	124	156
7Aa42	15-30	4-7	Interbedded ss/sh/ls	Peat	0-2	Till	1-100	128	166
7Aa43	30-50	2-4	Interbedded ss/sh/ls	Silty Loam	2-6	Interbedded ss/sh/ls	1-100	89	114
7Aa44	30-50	2-4	Interbedded ss/sh/ls	Silty Loam	2-6	Till	1-100	89	114
7Aa45	30-50	2-4	Interbedded ss/sh/ls	Sandy Loam	2-6	Till	1-100	93	124
7Aa46	50-75	2-4	Interbedded ss/sh/ls	Silty Loam	6-12	Interbedded ss/sh/ls	1-100	75	92
7Aa47	15-30	2-4	Interbedded ss/sh/ls	Silty Loam	6-12	Till	1-100	95	112
7Aa48	15-30	2-4	Interbedded ss/sh/ls	Sandy Loam	2-6	Till	1-100	103	134
7Aa49	15-30	2-4	Interbedded ss/sh/ls	Sandy Loam	0-2	Till	1-100	104	137
7Aa50	15-30	2-4	Interbedded ss/sh/ls	Silty Loam	2-6	Till	1-100	99	124
7Aa51	30-50	4-7	Interbedded ss/sh/ls	Silty Loam	6-12	Till	1-100	105	121
7Aa52	30-50	4-7	Interbedded ss/sh/ls	Clay Loam	0-2	Till	1-100	108	131
7Aa53	30-50	4-7	Interbedded ss/sh/ls	Clay Loam	2-6	Till	1-100	107	128
7Aa54	30-50	4-7	Interbedded ss/sh/ls	Silty Loam	0-2	Till	1-100	110	136
7Aa55	15-30	4-7	Interbedded ss/sh/ls	Clay Loam	0-2	Till	1-100	118	141
7Aa56	15-30	4-7	Interbedded ss/sh/ls	Clay Loam	2-6	Till	1-100	117	138
7Aa57	50-75	2-4	Interbedded ss/sh/ls	Silty Loam	6-12	Interbedded ss/sh/ls	1-100	75	92
7Aa58	50-75	2-4	Interbedded ss/sh/ls	Sandy Loam	6-12	Interbedded ss/sh/ls	1-100	79	102
7Aa59	75-100	2-4	Interbedded ss/sh/ls	Silty Loam	6-12	Interbedded ss/sh/ls	1-100	70	87
7Aa60	75-100	2-4	Interbedded ss/sh/ls	Silty Loam	2-6	Interbedded ss/sh/ls	1-100	74	99
7Aa61	50-75	4-7	Interbedded ss/sh/ls	Sandy Loam	0-2	Till	1-100	104	136
7Aa62	15-30	4-7	Interbedded ss/sh/ls	Peat	2-6	Till	1-100	127	163
7Aa63	75-100	4-7	Interbedded ss/sh/ls	Silty Loam	2-6	Till	1-100	94	118

Setting	Depth to Water	Recharge	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Aa64	100+	2-4	Interbedded ss/sh/ls	Silty Loam	2-6	Interbedded ss/sh/ls	1-100	77	101
7Aa65	100+	2-4	Interbedded ss/sh/ls	Silty Loam	6-12	Interbedded ss/sh/ls	1-100	73	89
7Aa66	30-50	4-7	Interbedded ss/sh/ls	Sandy Loam	2-6	Till	1-100	113	143
7Aa67	75-100	4-7	Interbedded ss/sh/ls	Clay Loam	0-2	Till	1-100	93	116
7Aa68	75-100	4-7	Interbedded ss/sh/ls	Sandy Loam	2-6	Till	1-100	98	128
7Aa69	5-15	4-7	Interbedded ss/sh/ls	Clay Loam	2-6	Interbedded ss/sh/ls	1-100	127	148
7Aa70	5-15	4-7	Interbedded ss/sh/ls	Clay Loam	0-2	Interbedded ss/sh/ls	1-100	128	151
7Aa71	5-15	4-7	Interbedded ss/sh/ls	Silty Loam	2-6	Interbedded ss/sh/ls	1-100	129	153
7Aa72	30-50	4-7	Interbedded ss/sh/ls	Clay Loam	6-12	Interbedded ss/sh/ls	1-100	103	116
7Aa73	30-50	4-7	Interbedded ss/sh/ls	Clay Loam	2-6	Interbedded ss/sh/ls	1-100	107	128
7Aa74	75-100	4-7	Interbedded ss/sh/ls	Clay Loam	2-6	Till	1-100	92	113
7Aa75	50-75	4-7	Interbedded ss/sh/ls	Clay Loam	0-2	Till	1-100	98	121
7Aa76	30-50	4-7	Interbedded ss/sh/ls	Sandy Loam	0-2	Till	1-100	114	146
7Aa77	30-50	2-4	Interbedded ss/sh/ls	Clay Loam	2-6	Interbedded ss/sh/ls	1-100	87	109
7Aa78	50-75	2-4	Interbedded ss/sh/ls	Clay Loam	2-6	Interbedded ss/sh/ls	1-100	85	106
7Aa79	50-75	2-4	Interbedded ss/sh/ls	Sandy Loam	2-6	Interbedded ss/sh/ls	1-100	91	121
7Aa80	50-75	2-4	Interbedded ss/sh/ls	Silty Loam	2-6	Interbedded ss/sh/ls	1-100	87	111
7Aa81	30-50	2-4	Interbedded ss/sh/ls	Silty Loam	6-12	Till	1-100	85	102
7Ad1	75-100	0-2	Sandstone	Sandy Loam	18+	Sandstone	100-300	73	86
7Ad2	100+	2-4	Sandstone	Silty Loam	2-6	Till	100-300	75	99
7Ad3	100+	2-4	Sandstone	Silty Loam	6-12	Till	100-300	71	87
7Ad4	50-75	2-4	Sandstone	Silty Loam	0-2	Till	100-300	86	112
7Ad5	50-75	2-4	Sandstone	Silty Loam	6-12	Till	100-300	81	97
7Ad6	50-75	0-2	Sandstone	Silty Loam	6-12	Sandstone	100-300	78	93
7Ad7	50-75	2-4	Sandstone	Silty Loam	2-6	Till	100-300	85	109
7Ad8	50-75	2-4	Sandstone	Clay Loam	6-12	Sandstone	100-300	84	96
7Ad9	50-75	0-2	Sandstone	Silty Loam	12-18	Sandstone	100-300	76	87
7Ad10	100+	0-2	Sandstone	Sandy Loam	12-18	Sandstone	100-300	70	87
7Ad11	100+	0-2	Sandstone	Silty Loam	12-18	Sandstone	100-300	66	77
7Ad12	100+	2-4	Sandstone	Sandy Loam	6-12	Till	100-300	75	97
7Ad13	30-50	4-7	Sandstone	Sandy Loam	6-12	Till	100-300	112	133
7Ad14	30-50	4-7	Sandstone	Silty Loam	6-12	Till	100-300	108	123

Setting	Depth to Water	Recharge	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Ad15	30-50	4-7	Sandstone	Silty Loam	0-2	Till	100-300	113	138
7Ad16	30-50	4-7	Sandstone	Sandy Loam	0-2	Till	100-300	117	148
7Ad17	30-50	4-7	Sandstone	Sandy Loam	12-18	Till	100-300	110	127
7Ad18	100+	2-4	Sandstone	Silty Loam	6-12	Sandstone	100-300	76	91
7Ad19	100+	2-4	Sandstone	Sandy Loam	2-6	Till	100-300	79	109
7Ad20	50-75	4-7	Sandstone	Sandy Loam	2-6	Till	100-300	106	135
7Ad21	50-75	4-7	Sandstone	Sandy Loam	6-12	Till	100-300	102	123
7Ad22	50-75	4-7	Sandstone	Sandy Loam	0-2	Till	100-300	107	138
7Ad23	50-75	4-7	Sandstone	Silty Loam	0-2	Till	100-300	103	128
7Ad24	50-75	4-7	Sandstone	Silty Loam	6-12	Till	100-300	98	113
7Ad25	50-75	4-7	Sandstone	Silty Loam	2-6	Till	100-300	102	125
7Ad26	15-30	4-7	Sandstone	Sandy Loam	6-12	Till	100-300	122	143
7Ad27	15-30	4-7	Sandstone	Silty Loam	6-12	Till	100-300	118	133
7Ad28	15-30	4-7	Sandstone	Silty Loam	2-6	Till	100-300	122	145
7Ad29	30-50	4-7	Sandstone	Silty Loam	2-6	Till	100-300	112	135
7Ad30	50-75	2-4	Sandstone	Silty Loam	6-12	Sandstone	100-300	86	101
7Ad31	100+	2-4	Sandstone	Silty Loam	2-6	Sandstone	100-300	80	103
7Ad32	15-30	2-4	Sandstone	Clay Loam	2-6	Silt & clay	1-100	97	119
7Ad33	15-30	2-4	Sandstone	Clay Loam	0-2	Silt & clay	1-100	93	118
7Ae1	30-50	2-4	Shale	Clay Loam	2-6	Sand & gvl w/slt & cl	1-100	81	103
7Ae2	30-50	2-4	Shale	Clay Loam	0-2	Sand & gvl w/slt & cl	1-100	82	106
7Ae3	15-30	2-4	Shale	Clay Loam	2-6	Sand & gvl w/slt & cl	1-100	91	113
7Ae4	15-30	2-4	Shale	Clay Loam	0-2	Sand & gvl w/slt & cl	1-100	92	116
7Ae5	15-30	2-4	Shale	Silty Loam	0-2	Sand & gvl w/slt & cl	1-100	94	121
7Ae6	5-15	2-4	Shale	Clay Loam	0-2	Sand & gvl w/slt & cl	1-100	97	122
7Ae7	5-15	2-4	Shale	Sandy Loam	0-2	Sand & gvl w/slt & cl	1-100	103	137
7Ae8	15-30	2-4	Shale	Clay Loam	0-2	Till	1-100	87	112
7Ae9	15-30	2-4	Shale	Silty Loam	0-2	Till	1-100	89	117
7Ae10	5-15	2-4	Shale	Clay Loam	0-2	Till	1-100	97	122
7Ae11	5-15	2-4	Shale	Sandy Loam	0-2	Till	1-100	103	137
7Ae12	5-15	2-4	Shale	Clay Loam	2-6	Sand & gvl w/slt & cl	1-100	101	123
7Ae13	5-15	2-4	Shale	Clay Loam	0-2	Sand & gvl w/slt & cl	1-100	102	126
7Ae14	5-15	2-4	Shale	Sandy Loam	0-2	Sand & gvl w/slt & cl	1-100	108	141
7Ae15	5-15	2-4	Shale	Clay Loam	6-12	Sand & gvl w/slt & cl	1-100	97	111
7Ae16	5-15	2-4	Shale	Silty Loam	0-2	Sand & gvl w/slt & cl	1-100	104	131

Setting	Depth to Water	Recharge	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Ae17	5-15	2-4	Shale	Silty Loam	0-2	Till	1-100	99	127
7Ae18	5-15	2-4	Shale	Silty Loam	2-6	Till	1-100	98	124
7Ae19	15-30	2-4	Shale	Silty Loam	2-6	Till	1-100	88	114
7Ae20	15-30	2-4	Shale	Sandy Loam	0-2	Till	1-100	93	127
7Ae21	5-15	2-4	Shale	Clay Loam	2-6	Till	1-100	96	119
7Ae22	15-30	2-4	Shale	Silty Loam	2-6	Sand & gvl w/slt & cl	1-100	93	118
7Ae23	15-30	2-4	Shale	Clay Loam	2-6	Till	1-100	86	109
7Ae24	15-30	2-4	Shale	Silty Loam	0-2	Silt & clay	1-100	89	117
7Ae25	5-15	4-7	Shale	Silty Loam	0-2	Silt & clay	1-100	111	139
7Ae26	5-15	4-7	Shale	Silty Loam	2-6	Sand & gvl w/slt & cl	1-100	110	136
7Ae27	5-15	4-7	Shale	Clay Loam	0-2	Silt & clay	1-100	109	134
7Ae28	5-15	4-7	Shale	Clay Loam	2-6	Silt & clay	1-100	108	131
7Ae29	15-30	2-4	Shale	Clay Loam	0-2	Silt & clay	1-100	87	112
7Af1	15-30	4-7	Sand & gravel	Clay Loam	2-6	Till	300-700	126	144
7Af2	15-30	4-7	Sand & gravel	Silty Loam	0-2	Till	300-700	129	152
7Af3	15-30	4-7	Sand & gravel	Clay Loam	0-2	Till	300-700	122	143
7Af4	15-30	4-7	Sand & gravel	Silty Loam	0-2	Till	300-700	124	148
7Af5	15-30	4-7	Sand & gravel	Silty Loam	2-6	Till	300-700	123	145
7Af6	15-30	4-7	Sand & gravel	Clay Loam	2-6	Till	300-700	121	140
7Af7	30-50	4-7	Sand & gravel	Clay Loam	0-2	Till	300-700	112	133
7Af8	30-50	4-7	Sand & gravel	Silty Loam	0-2	Till	300-700	114	138
7Af9	15-30	4-7	Sand & gravel	Silty Loam	2-6	Till	300-700	128	149
7Af10	30-50	4-7	Sand & gravel	Clay Loam	2-6	Till	300-700	116	134
7Af11	15-30	4-7	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	100-300	121	151
7Bb1	30-50	4-7	Interbedded ss/sh/ls	Sandy Loam	2-6	Sand & gvl w/slt & cl	1-100	110	140
7Bb2	15-30	4-7	Interbedded ss/sh/ls	Sandy Loam	0-2	Sand & gvl w/slt & cl	1-100	121	153
7Bb3	15-30	4-7	Interbedded ss/sh/ls	Silty Loam	0-2	Sand & gvl w/slt & cl	1-100	117	143
7Bb4	30-50	4-7	Interbedded ss/sh/ls	Silty Loam	2-6	Sand & gvl w/slt & cl	1-100	106	130
7C1	30-50	4-7	Interbedded ss/sh/ls	Clay Loam	2-6	Till	1-100	107	128
7C2	30-50	4-7	Interbedded ss/sh/ls	Clay Loam	0-2	Till	1-100	108	131
7C3	30-50	4-7	Interbedded ss/sh/ls	Silty Loam	2-6	Till	1-100	109	133
7C4	15-30	4-7	Interbedded ss/sh/ls	Clay Loam	0-2	Till	1-100	118	141
7C5	15-30	4-7	Interbedded ss/sh/ls	Clay Loam	2-6	Till	1-100	117	138

Setting	Depth to Water	Recharge	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7C6	15-30	4-7	Interbedded ss/sh/ls	Silty Loam	2-6	Till	1-100	119	143
7C7	15-30	4-7	Interbedded ss/sh/ls	Silty Loam	0-2	Till	1-100	120	146
7C8	5-15	4-7	Sand & gravel	Silty Loam	2-6	Silt & clay	300-700	134	157
7C9	5-15	4-7	Shale	Silty Loam	2-6	Silt & clay	1-100	110	136
7C10	15-30	4-7	Sand & gravel	Clay Loam	2-6	Till	300-700	126	144
7C11	50-75	4-7	Sand & gravel	Clay Loam	2-6	Till	300-700	106	124
7C12	50-75	4-7	Sand & gravel	Clay Loam	0-2	Till	300-700	107	127
7C13	50-75	4-7	Sand & gravel	Silty Loam	0-2	Till	300-700	109	132
7C14	50-75	4-7	Sand & gravel	Sandy Loam	0-2	Till	300-700	113	142
7C15	50-75	2-4	Shale	Clay Loam	2-6	Sand & gvl w/slt & cl	1-100	71	93
7C16	15-30	2-4	Shale	Clay Loam	2-6	Sand & gvl w/slt & cl	1-100	91	113
7C17	5-15	4-7	Shale	Clay Loam	2-6	Sand & gvl w/slt & cl	1-100	113	135
7C18	5-15	4-7	Shale	Silty Loam	2-6	Sand & gvl w/slt & cl	1-100	115	140
7C19	15-30	2-4	Shale	Silty Loam	2-6	Sand & gvl w/slt & cl	1-100	93	118
7C20	15-30	2-4	Shale	Sandy Loam	2-6	Sand & gvl w/slt & cl	1-100	97	128
7C21	50-75	4-7	Interbedded ss/sh/ls	Clay Loam	2-6	Sand & gvl w/slt & cl	1-100	97	118
7C22	50-75	4-7	Interbedded ss/sh/ls	Silty Loam	2-6	Sand & gvl w/slt & cl	1-100	99	123
7C23	75-100	4-7	Interbedded ss/sh/ls	Clay Loam	2-6	Sand & gvl w/slt & cl	1-100	92	113
7C24	30-50	4-7	Interbedded ss/sh/ls	Clay Loam	2-6	Sand & gvl w/slt & cl	1-100	107	128
7C25	30-50	4-7	Interbedded ss/sh/ls	Silty Loam	2-6	Sand & gvl w/slt & cl	1-100	109	133
7C26	5-15	4-7	Shale	Clay Loam	0-2	Sand & gvl w/slt & cl	1-100	114	138
7C27	15-30	2-4	Shale	Clay Loam	0-2	Sand & gvl w/slt & cl	1-100	92	116
7C28	15-30	2-4	Shale	Silty Loam	0-2	Sand & gvl w/slt & cl	1-100	94	121
7C29	5-15	4-7	Shale	Sandy Loam	0-2	Sand & gvl w/slt & cl	1-100	120	153
7C30	15-30	2-4	Shale	Sandy Loam	0-2	Sand & gvl w/slt & cl	1-100	98	131
7C31	5-15	4-7	Shale	Silty Loam	0-2	Sand & gvl w/slt & cl	1-100	116	143
7C32	15-30	4-7	Sand & gravel	Clay Loam	0-2	Sand & gvl w/slt & cl	300-700	127	147
7C33	50-75	2-4	Shale	Silty Loam	0-2	Sand & gvl w/slt & cl	1-100	74	101
7C34	5-15	4-7	Shale	Clay Loam	2-6	Silt & clay	1-100	108	131
7C35	15-30	2-4	Sandstone	Silty Loam	2-6	Sand & gvl w/slt & cl	1-100	99	124

Setting	Depth to Water	Recharge	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7C36	15-30	2-4	Sandstone	Silty Loam	0-2	Sand & gvl w/slt & cl	1-100	100	127
7C37	5-15	4-7	Sandstone	Loam	0-2	Sand & gvl w/slt & cl	1-100	124	154
7D1	15-30	4-7	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	144	172
7D2	30-50	7-10	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	700-1000	144	164
7D3	30-50	7-10	Sand & gravel	Sandy Loam	6-12	Sand & gvl w/slt & cl	700-1000	143	159
7D4	15-30	4-7	Sandstone	Silty Loam	0-2	Sand & gvl w/slt & cl	100-300	123	148
7D5	100+	2-4	Sand & gravel	Silty Loam	12-18	Till	300-700	75	85
7D6	5-15	7-10	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	700-1000	167	187
7D7	5-15	7-10	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	700-1000	164	184
7D8	5-15	7-10	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	700-1000	163	181
7D9	15-30	7-10	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	700-1000	158	184
7D10	75-100	7-10	Sand & gravel	Silty Loam	6-12	Sand & gvl w/slt & cl	700-1000	124	134
7D11	75-100	7-10	Sand & gravel	Sandy Loam	6-12	Sand & gvl w/slt & cl	700-1000	128	144
7D12	75-100	7-10	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	700-1000	133	159
7D13	75-100	7-10	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	700-1000	129	149
7D14	30-50	7-10	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	700-1000	148	174
7D15	5-15	7-10	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	700-1000	176	201
7D16	5-15	7-10	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	700-1000	172	191
7D17	30-50	4-7	Sandstone	Sandy Loam	6-12	Sand & gvl w/slt & cl	100-300	112	133
7D18	30-50	4-7	Sandstone	Sandy Loam	0-2	Sand & gvl w/slt & cl	100-300	117	148
7D19	30-50	4-7	Sandstone	Clay Loam	0-2	Sand & gvl w/slt & cl	100-300	111	133
7D20	30-50	4-7	Sandstone	Silty Loam	0-2	Sand & gvl w/slt & cl	100-300	113	138
7D21	5-15	7-10	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	700-1000	175	198
7D22	30-50	7-10	Sand & gravel	Peat	0-2	Sand & gvl w/slt & cl	700-1000	152	184
7D23	15-30	4-7	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	300-700	140	166
7D24	30-50	7-10	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	700-1000	147	171
7D25	50-75	4-7	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	116	136

Setting	Depth to Water	Recharge	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7D26	15-30	7-10	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	700-1000	153	171
7D27	15-30	7-10	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	700-1000	157	181
7D28	5-15	7-10	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	700-1000	175	198
7D29	15-30	7-10	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	700-1000	154	174
7D30	15-30	7-10	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	700-1000	162	181
7D31	50-75	4-7	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	700-1000	125	143
7D32	30-50	7-10	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	700-1000	143	161
7D33	30-50	7-10	Sand & gravel	Silty Loam	6-12	Sand & gvl w/slt & cl	700-1000	139	149
7D34	50-75	7-10	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	700-1000	137	161
7D35	50-75	7-10	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	700-1000	138	164
7D36	50-75	7-10	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	700-1000	134	154
7D37	50-75	7-10	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	700-1000	133	151
7D38	30-50	4-7	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	700-1000	131	156
7D39	30-50	4-7	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	700-1000	127	146
7D40	30-50	4-7	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	700-1000	128	149
7D41	30-50	4-7	Sand & gravel	Sandy Loam	6-12	Sand & gvl w/slt & cl	700-1000	127	144
7D42	30-50	4-7	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	700-1000	132	159
7D43	30-50	4-7	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	134	162
7D44	30-50	4-7	Sand & gravel	Sandy Loam	6-12	Sand & gvl w/slt & cl	300-700	129	147
7D45	30-50	4-7	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	130	152
7D46	100+	4-7	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	101	122
7D47	30-50	4-7	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	300-700	125	152
7D48	30-50	4-7	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	121	142
7D49	15-30	4-7	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	141	169
7D50	15-30	4-7	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	137	159
7D51	15-30	4-7	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	128	149
7D52	30-50	7-10	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	139	167

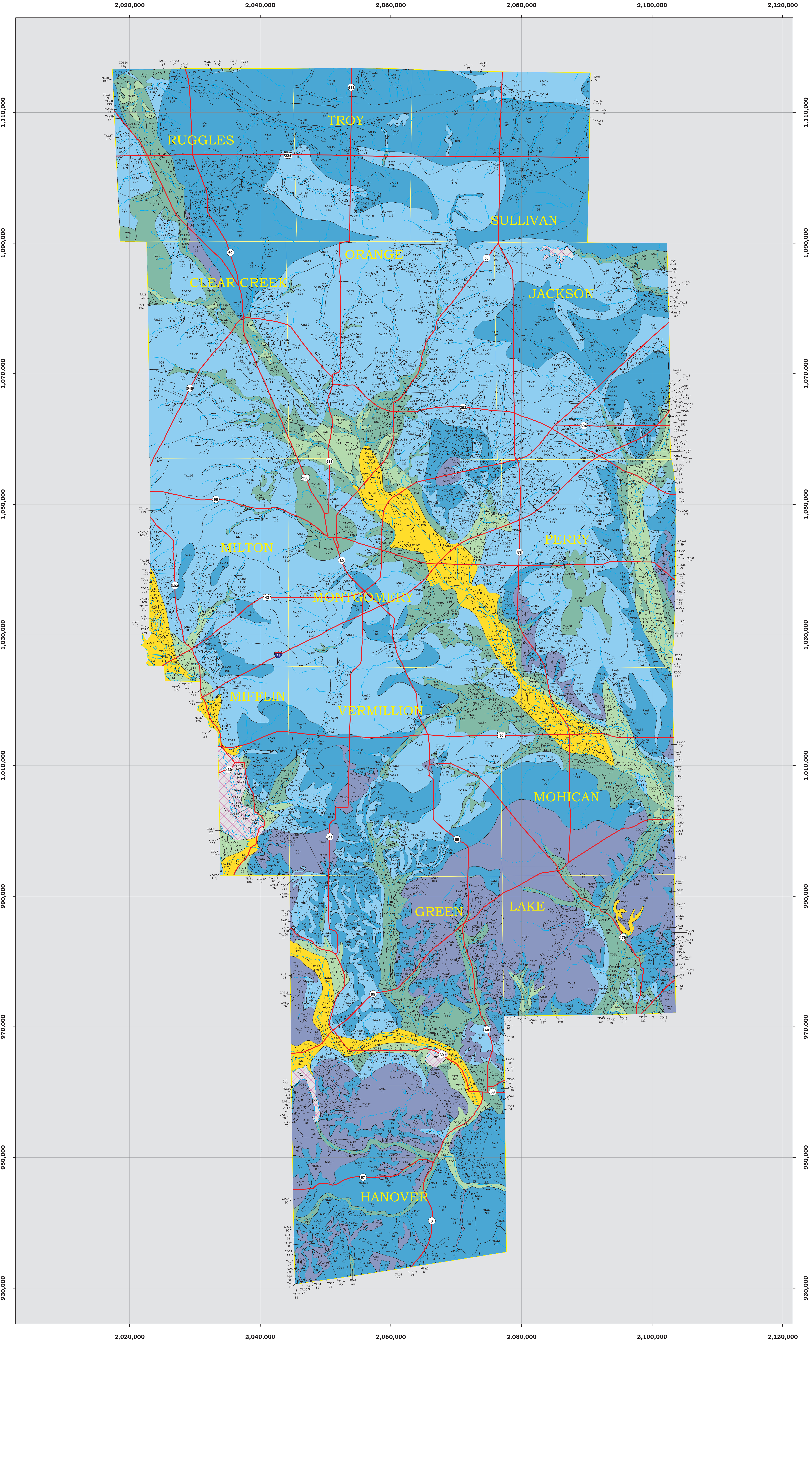
Setting	Depth to Water	Recharge	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7D53	15-30	7-10	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	148	170
7D54	30-50	4-7	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	131	159
7D55	30-50	4-7	Sand & gravel	Sandy Loam	6-12	Sand & gvl w/slt & cl	300-700	129	147
7D56	30-50	4-7	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	300-700	133	159
7D57	30-50	4-7	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	300-700	122	149
7D58	30-50	4-7	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	118	139
7D59	30-50	4-7	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	119	142
7D60	30-50	4-7	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	123	152
7D61	50-75	4-7	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	300-700	107	135
7D62	50-75	4-7	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	103	125
7D63	50-75	4-7	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	104	128
7D64	50-75	2-4	Sand & gravel	Clay Loam	2-6	Sand & gvl w/slt & cl	300-700	89	108
7D65	50-75	2-4	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	91	113
7D66	50-75	2-4	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	92	116
7D67	15-30	4-7	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	300-700	127	155
7D68	15-30	4-7	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	1-100	114	139
7D69	30-50	4-7	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	126	155
7D70	15-30	7-10	Sand & gravel	Peat	0-2	Sand & gvl w/slt & cl	300-700	156	190
7D71	30-50	4-7	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	122	145
7D72	15-30	7-10	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	152	180
7D73	15-30	4-7	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	300-700	135	162
7D74	30-50	7-10	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	142	170
7D75	30-50	7-10	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	138	160
7D76	15-30	4-7	Sand & gravel	Sandy Loam	6-12	Sand & gvl w/slt & cl	300-700	131	150
7D77	15-30	4-7	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	131	152
7D78	15-30	4-7	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	132	155
7D79	15-30	4-7	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	136	165

Setting	Depth to Water	Recharge	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7D80	15-30	4-7	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	129	152
7D81	15-30	4-7	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	133	162
7D82	15-30	4-7	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	300-700	132	159
7D83	30-50	7-10	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	700-1000	136	157
7D84	50-75	4-7	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	112	135
7D85	50-75	4-7	Sand & gravel	Clay Loam	0-2	Sand & gvl w/slt & cl	300-700	110	130
7D86	15-30	4-7	Sand & gravel	Silty Loam	2-6	Till	300-700	128	149
7D87	15-30	4-7	Sand & gravel	Sandy Loam	2-6	Till	300-700	132	159
7D88	50-75	4-7	Sand & gravel	Clay Loam	2-6	Sand & gvl w/slt & cl	300-700	109	127
7D89	15-30	7-10	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	300-700	151	177
7D90	15-30	7-10	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	147	167
7D91	30-50	7-10	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	300-700	138	164
7D92	30-50	7-10	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	134	154
7D93	30-50	7-10	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	135	157
7D94	30-50	7-10	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	139	167
7D95	5-15	7-10	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	150	173
7D96	5-15	7-10	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	154	183
7D97	5-15	7-10	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	300-700	153	180
7D98	5-15	7-10	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	149	170
7D99	15-30	7-10	Sand & gravel	Muck	0-2	Sand & gvl w/slt & cl	300-700	144	160
7D100	5-15	7-10	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	166	187
7D101	5-15	7-10	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	170	197
7D102	5-15	7-10	Sand & gravel	Peat	0-2	Sand & gvl w/slt & cl	300-700	174	207
7D103	5-15	7-10	Sand & gravel	Muck	0-2	Sand & gvl w/slt & cl	300-700	162	177
7D104	5-15	7-10	Sand & gravel	Clay Loam	0-2	Sand & gvl w/slt & cl	300-700	164	182
7D105	15-30	7-10	Sand & gravel	Sandy Loam	6-12	Sand & gvl w/slt & cl	300-700	147	165
7D106	15-30	4-7	Sand & gravel	Silty Loam	6-12	Sand & gvl w/slt & cl	300-700	127	140
7D107	50-75	4-7	Sand & gravel	Silty Loam	6-12	Sand & gvl w/slt & cl	300-700	107	120

Setting	Depth to Water	Recharge	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7D108	50-75	4-7	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	116	145
7D109	50-75	4-7	Sand & gravel	Sandy Loam	6-12	Sand & gvl w/slt & cl	300-700	111	130
7D110	50-75	4-7	Interbedded ss/sh/ls	Silty Loam	2-6	Sand & gvl w/slt & cl	1-100	94	119
7D111	50-75	4-7	Interbedded ss/sh/ls	Clay Loam	2-6	Sand & gvl w/slt & cl	1-100	92	114
7D112	15-30	7-10	Sand & gravel	Clay Loam	0-2	Sand & gvl w/slt & cl	300-700	146	165
7D113	30-50	7-10	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	700-1000	135	154
7D114	30-50	7-10	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	700-1000	140	167
7D115	30-50	7-10	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	700-1000	139	164
7D116	75-100	7-10	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	700-1000	132	156
7D117	75-100	7-10	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	700-1000	128	146
7D118	75-100	4-7	Sand & gravel	Silty Loam	2-6	Till	300-700	103	124
7D119	75-100	4-7	Sand & gravel	Sandy Loam	2-6	Till	300-700	107	134
7D120	75-100	4-7	Sand & gravel	Silty Loam	0-2	Till	300-700	104	127
7D121	5-15	7-10	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	700-1000	167	191
7D122	50-75	4-7	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	108	129
7D123	5-15	7-10	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	700-1000	171	188
7D124	15-30	7-10	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	700-1000	165	188
7D125	30-50	7-10	Sand & gravel	Clay Loam	2-6	Sand & gvl w/slt & cl	700-1000	141	156
7D126	5-15	7-10	Sand & gravel	Clay Loam	0-2	Sand & gvl w/slt & cl	700-1000	162	179
7D127	30-50	4-7	Sand & gravel	Silty Loam	2-6	Till	300-700	118	139
7D128	30-50	4-7	Sand & gravel	Sandy Loam	2-6	Till	300-700	122	149
7D129	50-75	4-7	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	300-700	120	146
7D130	5-15	4-7	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	147	169
7D131	5-15	7-10	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	300-700	169	194
7D132	15-30	4-7	Sand & gravel	Peat	0-2	Sand & gvl w/slt & cl	300-700	145	179
7D133	15-30	4-7	Sand & gravel	Clay Loam	0-2	Sand & gvl w/slt & cl	300-700	135	154
7D134	15-30	4-7	Sand & gravel	Clay Loam	2-6	Sand & gvl w/slt & cl	300-700	134	151
7D135	15-30	4-7	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	136	156
7D136	30-50	4-7	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	127	149

Setting	Depth to Water	Recharge	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7D137	30-50	4-7	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	300-700	131	159
7D138	30-50	4-7	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	126	146
7D139	30-50	4-7	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	300-700	130	156
7D140	30-50	4-7	Sand & gravel	Clay Loam	2-6	Sand & gvl w/slt & cl	300-700	124	141
7D141	50-75	4-7	Sand & gravel	Clay Loam	2-6	Sand & gvl w/slt & cl	300-700	114	131
7D142	50-75	4-7	Sand & gravel	Clay Loam	0-2	Sand & gvl w/slt & cl	300-700	115	134
7D143	50-75	4-7	Sand & gravel	Peat	2-6	Sand & gvl w/slt & cl	300-700	124	156
7D144	50-75	4-7	Sand & gravel	Peat	0-2	Sand & gvl w/slt & cl	300-700	125	159
7D145	50-75	4-7	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	117	139
7D146	30-50	4-7	Sand & gravel	Clay Loam	2-6	Sand & gvl w/slt & cl	300-700	119	137
7D147	15-30	7-10	Sand & gravel	Clay Loam	2-6	Sand & gvl w/slt & cl	300-700	145	162
7D148	50-75	4-7	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	111	132
7D149	15-30	7-10	Sand & gravel	Sandy Loam	2-6	Sand & gvl w/slt & cl	300-700	143	170
7D150	15-30	7-10	Sand & gravel	Silty Loam	2-6	Sand & gvl w/slt & cl	300-700	139	160
7D151	5-15	7-10	Sand & gravel	Clay Loam	2-6	Sand & gvl w/slt & cl	300-700	147	165
7D152	50-75	4-7	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	300-700	109	132
7D153	50-75	4-7	Sand & gravel	Clay Loam	2-6	Sand & gvl w/slt & cl	300-700	106	124
7D154	15-30	4-7	Sand & gravel	Clay Loam	2-6	Sand & gvl w/slt & cl	100-300	115	136
7D155	15-30	4-7	Sand & gravel	Silty Loam	0-2	Sand & gvl w/slt & cl	100-300	118	144
7D156	15-30	4-7	Sand & gravel	Sandy Loam	0-2	Sand & gvl w/slt & cl	100-300	122	154
7Ec1	5-15	4-7	Sandstone	Silty Loam	0-2	Silt & clay	100-300	133	158
7Ec2	15-30	4-7	Sandstone	Silty Loam	2-6	Silt & clay	100-300	122	145
7Ec3	30-50	4-7	Sandstone	Silty Loam	0-2	Silt & clay	100-300	113	138
7Ec4	30-50	4-7	Sandstone	Sandy Loam	0-2	Silt & clay	100-300	117	148
7Ec5	15-30	4-7	Interbedded ss/sh/ls	Silty Loam	2-6	Sand & gvl w/slt & cl	1-100	119	143
7Ec6	15-30	4-7	Interbedded ss/sh/ls	Silty Loam	0-2	Sand & gvl w/slt & cl	1-100	120	146
7Ec7	15-30	4-7	Interbedded ss/sh/ls	Sandy Loam	2-6	Sand & gvl w/slt & cl	1-100	123	153
7Ec8	15-30	4-7	Interbedded ss/sh/ls	Sandy Loam	0-2	Silt & clay	1-100	116	149

Setting	Depth to Water	Recharge	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pesticide Rating
7Ec9	15-30	4-7	Interbedded ss/sh/ls	Silty Loam	2-6	Silt & clay	1-100	111	136
7G1	75-100	2-4	Interbedded ss/sh/ls	Thin/Absent	6-12	Interbedded ss/sh/ls	100-300	93	126
7G2	75-100	2-4	Sandstone	Thin/Absent	6-12	Sandstone	100-300	93	126
7G3	75-100	0-2	Interbedded ss/sh/ls	Thin/Absent	18+	Interbedded ss/sh/ls	100-300	81	106
7G4	75-100	0-2	Sandstone	Thin/Absent	18+	Sandstone	100-300	81	106
7G5	50-75	4-7	Sandstone	Thin/Absent	6-12	Sandstone	100-300	110	143
7G6	100+	0-2	Interbedded ss/sh/ls	Thin/Absent	6-12	Interbedded ss/sh/ls	1-100	77	111
7G7	75-100	0-2	Interbedded ss/sh/ls	Thin/Absent	18+	Interbedded ss/sh/ls	100-300	81	106
7G8	100+	0-2	Sandstone	Thin/Absent	6-12	Sandstone	100-300	80	113
7G9	50-75	0-2	Sandstone	Thin/Absent	12-18	Sandstone	100-300	88	117
7G10	50-75	0-2	Sandstone	Clay Loam	12-18	Sandstone	100-300	74	82
7G11	50-75	0-2	Sandstone	Shrink/Swell Clay	2-6	Sandstone	100-300	88	120
7G12	50-75	0-2	Sandstone	Clay Loam	2-6	Sandstone	100-300	80	100
7G13	50-75	0-2	Sandstone	Thin/bsent	2-6	Sandstone	100-300	94	135
7G14	50-75	0-2	Sandstone	Thin/Absent	6-12	Sandstone	100-300	90	123
7G15	50-75	0-2	Sandstone	Clay Loam	6-12	Sandstone	100-300	76	88
7G16	100+	0-2	Sandstone	Thin/Absent	12-18	Sandstone	100-300	78	107
7G17	100+	0-2	Sandstone	Thin/Absent	18+	Sandstone	100-300	76	101
7G18	100+	2-4	Sandstone	Thin/Absent	6-12	Sandstone	100-300	88	121
7G19	50-75	4-7	Sandstone	Thin/Absent	2-6	Sandstone	100-300	114	155
7G20	100+	2-4	Sandstone	Thin/Absent	2-6	Sandstone	100-300	92	133
7G21	100+	2-4	Interbedded ss/sh/ls	Thin/Absent	6-12	Interbedded ss/sh/ls	1-100	85	119
7G22	100+	2-4	Interbedded ss/sh/ls	Thin/Absent	2-6	Interbedded ss/sh/ls	1-100	89	131
7G23	50-75	4-7	Interbedded ss/sh/ls	Thin/Absent	6-12	Interbedded ss/sh/ls	1-100	107	141
7G24	50-75	4-7	Interbedded ss/sh/ls	Thin/Absent	2-6	Interbedded ss/sh/ls	1-100	111	153
7G25	15-30	4-7	Interbedded ss/sh/ls	Thin/Absent	2-6	Interbedded ss/sh/ls	1-100	131	173
7G26	75-100	4-7	Interbedded ss/sh/ls	Thin/Absent	6-12	Interbedded ss/sh/ls	1-100	102	136
7G27	50-75	2-4	Interbedded ss/sh/ls	Thin/Absent	6-12	Interbedded ss/sh/ls	1-100	95	129
7G28	50-75	2-4	Interbedded ss/sh/ls	Thin/Absent	6-12	Interbedded ss/sh/ls	1-100	87	122
7G29	75-100	2-4	Interbedded ss/sh/ls	Thin/Absent	6-12	Interbedded ss/sh/ls	1-100	82	117
7G30	30-50	4-7	Interbedded ss/sh/ls	Thin/Absent	6-12	Interbedded ss/sh/ls	1-100	117	151
7G31	15-30	4-7	Interbedded ss/sh/ls	Thin/Absent	6-12	Interbedded ss/sh/ls	1-100	127	161



Ground Water Pollution Potential of Ashland County

by
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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
147 ← 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
- Townships

Index Ranges

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

N

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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