GROUND WATER POLLUTION POTENTIAL OF PREBLE COUNTY, OHIO

BY

A. WAYNE JONES

GROUND WATER POLLUTION POTENTIAL REPORT NO. 26

OHIO DEPARTMENT OF NATURAL RESOURCES

DIVISION OF WATER

GROUND WATER RESOURCES SECTION

MAY, 1992

ABSTRACT

A ground water pollution potential map of Preble 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 form the basis of the system and incorporate the major hydrogeologic factors that affect and control ground water movement and occurrence including depth to water, net recharge, aquifer media, soil media, topography, impact of the vadose zone media and hydraulic conductivity of the aquifer. These factors, which form the acronym DRASTIC, are incorporated into a relative ranking scheme that uses a combination of weights and ratings to produce a numerical value called the ground water pollution potential index. Hydrogeologic settings are combined with the pollution potential indexes to create units that can be graphically displayed on a map.

Preble County lies within the Glaciated Central hydrogeologic region. The county is covered by variable thicknesses of glacial till, lacustrine deposits, and outwash. These unconsolidated glacial deposits are underlain by limestone, shale and shaley limestone bedrock. Ground water yields are dependent on the type of aquifer and vary greatly throughout the county. Pollution potential indexes are relatively low to moderate in areas of till or lacustrine cover over bedrock. Buried valleys containing sand and gravel aquifers, and areas covered by outwash have moderate to high vulnerabilities to contamination.

Ground water pollution potential mapping in Preble County resulted in a map with symbols and colors which illustrate areas of varying ground water contamination vulnerability. Seven hydrogeologic settings were identified in Preble County with computed ground water pollution potential indexes ranging from 62 to 179.

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 Preble 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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ACKNOWLEDGEMENTS

The preparation of the Preble County Ground Water Pollution Potential report and map involved the contribution and work of a number of individuals in the Division of Water. Grateful acknowledgement is given to the following individuals for their technical review and map production, text authorship, report editing and preparation:

Map preparation and review:	Wayne Jones Paul Spahr Mike Angle
Map print production and review:	Xiaoning Jiang Michael Hallfrisch Wayne Jones David Orr
Report production and review:	Wayne Jones Michael Hallfrisch
Report editing:	Rebecca J. Petty William Mattox
Desktop publishing and report design:	David Orr

INTRODUCTION

The need for protection and management of ground water resources in Ohio has been clearly recognized. About 42 per cent of Ohio citizens rely on ground water for their drinking and household uses from both municipal and private wells. Industry and agriculture also utilize significant quantities of ground water for processing and irrigation. In Ohio, approximately 700,000 rural households depend on private wells; approximately 4,000 of these wells exist in Preble County.

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

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

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

APPLICATIONS OF POLLUTION POTENTIAL MAPS

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

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

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

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

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

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

SUMMARY OF THE DRASTIC MAPPING PROCESS

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

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

The application of DRASTIC to an area requires the recognition of a set of assumptions made in the development of the system. DRASTIC evaluates the pollution potential of an area assuming a contaminant with the mobility of water, introduced at the surface, and flushed into the ground water by precipitation. Most important, DRASTIC cannot be applied to areas smaller than 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 Preble County. Inherent within each hydrogeologic setting are the physical characteristics which affect the ground water pollution potential. These characteristics or factors identified during the development of the DRASTIC system include:

D - Depth to Water

R - Net Recharge

A - Aquifer Media

S - Soil Media

T - Topography

I - Impact of the Vadose Zone Media

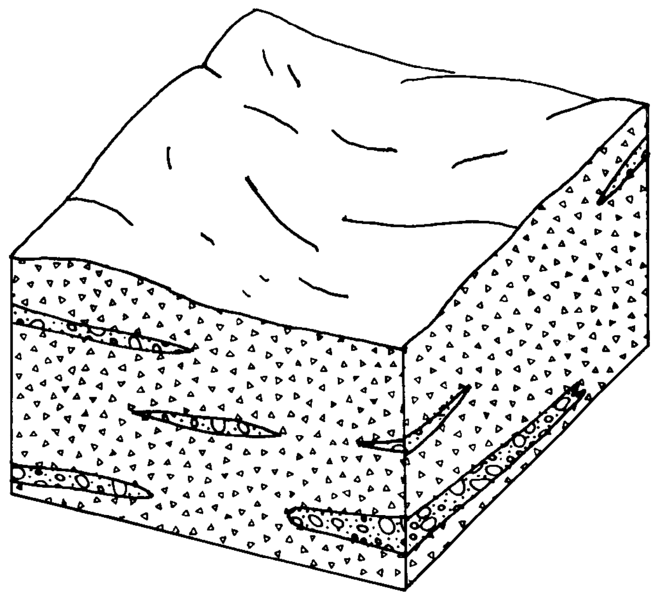
C - Conductivity (Hydraulic) of the Aquifer

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

<u>Depth to water</u> 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.

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

<u>Aquifer media</u> 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.



7Af Sand and Gravel Interbedded in Glacial Till

This hydrogeologic setting is characterized by sand and gravel interbedded within glacial till. The till is composed of clay, silt, sand and gravel in varying amounts. The sand and gravel deposits vary from small isolated lenses to large areally extensive deposits. Sand and gravel serves as the principal aquifer in this setting. Recharge occurs from infiltration of precipitation through the glacial till. Depth to water is highly variable. Soils are typically classified as clay loam.

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

Soil media refers to the upper six feet of the unsaturated zone that is characterized by significant biological activity. The type of soil media can influence the amount of recharge that can move through the soil column due to variations in soil permeability. Various soil types also have the ability to attenuate or retard a contaminant as it moves throughout the soil profile. Soil media is based on textural classifications of soils and considers relative thicknesses and attenuation characteristics of each profile within the soil.

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

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

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

Weighting and Rating System

DRASTIC uses a numerical weighting and rating system that is combined with the DRASTIC factors to calculate a ground water pollution potential index or relative measure of vulnerability to contamination. The DRASTIC factors are weighted from 1 to 5 according to their relative importance to each other with regard to contamination potential (Table 1). Each factor is then divided into ranges or media types and assigned a rating from 1 to 10 based on their significance to pollution potential (Tables 2-8). The rating for each factor is selected based on available information and professional judgement. 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. The higher the DRASTIC index, the greater the vulnerability to contamination. The index generated provides only a relative evaluation tool and is not designed to produce absolute answers or to represent units of vulnerability. Pollution potential indexes of various settings should be compared to each other only with consideration of the factors that were evaluated in determining the vulnerability of the area.

Pesticide DRASTIC

A special version of DRASTIC was developed to be used where the application of pesticides is a concern. The weights assigned to the DRASTIC factors were changed to reflect the processes that affect pesticide movement into the subsurface with particular emphasis on soils. 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
Massive Shale	1-3	2
Metamorphic / Igneous	2-5	3
Weathered Metamorphic / Igneous	3-5	4
Glacial Till	4-6	5
Bedded Sandstone, Limestone and Shale Sequences	5-9	6
Massive Sandstone	4-9	6
Massive Limestone	4-9	6
Sand and Gravel	4-9	8
Basalt	2-10	9
Karst Limestone	9-10	10
Weight: 3	Pesticide Weight: 3	

TABLE 5. RANGES AND RATINGS FOR SOIL MEDIA

SOIL MEDIA	
Range	Rating
Thin or Absent	10
Gravel	10
Sand	9
Peat	8
Shrinking and / or Aggregated Clay	7
Sandy Loam	6
Loam	5
Silty Loam	4
Clay Loam	3
Muck	2
Nonshrinking and Nonaggregated 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
Bedded Limestone, Sandstone, Shale	4-8	6
Sand and Gravel with significant Silt and Clay	4-8	6
Metamorphic/Igneous	2-8	4
Sand and Gravel	6-9	8
Basalt	2-10	9
Karst Limestone	8-10	10
Weight: 5	Pesticide Weight: 4	

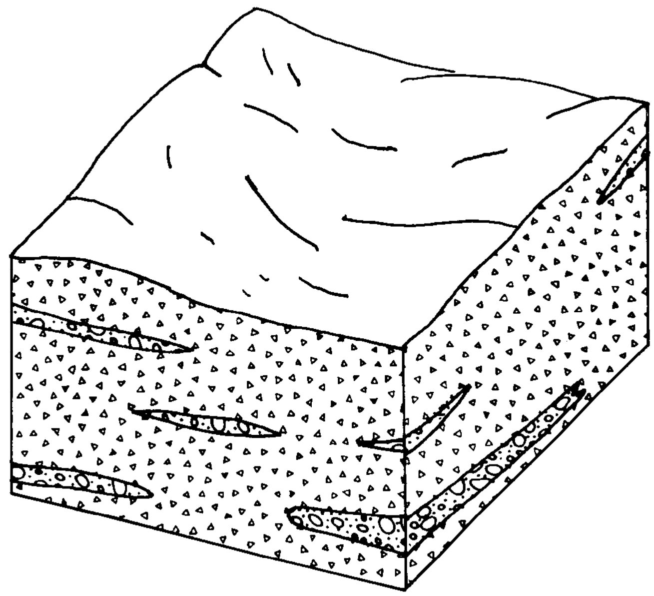
TABLE 8. RANGES AND RATINGS FOR HYDRAULIC CONDUCTIVITY

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 7Af1 Sand and Gravel Interbedded in Glacial Till, identified in mapping Preble 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 110. This numerical value has no intrinsic meaning, but can be readily compared to a value obtained for other settings in the county. DRASTIC indexes for typical hydrogeologic settings and values across the United States range from 65 to 223. The diversity of hydrogeologic conditions in Preble County produces settings with a wide range of vulnerability to ground water contamination. Calculated pollution potential indexes for the seven settings identified in the county range from 62 to 179.

Hydrogeologic settings identified in an area are combined with the pollution potential indexes to create units that can be graphically displayed on maps. Pollution potential mapping in Preble 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 Preble County is included with this report.



SETTING 7Af1		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	NUMBER
Depth to Water	30-50	5	5	25
Net Recharge	4-7	4	6	24
Aquifer Media	Sand & Gravel	3	5	15
Soil Media	Loam	2	5	10
Topography	0-2%	1	10	10
Impact Vadose Zone	Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		DRASTIC	INDEX	110

Figure 2. Description of the hydrogeologic setting - 7Af1 Sand and Gravel Interbedded in Glacial Till.

INTERPRETATION AND USE OF A GROUND WATER POLLUTION POTENTIAL MAP

The application of the DRASTIC system to evaluate an area's vulnerability to contamination produces hydrogeologic settings with corresponding pollution potential indexes. The higher the pollution potential index, the greater the susceptibility to contamination. 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:

7Af1 - defines the hydrogeologic region and setting
110 - defines the relative pollution potential

Here the first number (7) refers to the major hydrogeologic region and the upper and lower case letters (Af) refer 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 (110) is the calculated pollution potential index for this unique setting. The charts for each setting provide a reference to show how the pollution potential index was derived in an area.

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

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

GENERAL INFORMATION ABOUT PREBLE COUNTY

Preble County, in southwestern Ohio, occupies an area of 430 square miles (Simmons, 1989). This rectangular shaped county has 12 townships and a population of 40,113 (U.S. Department of Commerce, 1991). Preble County is bordered on the north by Darke County, on the east by Montgomery and Butler Counties, on the south by Butler County, and on the west by the state of Indiana (Figure 3). The county seat, Eaton, has a population of 6839 (U.S. Department of Commerce, 1981). The economy of Preble County is based primarily on agriculture. The fertile till-based soils are well suited to raising corn, wheat, oats, soybeans and hay. These crops are used mainly to feed the large livestock herds raised in the county.

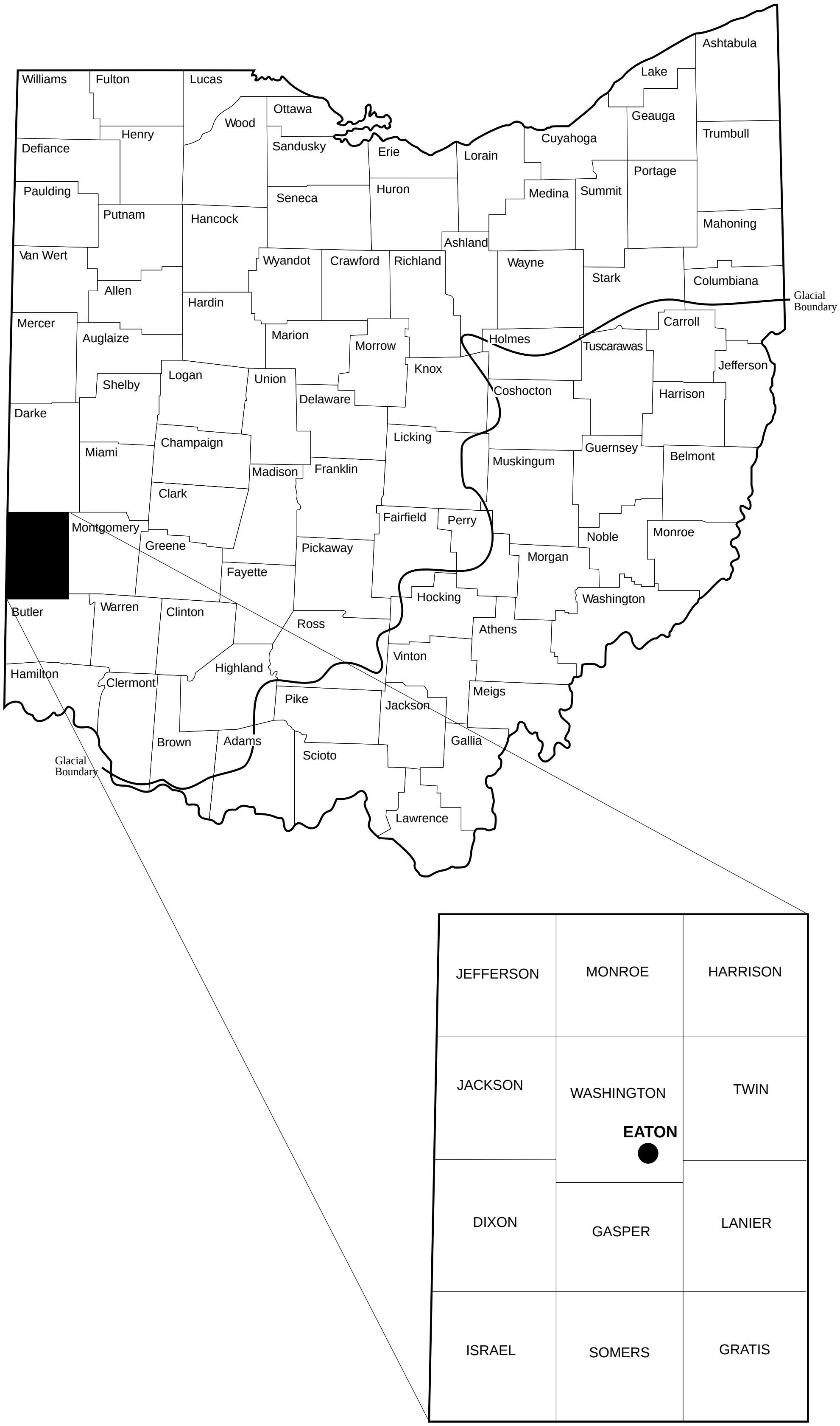
Physiography

Preble County lies in the Till Plains Region of the Central Lowlands Physiographic Province (Fenneman, 1938). A varying thickness of glacial sediments overlies gently dipping bedrock on the western flank of the Cincinnati Arch.

The pre-glacial bedrock surface in Preble County had very little relief; therefore, the current topography is the result of glacial action in the region. Most of the county is relatively flat to gently rolling, with stream dissected areas providing the greatest elevation changes. Topographic elevations range from a high of 1240 feet above mean sea level (m.s.l.) in Jackson Township to a low of 760 feet (m.s.l.) in Somers Township.

There are two end moraines in Preble County: the Farmersville Moraine, which is located in the central section of the county; and the Camden Moraine, which is located in the southern section of the county. An end moraine is a ridge-like accumulation of unstratified glacial sediments consisting of silt, clay, sand, and gravel. In Preble County there is little surface expression of the moraines. A traveler crossing the moraines may not notice a change in topographic relief. Identification of the moraine is made by soil types and the diversion of surface drainage.

All surface streams in Preble County drain into the Great Miami River Basin. Major tributaries to the Great Miami River which flow through Preble County are: East Fork of the Whitewater River, Four Mile Creek, Seven Mile Creek, and Twin Creek.



PREBLE COUNTY

Figure 3. Location of Preble County, Ohio

Climate

Weather bureau data for the 30-year period from 1951 through 1980 shows an average annual precipitation of 39.41 inches at Eaton (U.S. Department of Commerce, 1982). Most of the precipitation occurs in the form of rain during the spring and summer months. Average annual temperature for the same period was 52.10 degrees Fahrenheit at the Eaton reporting station (U.S. Department of Commerce, 1982).

Pre- and Inter-glacial Drainage

The pre-glacial bedrock surface in Preble County was gently undulating with no deeply incised valleys (Harker and Bernhagen, 1943). The earliest pre-glacial drainage in most of Ohio was controlled by the ancestral Teays River. The Teays flowed from North Carolina through the south-central section of Ohio then turned to the northwest, entering Indiana from Mercer County (Figure 4) (Stout et al., 1943) . Teays Stage pre-glacial streams in Preble County drained to the south-southwest through the ancestral Germantown Creek and other unnamed channels into the Hamilton River (Figure 5a) (Stout et al., 1943). The current bedrock valley floor, from Camden south on Seven Mile Creek, represents an ancestral channel which fed into the Hamilton River. The Hamilton River flowed through southwestern Ohio to join the Norwood River in Indiana (Stout et al., 1943). The Norwood eventually drained into the Teays near the Illinois border (Angle, pers. comm., 1991)

The flow of the Teays River was blocked by glacial ice during the pre-Illinoian (Kansan) glacial epoch. Because of the blockage, water levels rose and drainage changed in southwestern Ohio. A new drainage system, referred to as Deep Stage, was formed (Figure 5b) (Stout et al., 1943). Some rivers remained in their old channels while others diverted or changed flow direction. Regional uplift began a new stage of stream erosion, creating an immature drainage pattern. The ancestral Middletown River, which fed the Cincinnati River, occupied a channel very similar to the channel occupied by the Hamilton River during Teays time (Stout et al., 1943). Much of the stream flow was to the south and the system appeared similar to modern drainage patterns controlled by the Ohio River. With the arrival of Illinoian ice, basins in southwest Ohio developed new streams with deep channels, steep sloping valley walls and many small tributaries (Stout et al., 1943).

Buried valleys in Preble County exist where pre-glacial valleys have been filled with glacial deposits. Shallow buried valleys occur in several locations throughout the county and may or may not have a modern stream associated with them.

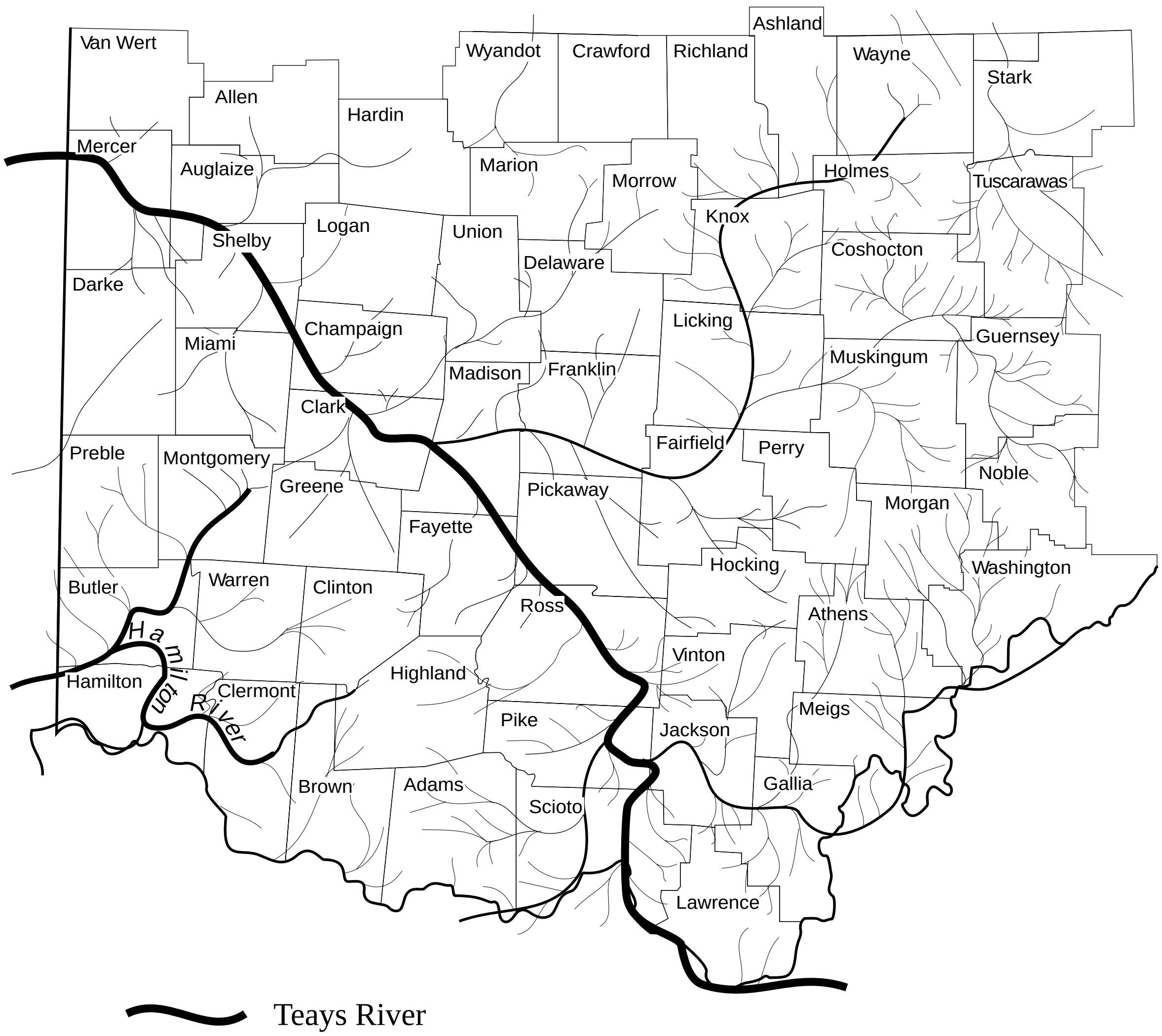
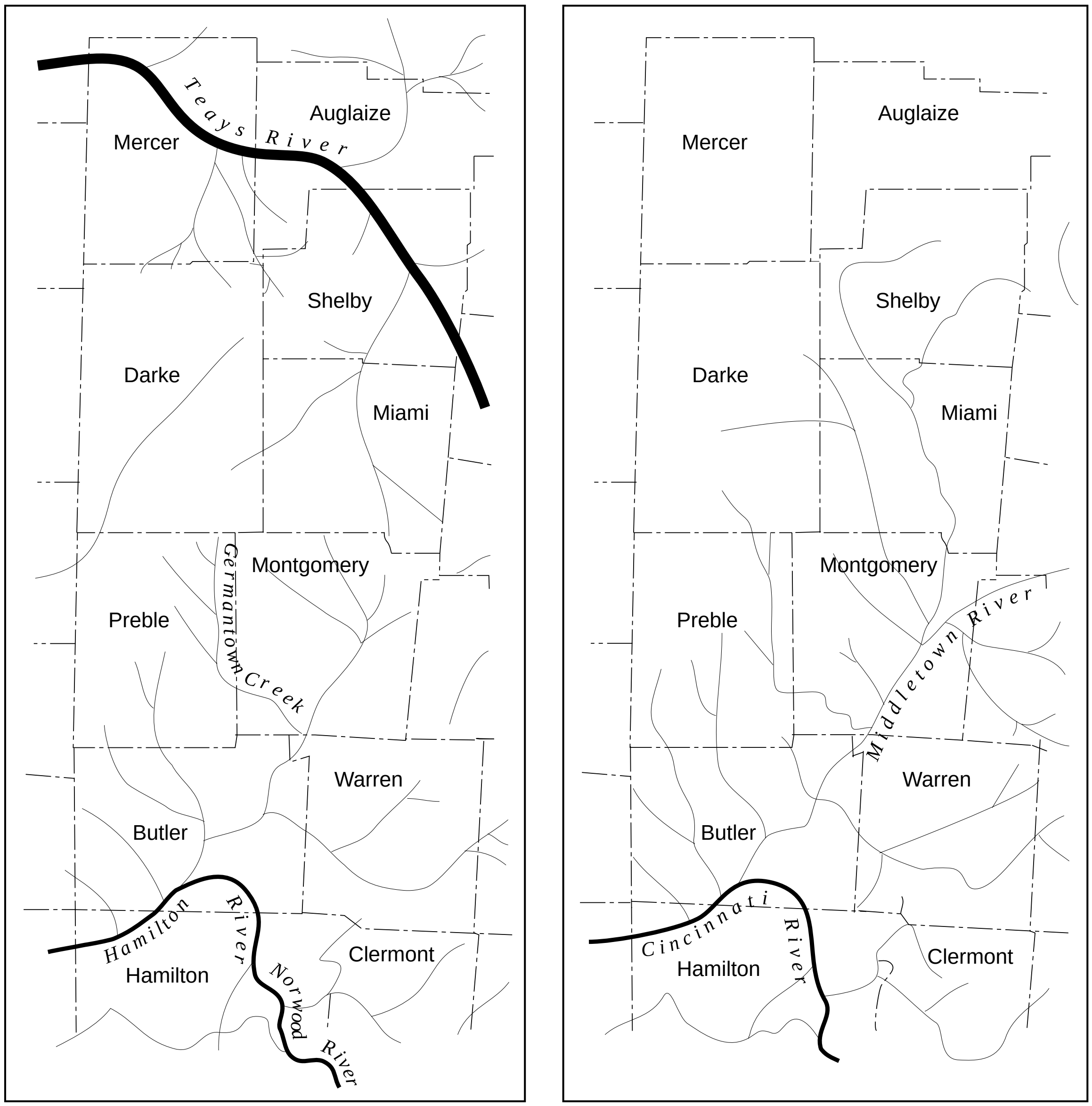


Figure 4. Teays Stage drainage in southwestern Ohio
(Modified from Stout et al., 1943)



(a) Teays Stage (b) Deep Stage

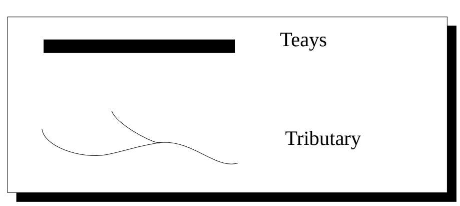


Figure 5. Teays and Deep Stage drainage in southwestern Ohio
(Modified from Stout et al., 1943)

Glacial Geology

The Pleistocene Epoch (2 million to 10,000 years ago) was a time of major advances and retreats of continental ice-sheets in northern North America. The glacial history of Preble County spans all four episodes of Pleistocene glaciation. These episodes, in order of increasing age, are: Wisconsinan, Illinoian, Kansan, and Nebraskan. The shallow bedrock valleys discussed in the previous section are the principal remnants of the Nebraskan and Kansan glacial stages in Preble County.

Most deposits of Illinioan age in southwest Ohio have been buried, eroded, or incorporated in Wisconsinan drift (Stewart, 1982). In locations where Illinoian aged till is exposed in southwest Ohio, the till is blue-gray, stoney, dense, plastic, and deeply leached (Stout et al., 1943). The parent material for Illinoian till in Preble County was the Silurian aged carbonates from northwestern Ohio.

Glacial till is a heterogeneous, non-sorted, non-stratified mixture of sand, gravel, silt, and clay deposited directly by glacial ice. The principal components of most tills are silt and clay. Compactibility depends on whether the ice sheet was moving or melting when the till was formed. Moving ice deposits a hard "lodgement" till; melting ice forms a softer "ablation" till.

The largest ice-sheet to pass over southwest Ohio occurred during the Wisconsinan glacial epoch (Stout et al., 1943). All surficial glacial materials in Preble County are Wisconsinan in age.

The thickness of glacial drift in Preble County varies from less than 5 feet to almost 300 feet. A thin veneer of glacial drift called ground moraine, consisting primarily of till, covers most of the bedrock surface. Several pre-glacial bedrock valleys have been filled with glacial sediment. These buried valleys, which contain sand, gravel, silt, and clay, can be as deep as 250 feet in Preble County.

There are two end moraines in the county: the Farmersville Moraine, which is the youngest, runs northwest to southeast across the central part of the county, and the Camden Moraine, which runs northwest to southeast across the southern portion of the county. The Farmersville Moraine is identified by the presence of the Boulder Belt, which is a large concentration of crystalline erratic boulders that were transported in place by glacial ice. Fence lines along the moraine often show boulders which have been removed from agricultural fields in the area. Several theories have been proposed to explain the concentration of boulders, but at this time there is no consensus on their origin. The moraine boundaries show little surface expression, and are difficult to identify in the field; therefore, they were not delineated in the mapping process.

There are three surfacial tills identified in Preble County. They are, from north to south: the Knightstown, Crawfordsville, and Shelbyville (Figure 6) (Goldthwait et al., 1981). These tills are all associated with the Miami and East Whitewater River lobes of the Camden Stade (substage).

The three oldest tills in Preble County, which are either buried or only exposed in deeply incised stream valleys, are from oldest to youngest: Whitewater, Fairhaven, and Fayette (Table 9) (Goldthwait and Rosengreen, 1969).

The oldest identified till in Preble County is the Whitewater Till (Gooding, 1963). Radiocarbon dating shows this till to be greater than 52,000 years old based on organic material found within the till (Stewart, 1982). There is a dispute over that age, as current data suggests that radiocarbon dates of materials over approximately 20,000 years are not reliable. One of the latest dating techniques is Amino Acid Racemization of molluscan shells found within the deposit. This technique indicates that the Whitewater, Fayette and Fairhaven Tills are older than previously thought (Miller et al., in progress). These techniques give a pre-Wisconsinan age, (Sangamonian interstade or Illinoian age).

While the ages of the Whitewater, Fairhaven, and Fayette Tills remain in question, the Shelbyville, Crawfordsville and Knightstown Tills are generally believed to have been produced by three separate ice advances during the Camden Stade (Wisconsinan) approximately 19,500 years ago (Stewart, 1982). The Shelbyville Till is the surficial till south of the Camden Moraine. This till was deposited by the East Whitewater River lobe from the northwest and the Miami lobe from the northeast (Gooding, 1963). Goldstein (1968) designated an upper and lower Shelbyville based on a site in the Reily-Millville region. These two tills, deposited by different lobes, also show a compositional difference.

The Crawfordsville Till is the surficial till on the Camden Moraine and extends north to the Farmersville Moraine. The Crawfordsville Till has a northeast fabric (alignment of sediments), and looks very similar to the Shelbyville on field examination.

The Knightstown Till extends north from the Farmersville Moraine, and is characterized by the highest clay concentration of the surficial tills in Preble County.

Bedrock Geology

The bedrock geology of Preble County consists of Ordovician and Silurian aged limestones and shales. Table 10 lists the formations found within the county.

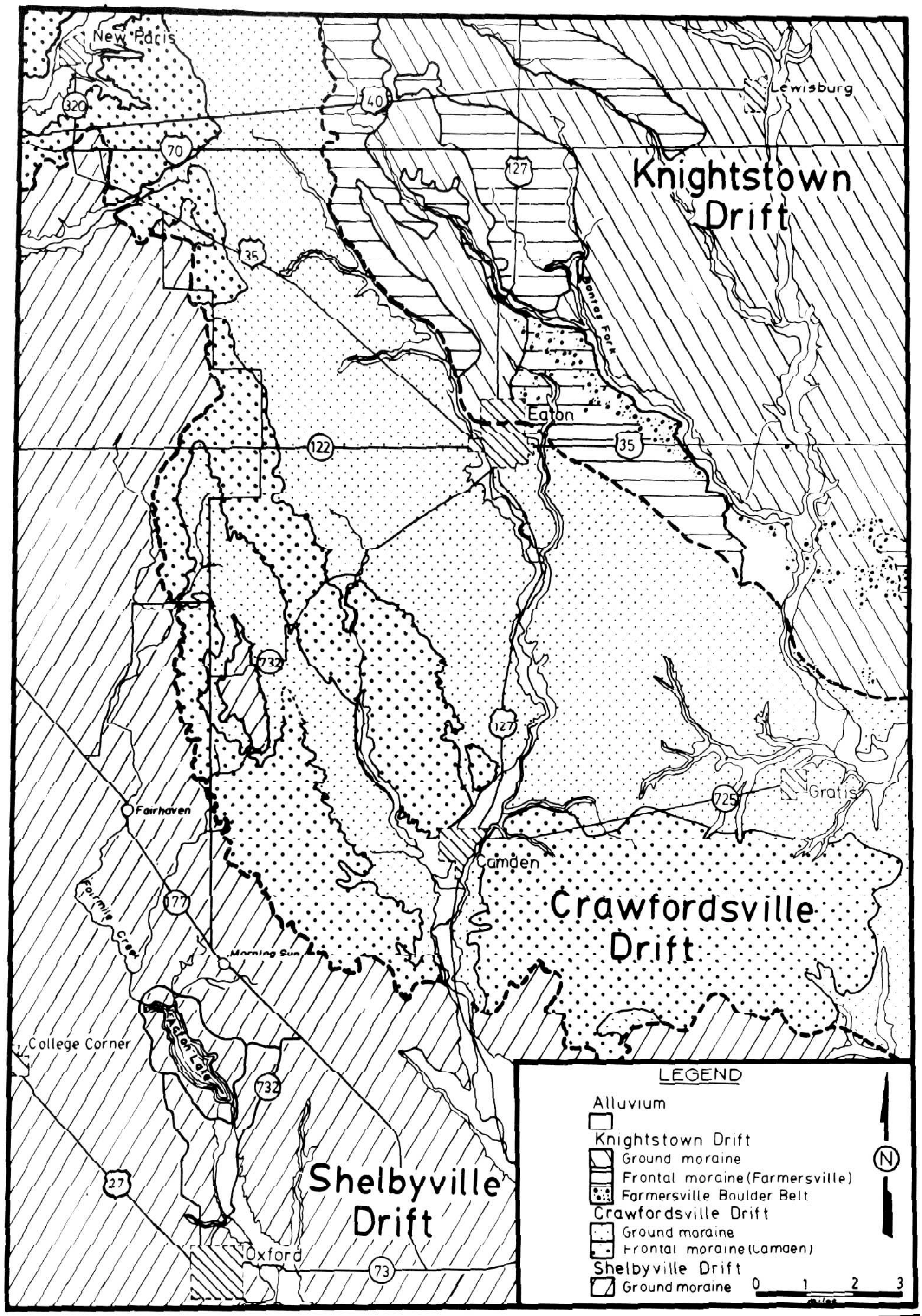


Figure 6. Wisconsinan surficial deposits of Preble County, Ohio
(From Stewart, 1982)

TABLE 9. PLEISTOCENE STRATIGRAPHY OF PREBLE COUNTY, OHIO
(Modified from Stewart, 1982)

<table>
<tr><td rowspan="11">WISCONSINAN GLACIAL STAGE</td><td rowspan="5">Camden Stade</td><td>Knightstown Phase</td></tr>
<tr><td>Crawfordsville Interphase</td></tr>
<tr><td>Crawfordsville Phase</td></tr>
<tr><td>Shelbyville Interphase</td></tr>
<tr><td>Shelbyville Phase</td></tr>
<tr><td colspan="2">Connersville Interstade</td></tr>
<tr><td colspan="2">Fayette Stade</td></tr>
<tr><td colspan="2">Sidney Interstade</td></tr>
<tr><td colspan="2">Fairhaven Stade</td></tr>
<tr><td colspan="2">New Paris Interstade</td></tr>
<tr><td colspan="2">Whitewater Stade</td></tr>
<tr><td>SANGAMON INTERGLACIAL STAGE</td><td colspan="2">SANGAMON WEATHERING</td></tr>
<tr><td rowspan="3">ILLINOIAN GLACIAL STAGE</td><td colspan="2">Richmond Stade</td></tr>
<tr><td colspan="2">Abington Interstade</td></tr>
<tr><td colspan="2">Centerville Stade</td></tr>
</table>

Ordovician aged bedrock extends over the southern and most of the eastern part of the county (Stout et al., 1943). The exposure of the oldest Silurian unit, the Brassfield Limestone, runs northeast to southwest across the central part of the county (Stout et al., 1943). North of the Brassfield exposure Springfield-Cedarville dolomites, which also belong to the Silurian System, are the upper- most bedrock units.

The Ordovician bedrock consists of soft shales interbedded with hard limestones. Classification of these rocks is based on either the fossil content (biostratigraphy), or the composition of the rocks (lithostratigraphy). Because of their highly fossiliferous nature, the stratigraphy of these rocks has been studied in as much detail as any bedrock unit in the United States. The thickness of Ordovician aged bedrock may be as great as 250 feet in some localities in Preble County.

TABLE 10. BEDROCK STRATIGRAPHY OF PREBLE COUNTY, OHIO
(Modified from Horvath and Sparling, 1967 and Harker and Bernhagen, 1943)

SYSTEM	SERIES	GROUP	FORMATION
SILURIAN	Niagaran	Lockport	Cedarville Dolomite
			Springfield Dolomite
			Euphemia Dolomite
		Sub Lockport	Laurel Dolomite
			Osgood Shale
			Dayton Limestone
	Alexandrian		Brassfield Limestone
ORDOVICIAN	Cincinnatian	Richmond	

To understand how bedrock forms, it is important to determine where the sediments came from and how they were deposited. During Ordovician time, southwestern Ohio was covered by a shallow inland sea. Sedimentary deposition was controlled by the structural relief of the Cincinnati Arch. The flank of the arch provided a platform for sediment accumulation. As the sea level changed from shallower to deeper the type of sediments deposited in a particular area changed. This is the reason that the vertical rock record shows a change from one bedrock type to another. The Ordovician bedrock, which was deposited as interbedded limestones and shales, documents these fluctuations in sea level.

The Richmond Group is the collective name for the interbedded shales and limestones of Ordovician age in southwestern Ohio. Ordovician limestones are very fossiliferous and therefore must have been deposited in clear water with an abundance of marine life. The limestones are composed of the mineralized skeletons of marine invertebrates and calcium carbonate that precipitated out of the sea water. The interbedded shales, sometimes referred to as clastic rocks, are composed of clay particles derived from weathered and eroded rocks. Shales typically form in low-energy environments of deposition.

In northern Preble County, at the Lewisburg Quarry, the Silurian section accounts for a total thickness of 65 feet (Horvath and Sparling, 1967). Seven distinct bedrock units have been identified by Horvath and Sparling at Lewisburg.

Deposition of Silurian bedrock in southwestern Ohio occurred during three separate periods of sedimentation (Horvath and Sparling, 1967). The depositional environment for the Brassfield Limestone is generally believed to be a shallow, gently sloping marine platform adjacent to a low-lying dry land surface. This environment was conducive to the deposition of sediments which eventually formed limestones and dolomites (carbonates).

The Brassfield ranges from a highly fossiliferous crystalline limestone to a more shaley limestone with some nodule development (Stout et al., 1943). The lower Brassfield is coarse grained and massive bedded. The upper Brassfield is thinner bedded and can be fossiliferous (Horvath and Sparling, 1967).

Sometime after the deposition of the Brassfield sea levels dropped. The Brassfield was then exposed to the atmosphere and experienced a period of weathering and erosion. A rise in sea level then resulted in a deeper water environment, favorable for the deposition of shale. During this time, the Dayton, Osgood, and Laurel formations were deposited above the Brassfield. A southerly source area for these land derived sediments has been suggested by Horvath and Sparling (1967).

Overlying the Brassfield is the Dayton Formation. A fine grained, dense limestone or dolomite that has been quarried extensively (Horvath and Sparling, 1967). The Dayton Formation is highly fossiliferous in some exposures (Kleffner and Ausich, 1988).

The Osgood Shale lies above the Dayton Formation. A clay-shale, the upper sections of the Osgood have limestone interbedded with the shale; lower parts of the section are exclusively shale (Horvath and Sparling, 1967).

The Osgood Shale is overlain by the Laurel Limestone. A medium-grained, dolomitic limestone. This formation contains residues of clay, silt, chert, pyrite, and glauconite (Horvath and Sparling, 1967).

The third period of sedimentation resulted in the deposition of the Euphemia, Springfield, and Cedarville units. Sea level changes allowed shelf deposition of carbonate sediments in moderately deep water. These three units correlate well with the carbonate bedrock units of northwest Ohio.

Foerste (1917) named the Euphemia Dolomite from an exposure in the Lewisburg quarry. The Euphemia is massive and porous, and can be identified by fossils of the various Brachiopod species present (Kleffner and Ausich, 1988).

The Springfield Formation is a light gray, fine to medium grained, and even bedded dolomite (Horvath and Sparling, 1967). It is vuggy and porous, and contains a high amount of quartz residue. (Stout et al., 1943).

Horvath and Sparling 1967 describe the Cedarville as a vuggy, massive, poorly bedded, fossiliferous, porous dolomite. The Euphemia and Cedarville are similar in fossil content and composition (Kleffner and Ausich, 1988). The Cedarville can be identified in section by the combination of fossil content and the physical properties of the rock.

Hydrogeology

Ground water in Preble County is found in several different types of deposits. The largest producing aquifers in Preble County are: the upper Silurian bedrock, especially the Cedarville Limestone; the Lower Silurian Brassfield Formation; and glacial sand and gravel occurring as outwash within a buried valley. Public water supplies throughout the county rely on these aquifers to deliver large sustained yields. The Ordovician limestones and shales provide meager supplies at best with a maximum yield of less than 5 gallons per minute. Discontinuous sand and gravel lenses incorporated in glacial till supply many residential water systems in the county.

The Silurian bedrock has the capacity to produce 100 gallons per minute at some locations in the county (Walker, 1986). The Cedarville and the Brassfield are the two units that supply the most water for residential and public water supplies. Secondary porosity is very important to obtain larger sustained yields. The Silurian Carbonates have solution enlarged openings along fractures and bedding planes. Because the carbonate bedrock is slightly soluable in water, the fractures and bedding planes are enlarged over time as ground water flows through them. In a tight bedrock, this enhances the aquifer’s ability to transmit water to a well.

The glacial outwash in the county has the potential to produce 500 gallons per minute (Walker, 1986). Outwash consists of water sorted sands and gravels that were deposited in front of the ice margin. Melt water flowing from the front of the ice sheet deposits the sand and gravel to form the outwash layer. The removal of fine material by water sorting creates large ground water storage and transmissive capacities in the aquifer. Outwash deposits occur in some present day river valley and most buried pre-glacial river valleys.

A buried valley is an ancient river valley formed before glaciation that has been subsequently filled with glacial material. Some buried valleys are filled with predominantly silts and clays while others have extensive sand and gravel deposits. Buried valleys in Preble County usually have some sand and gravel that can be developed into a water supply. Buried valleys represent some of the best aquifers in the state.

The Ordovician bedrock is the poorest source of ground water in the county. Where the glacial deposits are thin, and no sand and gravel is present, bedrock is the only ground water source available. Some ground water may be available at the interface between the glacial deposits and the bedrock. This zone is typically highly weathered, and is usually shown as gravel on water well logs. Because of its weathered nature, porosity and permeability are greater than the adjacent materials. Wells developed within the bedrock rely on fractures and bedding planes in the rock to provide conduits for the flow of ground water. Water must move through the fractures in the rock because the bedrock has little ability to transmit water. The shale has the porosity to store water, but does not have the internal permeability to transmit it to a well.

Sand and gravel deposits interbedded in the glacial till provide a highly variable source of ground water. Good yields are obtained where the deposits are sufficiently thick and coarse. There is little areal extent to these deposits, and in some areas nothing but non-water bearing clay and silt exist within the glacial drift.

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APPENDIX A

DESCRIPTION OF THE LOGIC IN FACTOR SELECTION

Depth to Water

Depth to water in Preble County was based on water well log data, the Ground Water Resources Map of Preble County (Walker, 1986), topographic maps, and field observations. Static water level measurements, recorded on water well logs, were the main sources of depth to water data. All Preble County aquifers are semi-confined or unconfined. However, the DRASTIC system recognizes only confined or unconfined aquifers. Because semi-confined aquifers in Preble County more closely resemble unconfined conditions rather than confined conditions, all aquifers in the county were rated as unconfined.

Water levels in the upland region, in the setting Glacial Till Over Bedded Sedimentary Rock (7Aa), range from 5-15 feet (9) below the surface to 30-50 feet below the surface (5). The average value for depth to water in this hydrogeologic setting is 15-30 feet below the surface (7).

In the areas with Glacial Till Over Limestone (7Ac), water depths varied from 5-15 (9), to 100+ (1) feet below the surface. However, most ground water levels were in the 15-30 range (7).

The hydrogeologic setting Sand and Gravel Interbedded in Glacial Till (7AF) also displayed a wide range of values for depth to water. Water levels ranged from 5-15 feet (9), to 100+ feet (1). The deeper static water levels generally occurred in areas of thicker glacial drift. The average value for depth to water was 15-30 (7).

The Buried Valley (7D) setting provides a wide range of values for depth to water, as the thickness of drift varies greatly. Value ranges were 0-5 (10) to 100+ (1) with the average being 15-30 (7).

Outwash (7Ba), Alluvium Over Till (7Ed), and Alluvium Over Limestone (7Ec) all have a shallow depth to water. Values were either 5-15 (9) or 15-30 (7). This reflects the fact that most of the occurrences of these deposits are associated with modern streams, which control depth to water.

Net Recharge

Net recharge is best defined as the amount of water that replenishes the aquifer system. The average value for recharge state-wide is approximately 6 inches per year (Pettyjohn and Henning, 1979). Precipitation minus runoff and evapotranspiration by plants, accounts for the net recharge to the aquifer. The factors that control the amount of recharge are soil composition, slope, and vadose material above the aquifer. If the soils and vadose materials are very permeable, recharge rates will be higher. Areas with thick, clay rich glacial till, have lower recharge rates. In areas where the bedrock is at or near the surface the recharge rates are higher. The number and size of fractures in the glacial till and in the bedrock also influence rates of recharge. The slope of the land surface controls how long precipitation is on the surface with time to infiltrate into the ground water supply. Flat-lying ground has greater recharge rates than highly sloping terrain.

The hydrogeologic setting of Glacial Till Over Bedded Sedimentary Rock (7Aa), has a recharge rate of 2-4 inches per year (3). Net recharge for Sand and Gravel Interbedded in Glacial Till (7Af) ranged from 2-4 inches per year (3), to 4-7 inches per year (6). The variation is controlled mostly by the composition of vadose zone materials.

In the Glacial Till Over Limestone Setting (7Ac) recharge was rated 2-4 inches per year (3) and 4-7 inches per year (6). The highest values for recharge were in the buried river valleys and in glacial outwash deposits. Outwash (7Ba) was mapped only in Jefferson Township, in the Whitewater River valley, and was rated 7-10 inches per year (8). Recharge in the Buried Valleys (7D), was rated 2-4 inches per year (3), 4-7 inches per year (6), and 7-10 inches per year (8). The highly variable nature of the drift in the buried valleys accounts for the variation in the values. The hydrogeologic settings of Alluvium Over Limestone (7Ec) and Alluvium Over Till (7Ed) have recharge rates of 2-4 inches per year (3), 4-7 inches per year (6), and 7-10 inches per year (8).

Aquifer Media

Aquifer media was evaluated primarily from water well logs on file at the Department of Natural Resources, Division of Water. Additional information was contributed by Harker and Bernhagen (1943), Dames and Moore (1972), the Ground Water Resources Map of Preble County (Walker 1986), Leow (1989a and 1989b) and by field investigation.

The aquifer rating for Glacial Till Over Bedded Sedimentary Rock (7Aa), which is interbedded limestone and shale, was a (3). The till over limestone setting (7Ac) was rated as a (5) or (6), as the limestone was the best bedrock aquifer in the county. Sand and Gravel Interbedded in Glacial Till (7Af) was rated from a (4) to a (6). Outwash deposits (7Ba), because of their coarse, well sorted nature, were rated as a (7). Buried Valley settings (7D) show a wide range of ratings from a (4) to an (8). Alluvium Over Limestone (7Ec), was rated as a (6) except where the bedrock is Ordovician age limestone and shale, where it was rated as a (3). Alluvium Over Glacial Till (7Ed) was rated from (4) to (7). The variability is based on the nature of the sand and gravel present in the alluvium.

Soil Media

The information used for soil analysis was the Soil Survey for Preble County (Lerch et al., 1969) and Forsyth (1965). Texture, organic content, permeability, and shrink/swell potential were used to give a DRASTIC rating to the first 6 feet of the soil profile.

Soils in the Glacial Till Over Bedded Sedimentary Rock (7Aa) were rated as clay (1), clay loam (3), silt loam (4), loam (5), and absent (10). In the Glacial Till Over Limestone setting (7Ac), soils were rated clay loam (3), silt loam (4), loam (5), absent (10). In the Sand and Gravel Interbedded in Glacial Till setting (7Af), soil types were rated as clay loam (3), silt loam (4), loam (5), sandy loam (6), and sand (9). The Outwash setting (7Ba) has soils rated as, loam (5) and sandy loam (6). Soils for the Buried Valley setting (7D) were rated clay loam (3), silt loam (4), loam (5), sandy loam (6) and sand (9). In the Alluvium Over Limestone setting (7Ec), soils were rated as clay loam (3), loam (5), and absent (10). In the Alluvium Over Till setting (7Ed) ratings were clay loam (3), silt loam (4), loam (5), and sandy loam (6). Table 11 lists the soils of Preble County and their individual DRASTIC ratings.

Topography

Topography was evaluated using a USGS 7 1/2 minute topographic quadrangle maps. Topography was then turned into slope percentages which were used for the rating process.

Much of the till plains of Preble County are dissected by streams creating areas with higher slope percentages. The till plains were rated 0-2% slope (10) to 12-18% slope (3). Values were controlled by the amount of dissection. The Buried Valley settings were rated 0-2% slope (10) to 12-18% slope (3). The floodplain areas and river valleys were rated as 0-2% slope (10) and 2-6% slope (9).

TABLE 11. PREBLE COUNTY SOILS (after Lerch et al., 1969)

Soil Name	DRASTIC Rating	Soil Media
Birkbeck	4	silt loam
Bonpas	7	shrink/swell clay
Brookston	3	clay loam
Casco-Rodman-Fox	9	sand
Celina	3	clay loam
Channahon-Fairmount	10	absent
Corwin	3	clay loam
Crane	4	silt loam
Crosby	5	loam
Dana	3	clay loam
Fairmount	10	absent
Fincastle	3	clay loam
Fox	5	loam
Landes	6	sandy loam
Lewisburg	5	loam
Medway	5	loam
Miami	5	loam
Miami-Celina	3	clay loam
Miami-Fox-Hennepin	5	loam
Millsdale	7	shrink/swell clay
Milton	7	shrink/swell clay
Ockley	4	silt loam
Ockley-Kendallville	4	silt loam
Odell	3	clay loam
Plattville	7	shrink/swell clay
Pyrmont	5	loam
Ragsdale	3	clay loam
Randolph	3	clay loam
Raub-Dana	3	clay loam
Reesville	3	clay loam
Ritchey-Channahon	10	absent
Ross	5	silt loam
Russell	3	clay loam
Shoals	5	loam
Sleeth	3	clay loam
Sloan	3	clay loam
Thackery	4	silt loam
Tippecanoe	4	silt loam
Warsaw	4	silt loam
Wea	4	silt loam
Westland	6	sandy loam
Wynn	7	shrink/swell clay
Xenia	4	silt loam

Impact of the Vadose Zone

The vadose zone is the unsaturated layer where any water present is at less than one atmosphere of pressure and is held in place by capillary action. The vadose zone was analyzed by the use of: water well records on file with the Ohio Department of Natural Resources, Division of Water; the Ground Water Resources Map of Preble County (Walker, 1986); and the following reports: Harker and Bernhagen (1943), Blackman (1970), Horvath and Sparling (1967), Oldfield (1977), Wilder (1987), Stewart (1982), and Goldthwait et al. (1981). In addition, field checks were performed in several areas where data were incomplete.

The majority of vadose material in Preble County is glacial till, which is composed mostly of sand, gravel, silt and clay. In some areas where glacial deposits are thin or absent, the shallow bedrock was rated as the vadose zone. In the hydrogeologic setting Glacial Till Over Bedded Sedimentary Rock (7Aa) the vadose zone was rated as a (3) in most areas and a (5) where the till is very sandy, highly fractured, or shallow fractured bedrock is the vadose material. In the Glacial Till Over Limestone setting (7Ac), glacial till was rated (3) or (4). In areas where the limestone is the vadose zone it was rated as a (5). Sand and Gravel Interbedded in Glacial Till (7Af) was rated as a (3) and (4). The till is rated a (3) in areas where clay concentrations are higher and a (4) where the till contains more sand. In the Outwash setting (7Ba), sand and gravel with significant silt and clay is the vadose material and is rated as a (6). The Buried Valley setting (7D) has vadose materials of sand and gravel, sand and gravel with silt and clay, and glacial till. The till was rated (3), (4), or (5) depending on the amount of sand present. The sand and gravel with silt and clay was rated (4), (5), or (6). The sand and gravel vadose material in buried valleys occurred where a current stream exists over very coarse deposits and was rated (6), (7), or (8). Alluvium Over Limestone (7Ec) has limestone (4), limestone/shale (5), sand and gravel (5), sand and gravel with silt and clay (5) or (6). In the Alluvium Over Till setting, sand and gravel with silt and clay was rated (3), (4), or (5), sand and gravel and glacial till were rated (5).

Hydraulic Conductivity

Hydraulic conductivity values were based on the following references: water well logs on file at the Division of Water, Ground Water Resources of Preble County (Walker, 1986), unpublished data Dames & Moore (1972), Fetter (1988), Freeze and Cherry (1979), Norris and Fidler (1973), and field evaluation. In the DRASTIC system, hydraulic conductivity values were rated in gallons per day per foot squared (gpd/ft^2). Hydraulic conductivity values for Glacial Till Over Bedded Sedimentary Rocks (7Aa) were rated as 1-100 gpd/ft^2 (1). In the Glacial Till Over Limestone setting (7Ac), hydraulic conductivities were rated as 100-300 gpd/ft^2 (2). The hydrogeologic setting of Sand and Gravel Interbedded in Glacial Till (7Af) had ratings of 100-300 gpd/ft^2 (2) and 300-700 gpd/ft^2 (4). The Outwash setting (7Ba) was rated as 300-700 gpd/ft^2 (4). The Buried Valley setting (7D) values ranged from 1-100 gpd/ft^2 (2) to 1000-2000 gpd/ft^2 (8). The large variation in ratings is attributed to thickness and sorting of the material present. In the Alluvium Over Limestone setting ratings ranged from, 1-100 gpd/ft^2 (1) to 300-700 gpd/ft^2 (4). Alluvium Over Till (7Ed) was rated at 100-300 gpd/ft^2 (2) to 300-700 gpd/ft^2 (4).

APPENDIX B

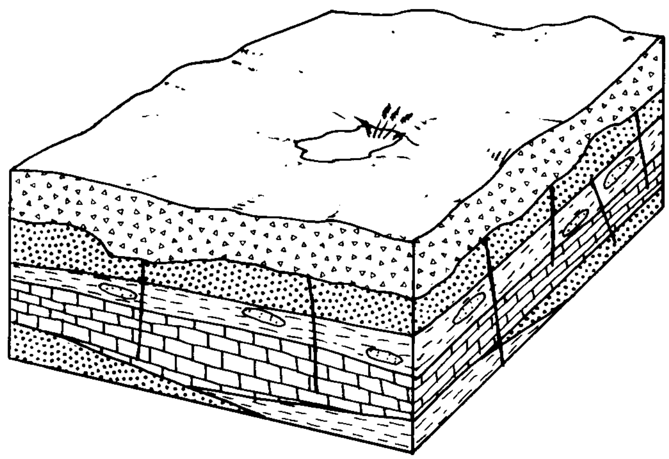
DESCRIPTION OF HYDROGEOLOGIC SETTINGS AND CHARTS

Ground water pollution potential mapping in Preble County resulted in the identification of seven 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. Computed pollution potential indexes for Preble County range from 62 to 179.

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.

TABLE 12. HYDROGEOLOGIC SETTINGS MAPPED IN PREBLE COUNTY, OHIO.

Hydrogeologic Settings	Range of GWPP Indexes	Number of Index Calculations
7Aa - Glacial Till Over Bedded Sedimentary Rock	79 - 124	40
7Ac - Glacial Till Over Solution Limestone	88 - 133	40
7Af - Sand & Gravel Interbedded in Glacial Till	75 - 133	64
7Ba - Outwash	160 - 162	2
7D - Buried Valley	62 - 179	80
7Ec - Alluvium Over Sedimentary Rock	126 - 157	5
7Bd - Alluvium Over Glacial Till	115 - 142	21



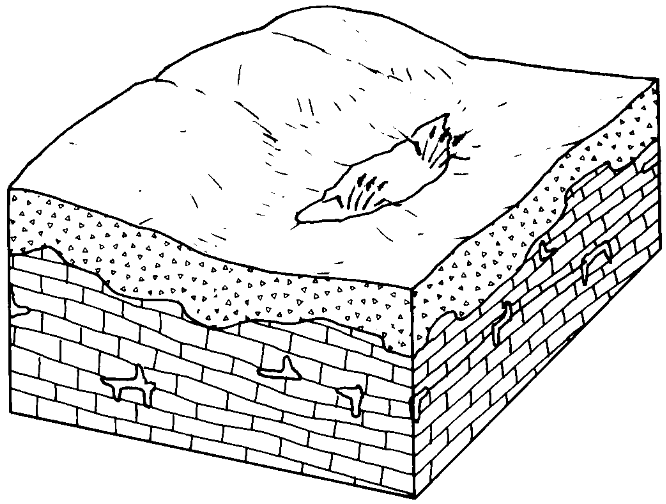
7Aa Glacial Till Over Bedded Sedimentary Rock

This hydrogeologic setting is characterized by relatively flat lying sedimentary rocks consisting of limestone and shale, which are covered by varying thicknesses of glacial till. The till is composed of clay, silt, sand, and gravel. Ground water occurs in the glacial deposits and in the fractured portions of the bedrock.

The clay rich nature of the soils and glacial till limit recharge to moderate amounts although precipitation is abundant. Depth to water is extremely variable depending in part on the thickness of the glacial till.

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Aa1	15-30	2-4	Interbedded Limestone and Shale	Clay Loam	0-2	Till	1-100	90	115
7Aa2	5-15	2-4	Interbedded Limestone and Shale	Clay Loam	0-2	Till	1-100	100	125
7Aa3	15-30	2-4	Interbedded Limestone and Shale	Clay Loam	6-12	Till	1-100	85	100
7Aa4	15-30	2-4	Interbedded Limestone and Shale	Clay Loam	0-2	Sand and Gravel W/ Silt and Clay	1-100	90	115
7Aa5	15-30	2-4	Interbedded Limestone and Shale	Clay Loam	2-6	Till	1-100	89	112
7Aa6	5-15	2-4	Interbedded Limestone and Shale	Loam	0-2	Till	1-100	104	135
7Aa7	5-15	2-4	Interbedded Limestone and Shale	Clay Loam	6-12	Till	1-100	95	110
7Aa8	15-30	2-4	Interbedded Limestone and Shale	Loam	6-12	Till	1-100	89	110
7Aa9	30-50	2-4	Interbedded Limestone and Shale	Clay Loam	2-6	Till	1-100	79	102
7Aa10	5-15	2-4	Interbedded Limestone and Shale	Silty Loam	0-2	Till	1-100	102	130
7Aa11	15-30	2-4	Interbedded Limestone and Shale	Silty Loam	0-2	Till	1-100	92	120
7Aa12	5-15	2-4	Interbedded Limestone and Shale	Clay Loam	2-6	Till	1-100	99	122
7Aa13	30-50	2-4	Interbedded Limestone and Shale	Loam	2-6	Till	1-100	83	112
7Aa14	15-30	2-4	Interbedded Limestone and Shale	Loam	0-2	Till	1-100	94	125

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Aa15	15-30	2-4	Interbedded Limestone and Shale	Clay Loam	2-6	Till	1-100	89	112
7Aa16	15-30	2-4	Interbedded Limestone and Shale	Thin or Absent	2-6	Interbedded Limestone and Shale	1-100	113	155
7Aa17	15-30	2-4	Interbedded Limestone and Shale	Thin or Absent	6-12	Interbedded Limestone and Shale	1-100	109	143
7Aa18	15-30	2-4	Interbedded Limestone and Shale	Loam	6-12	Till	100-300	92	112
7Aa19	15-30	2-4	Interbedded Limestone and Shale	Clay Loam	2-6	Till	1-100	89	112
7Aa20	15-30	2-4	Interbedded Limestone and Shale	Clay Loam	0-2	Interbedded Limestone and Shale	1-100	90	115
7Aa21	15-30	2-4	Interbedded Limestone and Shale	Thin or Absent	2-6	Interbedded Limestone and Shale	1-100	118	159
7Aa22	15-30	2-4	Interbedded Limestone and Shale	Silty Loam	2-6	Till	1-100	91	117
7Aa23	5-15	2-4	Interbedded Limestone and Shale	Thin or Absent	0-2	Interbedded Limestone and Shale	1-100	124	168
7Aa24	15-30	2-4	Interbedded Limestone and Shale	Loam	6-12	Till	1-100	99	118
7Aa25	5-15	2-4	Interbedded Limestone and Shale	Clay Loam	2-6	Till	1-100	109	130
7Aa26	5-15	2-4	Interbedded Limestone and Shale	Loam	2-6	Till	1-100	113	140
7Aa27	15-30	2-4	Interbedded Limestone and Shale	Loam	12-18	Till	1-100	97	112
7Aa28	15-30	2-4	Interbedded Limestone and Shale	Loam	6-12	Sand and Gravel W/ Silt and Clay	1-100	99	118
7Aa29	5-15	2-4	Interbedded Limestone and Shale	Clay Loam	0-2	Till	1-100	110	133
7Aa30	15-30	2-4	Interbedded Limestone and Shale	Loam	2-6	Till	1-100	103	130
7Aa31	15-30	2-4	Interbedded Limestone and Shale	Nonshrinking & Nonaggregated Clay	2-6	Till	1-100	95	110
7Aa32	15-30	2-4	Interbedded Limestone and Shale	Clay Loam	0-2	Till	1-100	100	123
7Aa33	15-30	2-4	Interbedded Limestone and Shale	Loam	2-6	Sand and Gravel W/ Silt and Clay	1-100	103	130
7Aa34	15-30	2-4	Interbedded Limestone and Shale	Silty Loam	6-12	Till	1-100	97	113
7Aa35	15-30	2-4	Interbedded Limestone and Shale	Thin or Absent	6-12	Till	1-100	109	143
7Aa36	30-50	2-4	Interbedded Limestone and Shale	Clay Loam	0-2	Till	1-100	80	105
7Aa37	15-30	2-4	Interbedded Limestone and Shale	Loam	6-12	Till	1-100	99	118
7Aa38	5-15	2-4	Interbedded Limestone and Shale	Clay Loam	0-2	Sand and Gravel W/ Silt and Clay	1-100	110	133
7Aa39	5-15	2-4	Interbedded Limestone and Shale	Clay Loam	2-6	Sand and Gravel W/ Silt and Clay	1-100	109	130
7Aa40	5-15	2-4	Interbedded Limestone and Shale	Loam	0-2	Interbedded Limestone and Shale	1-100	114	143

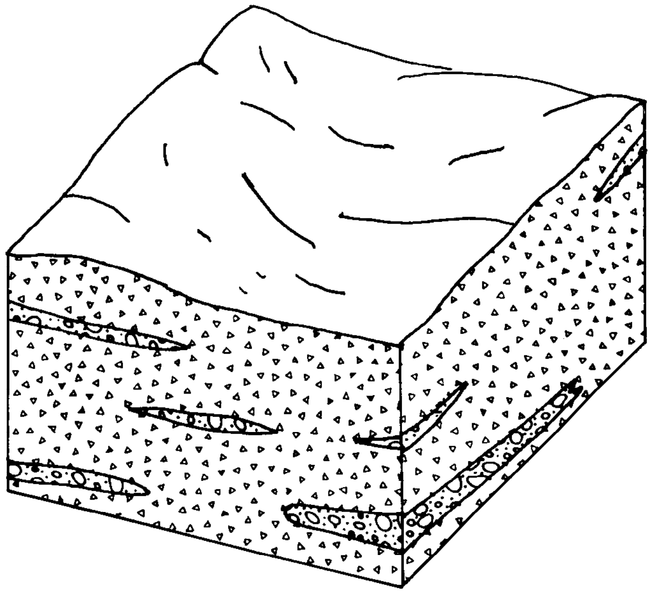


7Ac Glacial Till Over Limestone

This hydrogeologic setting is characterized by low relief with limestone or dolomite bedrock covered by varying thicknesses of glacial till. The till is composed of clay, silt, sand and gravel. Sand and gravel deposits within the till are generally not sufficiently thick to develop as a water supply. The limestone-dolomite bedrock serves as the aquifer in this setting. Ground water occurs in the fractured and solutioned portions of the formation. Recharge for the bedrock is from precipitation infiltration through the glacial till. Depth to water is highly variable based in part on the thickness of glacial sediments. Soils are typically clay loam.

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Ac1	15-30	4-7	Limestone	Silty Loam	0-2	Till	100-300	121	147
7Ac2	30-50	4-7	Limestone	Clay Loam	6-12	Till	100-300	104	117
7Ac3	15-30	4-7	Limestone	Loam	2-6	Till	100-300	122	149
7Ac4	5-15	4-7	Limestone	Silty Loam	0-2	Till	100-300	131	157
7Ac5	30-50	4-7	Limestone	Loam	2-6	Till	100-300	112	139
7Ac6	15-30	4-7	Limestone	Clay Loam	0-2	Sand and Gravel W/ Silt and Clay	100-300	119	142
7Ac7	30-50	4-7	Limestone	Clay Loam	0-2	Till	100-300	109	132
7Ac8	30-50	4-7	Limestone	Loam	0-2	Till	100-300	113	142
7Ac9	5-15	4-7	Limestone	Clay Loam	0-2	Till	100-300	129	152
7Ac10	5-15	4-7	Limestone	Silty Loam	6-12	Till	100-300	121	138
7Ac11	15-30	4-7	Limestone	Loam	2-6	Sand and Gravel W/ Silt and Clay	100-300	122	149
7Ac12	5-15	4-7	Limestone	Loam	0-2	Till	100-300	133	162
7Ac13	5-15	4-7	Limestone	Clay Loam	0-2	Sand and Gravel W/ Silt and Clay	100-300	129	152
7Ac14	15-30	4-7	Limestone	Clay Loam	6-12	Till	100-300	114	127
7Ac15	15-30	4-7	Limestone	Loam	0-2	Till	100-300	123	152
7Ac16	15-30	4-7	Limestone	Clay Loam	0-2	Till	100-300	119	142
7Ac17	50-75	4-7	Limestone	Loam	0-2	Till	100-300	103	132
7Ac18	50-75	4-7	Limestone	Loam	2-6	Till	100-300	102	129

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Ac19	30-50	4-7	Limestone	Clay Loam	2-6	Sand and Gravel W/ Silt and Clay	100-300	108	129
7Ac20	30-50	4-7	Limestone	Clay Loam	0-2	Sand and Gravel W/ Silt and Clay	100-300	109	132
7Ac21	50-75	4-7	Limestone	Clay Loam	2-6	Till	100-300	98	119
7Ac22	50-75	4-7	Limestone	Clay Loam	0-2	Till	100-300	99	122
7Ac23	5-15	4-7	Limestone	Clay Loam	0-2	Silt/Clay	100-300	129	152
7Ac24	15-30	4-7	Limestone	Loam	0-2	Till	100-300	123	152
7Ac25	15-30	4-7	Limestone	Loam	2-6	Till	100-300	117	145
7Ac26	15-30	4-7	Limestone	Clay Loam	0-2	Till	100-300	114	138
7Ac27	30-50	4-7	Limestone	Clay Loam	0-2	Till	100-300	104	128
7Ac28	5-15	2-4	Limestone	Clay Loam	0-2	Till	100-300	109	133
7Ac29	15-30	2-4	Limestone	Clay Loam	0-2	Till	100-300	99	123
7Ac30	15-30	2-4	Limestone	Thin or Absent	0-2	Limestone	100-300	126	169
7Ac31	15-30	2-4	Limestone	Loam	0-2	Limestone	100-300	113	141
7Ac32	15-30	2-4	Limestone	Loam	0-2	Till	100-300	103	133
7Ac33	15-30	2-4	Limestone	Thin or Absent	0-2	Limestone	100-300	123	166
7Ac34	15-30	2-4	Limestone	Clay Loam	0-2	Till	100-300	99	123
7Ac35	15-30	2-4	Limestone	Silty Loam	0-2	Till	100-300	101	128
7Ac36	15-30	4-7	Limestone	Loam	6-12	Till	100-300	118	137
7Ac37	100+	0-2	Limestone	Loam	6-12	Till	100-300	65	84
7Ac38	75-100	0-2	Limestone	Loam	6-12	Till	100-300	70	89
7Ac39	15-30	4-7	Limestone	Clay Loam	0-2	Till	100-300	116	139
7Ac40	50-75	4-7	Limestone	Clay Loam	6-12	Till	100-300	94	107

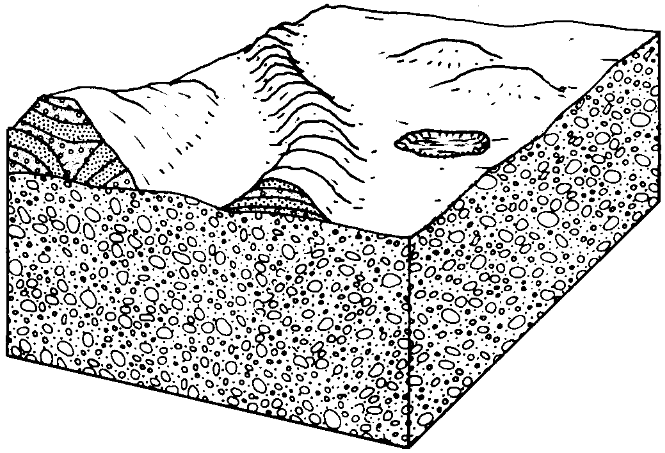


7Af Sand and Gravel Interbedded in Glacial Till

This hydrogeologic setting is characterized by sand and gravel interbedded within glacial till. The till is composed of clay, silt, sand and gravel in varying amounts. The sand and gravel deposits vary from small isolated lenses to large areally extensive deposits. Sand and gravel serves as the principal aquifer in this setting. Recharge occurs from infiltration of precipitation through the glacial till. Depth to water is highly variable. Soils are typically classified as clay loam.

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Af1	30-50	4-7	Sand and Gravel	Loam	0-2	Till	100-300	110	139
7Af2	30-50	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	106	129
7Af3	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	129	152
7Af4	15-30	4-7	Sand and Gravel	Loam	0-2	Till	100-300	123	152
7Af5	30-50	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	109	132
7Af6	5-15	4-7	Sand and Gravel	Loam	0-2	Till	100-300	133	162
7Af7	50-75	4-7	Sand and Gravel	Loam	0-2	Till	100-300	103	132
7Af8	15-30	4-7	Sand and Gravel	Clay Loam	2-6	Sand and Gravel W/ Silt and Clay	100-300	118	139
7Af9	30-50	4-7	Sand and Gravel	Loam	2-6	Till	100-300	112	139
7Af10	30-50	4-7	Sand and Gravel	Loam	0-2	Till	100-300	113	142
7Af11	50-75	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	99	122
7Af12	75-100	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	94	117
7Af13	75-100	2-4	Sand and Gravel	Clay Loam	6-12	Till	100-300	77	90
7Af14	15-30	4-7	Sand and Gravel	Clay Loam	6-12	Till	100-300	117	130
7Af15	100+	2-4	Sand and Gravel	Loam	2-6	Till	100-300	80	107
7Af16	50-75	4-7	Sand and Gravel	Clay Loam	6-12	Till	100-300	94	107
7Af17	15-30	4-7	Sand and Gravel	Loam	6-12	Till	100-300	118	137
7Af18	50-75	4-7	Sand and Gravel	Loam	6-12	Till	100-300	98	117
7Af19	50-75	4-7	Sand and Gravel	Clay Loam	2-6	Till	100-300	98	119

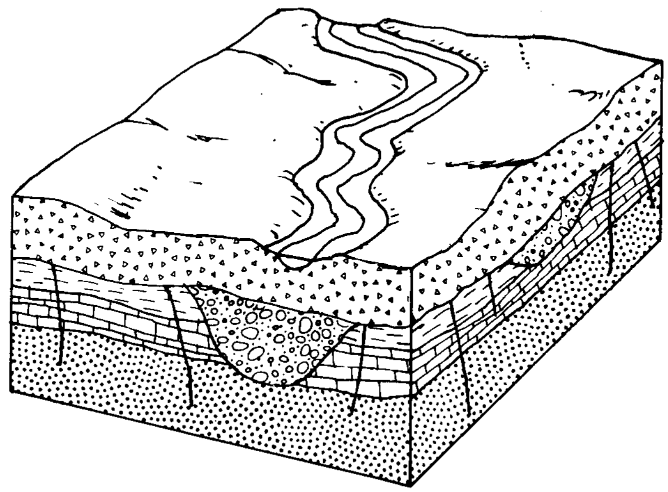
Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Af20	15-30	2-4	Sand and Gravel	Clay Loam	0-2	Silt/Clay	100-300	96	120
7Af21	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	108	132
7Af22	30-50	2-4	Sand and Gravel	Clay Loam	2-6	Silt/Clay	100-300	85	107
7Af23	15-30	2-4	Sand and Gravel	Loam	2-6	Till	100-300	99	127
7Af24	15-30	2-4	Sand and Gravel	Clay Loam	2-6	Silt/Clay	100-300	95	117
7Af25	15-30	2-4	Sand and Gravel	Silty Loam	0-2	Till	100-300	98	125
7Af26	15-30	2-4	Sand and Gravel	Clay Loam	0-2	Till	100-300	96	120
7Af27	30-50	2-4	Sand and Gravel	Clay Loam	2-6	Till	100-300	85	107
7Af28	15-30	2-4	Sand and Gravel	Clay Loam	2-6	Till	100-300	95	117
7Af29	30-50	2-4	Sand and Gravel	Clay Loam	0-2	Till	100-300	86	110
7Af30	5-15	2-4	Sand and Gravel	Loam	2-6	Till	100-300	109	137
7Af31	50-75	2-4	Sand and Gravel	Clay Loam	2-6	Till	100-300	75	97
7Af32	50-75	2-4	Sand and Gravel	Clay Loam	0-2	Till	100-300	76	100
7Af33	15-30	2-4	Sand and Gravel	Loam	2-6	Till	100-300	99	127
7Af34	15-30	2-4	Sand and Gravel	Loam	0-2	Till	100-300	100	130
7Af35	15-30	2-4	Sand and Gravel	Clay Loam	0-2	Till	100-300	99	123
7Af36	15-30	2-4	Sand and Gravel	Sandy Loam	0-2	Till	100-300	105	138
7Af38	5-15	2-4	Sand and Gravel	Loam	0-2	Till	100-300	113	143
7Af39	50-75	2-4	Sand and Gravel	Clay Loam	0-2	Till	100-300	79	103
7Af40	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Till	100-300	128	154
7Af41	15-30	2-4	Sand and Gravel	Silty Loam	0-2	Till	100-300	101	128
7Af42	30-50	2-4	Sand and Gravel	Clay Loam	0-2	Till	100-300	89	113
7Af44	15-30	2-4	Sand and Gravel	Loam	2-6	Till	100-300	102	130
7Af45	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	119	142
7Af46	50-75	2-4	Sand and Gravel	Loam	0-2	Silt/Clay	100-300	83	113
7Af47	15-30	4-7	Sand and Gravel	Loam	0-2	Sand and Gravel W/ Silt and Clay	100-300	123	152
7Af48	30-50	4-7	Sand and Gravel	Clay Loam	2-6	Till	100-300	108	129
7Af49	15-30	4-7	Sand and Gravel	Loam	2-6	Till	100-300	116	143
7Af50	15-30	4-7	Sand and Gravel	Loam	2-6	Till	300-700	128	153
7Af51	5-15	2-4	Sand and Gravel	Loam	0-2	Till	100-300	110	140
7Af52	30-50	4-7	Sand and Gravel	Loam	6-12	Till	100-300	108	127
7Af53	5-15	2-4	Sand and Gravel	Clay Loam	0-2	Till	100-300	106	130
7Af54	15-30	2-4	Sand and Gravel	Loam	6-12	Till	100-300	95	115
7Af55	15-30	4-7	Sand and Gravel	Clay Loam	2-6	Till	100-300	118	139
7Af56	30-50	4-7	Sand and Gravel	Sand	6-12	Till	100-300	116	147
7Af57	30-50	4-7	Sand and Gravel	Silty Loam	2-6	Till	100-300	110	134
7Af58	100+	0-2	Sand and Gravel	Loam	6-12	Till	100-300	68	87
7Af59	5-15	4-7	Sand and Gravel	Loam	6-12	Till	100-300	128	147
7Af60	100+	0-2	Sand and Gravel	Clay Loam	0-2	Till	100-300	69	92
7Af61	15-30	4-7	Sand and Gravel	Clay Loam	6-12	Till	100-300	114	127
7Af62	15-30	2-4	Sand and Gravel	Loam	6-12	Till	1-100	92	113
7Af63	15-30	2-4	Sand and Gravel	Clay Loam	2-6	Till	100-300	95	117
7Af64	50-75	4-7	Sand and Gravel	Loam	2-6	Till	100-300	102	129



7Ba Outwash

This hydrogeologic setting is characterized by moderate to low topography, with ice contact deposits overlying glacial till or sedimentary bedrock. Outwash consists of stratified sediments deposited in front of a glacier by meltwater streams. These well sorted sand and gravel deposits may be in direct hydraulic connection with the underlying till or bedrock. The outwash may serve as the principal aquifer in this setting. Recharge is from direct precipitation infiltration through the overlying deposits. Soil type and water levels are both highly variable.

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Ba1	5-15	7-10	Sand and Gravel	Sandy Loam	0-2	Sand and Gravel W/ Silt and Clay	300-700	162	190
7Ba2	5-15	7-10	Sand and Gravel	Loam	0-2	Sand and Gravel W/ Silt and Clay	300-700	160	185



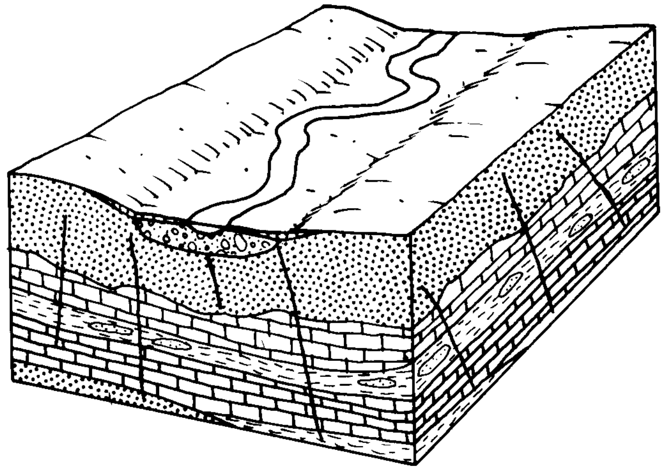
<u>7D Buried Valley</u>

This hydrogeologic setting is characterized by thick deposits of clay, silt, sand and gravel deposited in pre-glacial or inter-glacial river valleys. These deposits may or may not underlie a present-day stream. When sand and gravel deposits are thick, buried valleys are capable of yielding large quantities of water. Soils are highly variable ranging from clay loam to sand. Static water levels are highly variable and depend on the thickness of surficial deposits. Recharge to the aquifer is from surficial infiltration of precipitation and regional ground water flow from the surrounding bedrock.

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7D2	15-30	4-7	Sand and Gravel	Loam	2-6	Till	100-300	122	149
7D3	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Sand and Gravel W/ Silt and Clay	100-300	129	152
7D4	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	119	142
7D5	5-15	4-7	Sand and Gravel	Loam	0-2	Silt/Clay	100-300	133	162
7D6	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Sand and Gravel W/ Silt and Clay	100-300	129	152
7D7	30-50	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	109	132
7D8	15-30	4-7	Sand and Gravel	Clay Loam	6-12	Till	100-300	114	127
7D9	15-30	4-7	Sand and Gravel	Clay Loam	12-18	Till	100-300	112	121
7D10	30-50	4-7	Sand and Gravel	Loam	2-6	Till	100-300	112	139
7D11	15-30	4-7	Sand and Gravel	Clay Loam	2-6	Till	100-300	118	139
7D12	5-15	4-7	Sand and Gravel	Clay Loam	12-18	Till	100-300	122	131
7D13	30-50	4-7	Sand and Gravel	Loam	6-12	Till	100-300	108	127
7D14	50-75	4-7	Sand and Gravel	Loam	6-12	Till	100-300	98	117
7D15	50-75	4-7	Sand and Gravel	Clay Loam	6-12	Till	100-300	94	107
7D16	5-15	2-4	Sand and Gravel	Clay Loam	0-2	Till	100-300	109	133
7D17	50-75	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	99	122
7D18	0-5	7-10	Sand and Gravel	Loam	0-2	Sand and Gravel W/ Silt and Clay	100-300	151	179
7D19	5-15	7-10	Sand and Gravel	Silty Loam	0-2	Sand and Gravel	1000-2000	175	192
7D20	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	124	148
7D21	5-15	4-7	Sand and Gravel	Loam	0-2	Till	300-700	142	169
7D22	5-15	4-7	Sand and Gravel	Loam	2-6	Till	300-700	141	166

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7D23	15-30	2-4	Sand and Gravel	Loam	0-2	Till	100-300	100	130
7D24	15-30	2-4	Sand and Gravel	Loam	2-6	Till	100-300	99	127
7D25	15-30	2-4	Sand and Gravel	Silty Loam	0-2	Till	100-300	101	127
7D26	15-30	2-4	Sand and Gravel	Loam	2-6	Till	100-300	102	129
7D27	5-15	7-10	Sand and Gravel	Sandy Loam	0-2	Sand and Gravel	700-1000	176	201
7D28	15-30	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	122	144
7D29	30-50	2-4	Sand and Gravel	Clay Loam	2-6	Till	1-100	82	105
7D30	5-15	7-10	Sand and Gravel	Loam	0-2	Sand and Gravel	300-700	165	189
7D31	15-30	4-7	Sand and Gravel	Loam	6-12	Till	100-300	110	130
7D32	50-75	4-7	Sand and Gravel	Silty Loam	6-12	Till	100-300	88	105
7D33	75-100	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	86	110
7D34	100+	2-4	Sand and Gravel	Loam	2-6	Till	100-300	72	100
7D35	100+	2-4	Sand and Gravel	Loam	0-2	Till	100-300	73	103
7D36	50-75	4-7	Sand and Gravel	Loam	2-6	Till	100-300	94	122
7D37	30-50	4-7	Sand and Gravel	Loam	2-6	Till	100-300	104	132
7D38	75-100	2-4	Sand and Gravel	Clay Loam	2-6	Till	100-300	73	95
7D39	75-100	2-4	Sand and Gravel	Clay Loam	0-2	Till	100-300	74	98
7D40	30-50	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	101	125
7D41	50-75	4-7	Sand and Gravel	Clay Loam	0-2	Till	100-300	91	115
7D42	15-30	2-4	Sand and Gravel	Clay Loam	0-2	Till	1-100	93	118
7D43	15-30	2-4	Sand and Gravel	Silty Loam	0-2	Till	1-100	95	123
7D44	5-15	4-7	Sand and Gravel	Loam	0-2	Sand and Gravel W/ Silt and Clay	100-300	130	159
7D45	5-15	4-7	Sand and Gravel	Loam	0-2	Sand and Gravel W/ Silt and Clay	100-300	133	162
7D46	5-15	4-7	Sand and Gravel	Loam	0-2	Sand and Gravel	300-700	152	177
7D47	5-15	7-10	Sand and Gravel	Loam	0-2	Sand and Gravel	1000-2000	177	197
7D48	5-15	7-10	Sand and Gravel	Loam	0-2	Sand and Gravel	700-1000	166	189
7D49	5-15	4-7	Sand and Gravel	Loam	0-2	Sand and Gravel W/ Silt and Clay	300-700	139	166
7D50	5-15	4-7	Sand and Gravel	Loam	0-2	Sand and Gravel W/ Silt and Clay	300-700	144	170
7D51	5-15	4-7	Sand and Gravel	Loam	0-2	Sand and Gravel W/ Silt and Clay	100-300	138	166
7D52	5-15	4-7	Sand and Gravel	Loam	0-2	Sand and Gravel W/ Silt and Clay	300-700	147	173
7D53	5-15	7-10	Sand and Gravel	Silty Loam	0-2	Sand and Gravel	700-1000	172	191
7D54	5-15	7-10	Sand and Gravel	Loam	0-2	Sand and Gravel	700-1000	174	196
7D55	5-15	7-10	Sand and Gravel	Loam	0-2	Sand and Gravel	700-1000	179	200
7D56	5-15	7-10	Sand and Gravel	Loam	0-2	Sand and Gravel	700-1000	171	193
7D57	5-15	4-7	Sand and Gravel	Loam	0-2	Sand and Gravel W/ Silt and Clay	300-700	139	166
7D58	5-15	4-7	Sand and Gravel	Loam	0-2	Sand and Gravel W/ Silt and Clay	1-100	134	162
7D59	5-15	4-7	Sand and Gravel	Loam	0-2	Sand and Gravel W/ Silt and Clay	100-300	135	163
7D60	100+	2-4	Sand and Gravel	Clay Loam	2-6	Till	1-100	62	85
7D61	5-15	4-7	Sand and Gravel	Loam	0-2	Sand and Gravel	100-300	135	163
7D62	5-15	4-7	Sand and Gravel	Sand	0-2	Sand and Gravel W/ Silt and Clay	100-300	143	183
7D63	5-15	2-4	Sand and Gravel	Loam	6-12	Till	1-100	112	131
7D64	5-15	4-7	Sand and Gravel	Loam	0-2	Till	1-100	124	154

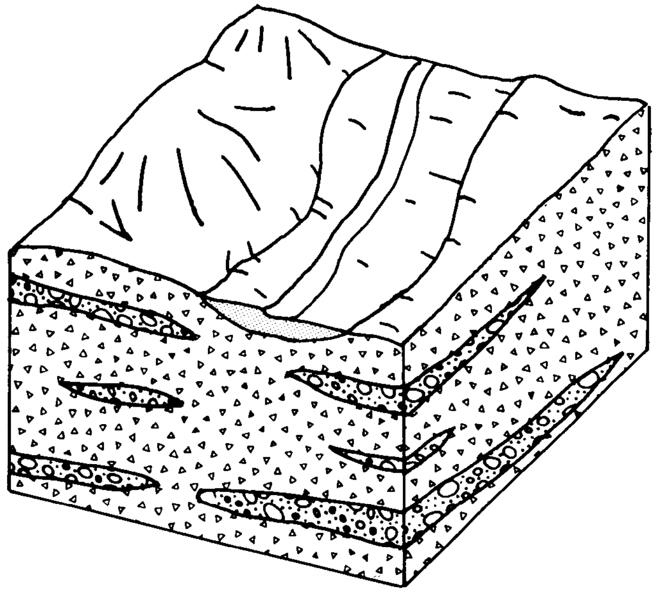
Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7D65	30-50	2-4	Sand and Gravel	Clay Loam	0-2	Till	1-100	83	108
7D66	50-75	2-4	Sand and Gravel	Sandy Loam	6-12	Till	1-100	74	98
7D67	50-75	4-7	Sand and Gravel	Loam	0-2	Till	100-300	103	132
7D68	50-75	2-4	Sand and Gravel	Loam	0-2	Till	100-300	83	113
7D69	15-30	2-4	Sand and Gravel	Clay Loam	0-2	Till	100-300	99	123
7D70	75-100	2-4	Sand and Gravel	Loam	0-2	Till	100-300	78	108
7D71	30-50	2-4	Sand and Gravel	Clay Loam	0-2	Till	100-300	89	113
7D72	15-30	2-4	Sand and Gravel	Clay Loam	0-2	Till	100-300	96	120
7D73	50-75	2-4	Sand and Gravel	Clay Loam	0-2	Till	100-300	76	100
7D74	5-15	2-4	Sand and Gravel	Silty Loam	0-2	Till	100-300	111	138
7D75	5-15	2-4	Sand and Gravel	Loam	0-2	Till	100-300	113	143
7D76	50-75	2-4	Sand and Gravel	Clay Loam	0-2	Till	100-300	79	103
7D77	75-100	2-4	Sand and Gravel	Clay Loam	0-2	Till	100-300	74	98
7D78	5-15	4-7	Sand and Gravel	Loam	2-6	Till	100-300	131	157
7D79	5-15	4-7	Sand and Gravel	Loam	6-12	Sand and Gravel	300-700	147	162
7D80	50-75	4-7	Sand and Gravel	Clay Loam	2-6	Till	100-300	90	112



7Ec Alluvium Over Limestone

This hydrogeologic setting is characterized by low topography with present-day alluvium deposits over sedimentary bedrock. The alluvium is composed of clay, silt, sand, and gravel. Depth to water is shallow and the stream is usually in hydraulic connection with the alluvial deposits. The alluvium is underlain by sedimentary bedrock which serves as the principal aquifer in this setting. Recharge occurs by infiltration of precipitation and surface water through the alluvium into the bedrock aquifer. Soils are typically classified as clay loam.

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Ec1	5-15	7-10	Limestone	Clay Loam	0-2	Limestone	300-700	143	164
7Ec2	5-15	4-7	Interbedded Limestone and Shale	Thin or Absent	2-6	Interbedded Limestone and Shale	100-300	138	179
7Ec3	5-15	4-7	Limestone	Loam	0-2	Sand and Gravel	100-300	138	166
7Ec4	5-15	7-10	Limestone	Loam	0-2	Sand and Gravel W/ Silt and Clay	300-700	157	182
7Ec5	5-15	2-4	Interbedded Limestone and Shale	Loam	0-2	Sand and Gravel W/ Silt and Clay	1-100	114	143



7Ed Alluvium Over Glacial Till

This setting is characterized by low topography with thin to moderate thicknesses of present-day, stream deposited alluvium. The alluvium is composed of clay, silt, sand, and gravel. The underlying sand and gravel deposits in the glacial till serves as the primary aquifer. The depth to water is shallow and the stream is usually in hydraulic connection with the deposits. Recharge occurs by infiltration through the alluvium to the sand and gravel within the till. Soils are typically classified as silt loam.

Setting	Depth to Water (feet)	Recharge (In/Yr)	Aquifer Media	Soil Media	Topography	Vadose Zone Media	Hydraulic Conductivity	Rating	Pest Rating
7Ed1	5-15	4-7	Sand and Gravel	Loam	0-2	Sand & Gravel W/ Silt & Clay	100-300	130	159
7Ed2	5-15	4-7	Sand and Gravel	Clay Loam	0-2	Sand & Gravel W/ Silt & Clay	100-300	129	152
7Ed3	5-15	4-7	Sand and Gravel	Loam	0-2	Sand & Gravel W/ Silt & Clay	100-300	135	163
7Ed4	5-15	4-7	Sand and Gravel	Loam	0-2	Sand & Gravel W/ Silt & Clay	100-300	133	162
7Ed5	5-15	4-7	Sand and Gravel	Loam	2-6	Sand & Gravel W/ Silt & Clay	100-300	121	149
7Ed6	5-15	4-7	Sand and Gravel	Loam	0-2	Silt/Clay	100-300	133	162
7Ed7	75-100	7-10	Sand and Gravel	Loam	6-12	Sand and Gravel	300-700	115	131
7Ed8	5-15	4-7	Sand and Gravel	Loam	0-2	Sand & Gravel W/ Silt & Clay	300-700	139	166
7Ed10	5-15	4-7	Sand and Gravel	Loam	0-2	Sand & Gravel W/ Silt & Clay	100-300	127	156
7Ed11	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Sand & Gravel W/ Silt & Clay	100-300	128	154
7Ed12	5-15	4-7	Sand and Gravel	Sandy Loam	0-2	Sand & Gravel W/ Silt & Clay	100-300	132	164
7Ed13	5-15	4-7	Sand and Gravel	Loam	0-2	Sand & Gravel W/ Silt & Clay	100-300	138	166
7Ed14	5-15	4-7	Sand and Gravel	Loam	0-2	Sand & Gravel W/ Silt & Clay	100-300	132	160
7Ed15	5-15	2-4	Sand and Gravel	Loam	0-2	Sand & Gravel W/ Silt & Clay	100-300	115	144
7Ed16	5-15	4-7	Sand and Gravel	Silty Loam	0-2	Sand & Gravel W/ Silt & Clay	100-300	131	157
7Ed17	5-15	4-7	Sand and Gravel	Loam	0-2	Sand and Gravel	100-300	128	158
7Ed18	5-15	2-4	Sand and Gravel	Silty Loam	0-2	Sand & Gravel W/ Silt & Clay	100-300	123	149
7Ed19	5-15	4-7	Sand and Gravel	Loam	0-2	Sand & Gravel W/ Silt & Clay	300-700	142	169
7Ed20	5-15	2-4	Sand and Gravel	Loam	2-6	Sand & Gravel W/ Silt & Clay	100-300	117	144
7Ed21	5-15	4-7	Sand and Gravel	Loam	0-2	Till	100-300	138	166

ERRATA SHEET
September 2005

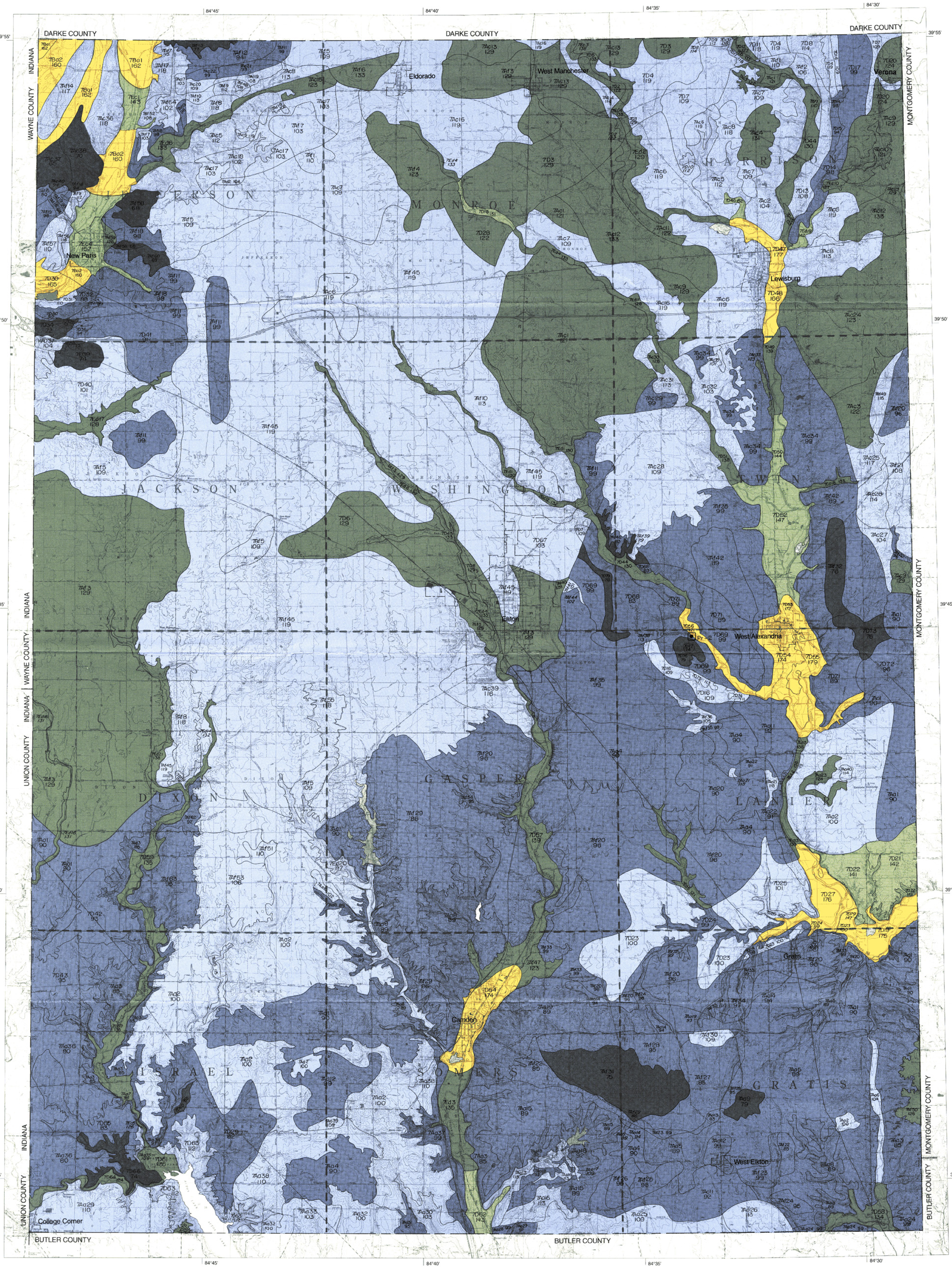
PREBLE COUNTY
Ground Water Pollution Potential Report No. 26

The following settings have been omitted from the setting tables and do not appear on the map.

7Af37; 7D1; 7Ed9

Ground Water Pollution Potential of PREBLE COUNTY

by
Wayne Jones



Miles

Kilometers

CONTOUR INTERVAL 10 FEET

N

County Line

Township Line

Incorporated City Limit

Description of Map Symbols

Hydrogeologic Region

Hydrogeologic Setting

7Ad6
98

Relative Pollution Potential

Observation Well Site *

Gravel Pit / Quarry

Pollution Potential Index Range

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

Hydrogeologic Settings

7Aa- Glacial Till Over Bedded Sedimentary Rock

7Ac- Glacial Till Over Limestone

7Af - Sand and Gravel Interbedded in Glacial Till

7Ba- Outwash

7D - Buried Valley

7Ec- Alluvium Over Bedded Sedimentary Rock

7Ed- Alluvium Over Glacial Till

A more detailed description of the hydrogeologic settings and the evaluation of the pollution potential may be found in the publication "Ground Water Pollution Potential of Preble County," GWPP Report No. 26, Ohio Department of Natural Resources, Division of Water.

The ground water pollution potential of this county has been mapped using the methodology described in U.S. EPA Publication EPA/600-2-87/035, "DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings" (Aller et al., 1987).

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

Published 1992
Ohio Department of Natural Resources
Division of Water
Ground Water Resources Section
1939 Fountain Square
Columbus, Ohio 43224

Xiaoning Jiang, Cartographer

Total copies printed: 500
Unit cost: $4.27
Publication date: 4/92

George V. Voinovich
Governor

Frances S. Buchholzer
Director