GROUND WATER POLLUTION POTENTIAL OF WOOD COUNTY, OHIO

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ABSTRACT

A ground water pollution potential mapping program for Ohio has been developed under the direction of the Division of Water, Ohio Department of Natural Resources, using the DRASTIC mapping process. The DRASTIC system consists of two major elements: the designation of mappable units, termed hydrogeologic settings, and the superposition of a relative rating system for pollution potential.

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

Wood County is located in the generally flat-lying Eastern Lake Plains Section of the Central Lowlands Physiographic Province (Fenneman, 1938). The county is covered by a variable thickness of glacial till, lacustrine depostis, and outwash. These unconsolidated glacial deposits are underlain by a relatively flat-lying sequence of Paleozoic sedimentary rocks consisting primarily of dolomite from the Silurian and Devonian Systems. Ground water yields are dependent on the type of aquifer and vary greatly throughout the county. Pollution potential indexes are low in areas of glacial lake plain deposits and moderately low to moderate in areas of sand and gravel interbedded in glacial till and glacial till over solution limestone. Indexes are moderately high to high in areas of marshes, swamps, beaches, beach ridges and sand dunes, as well as in areas of thin till over glacial till, alluvium over sedimentary rock, and river alluvium over glacial till. High to very high vulnerabilities to contaimination occur in areas of alluvium with out overbank deposits.

Ground water pollution potential analysis in Wood County resulted in a map with symbols and colors which illustrate areas of varying ground water contamination vulnerability. Nine hydrogeologic settings were identified in Wood County with computed ground water pollution potential indexes ranging from 63 to 198.

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 Wood 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 allocation of land use activities to appropriate areas, or to assist in protection, monitoring and clean-up efforts.

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INTRODUCTION

The need for protection and management of ground water resources in Ohio has been clearly recognized. About 42 per cent of Ohio citizens rely on ground water for 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 700,000 rural households depend on private wells; approximately 6,560 of these wells exist in Wood 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 the restoration 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 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 Wood 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 allocation of 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 more or less suitable for land disposal activities. Once these areas have been identified, a county can collect more site-specific information and combine this with other local factors to determine site suitability.

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

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

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

SUMMARY OF THE DRASTIC MAPPING PROCESS

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

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

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

Hydrogeologic Settings and Factors

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

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

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

D - Depth to Water

R - Net Recharge

A - Aquifer Media

S - Soil Media

T - Topography

I - Impact of the Vadose Zone Media

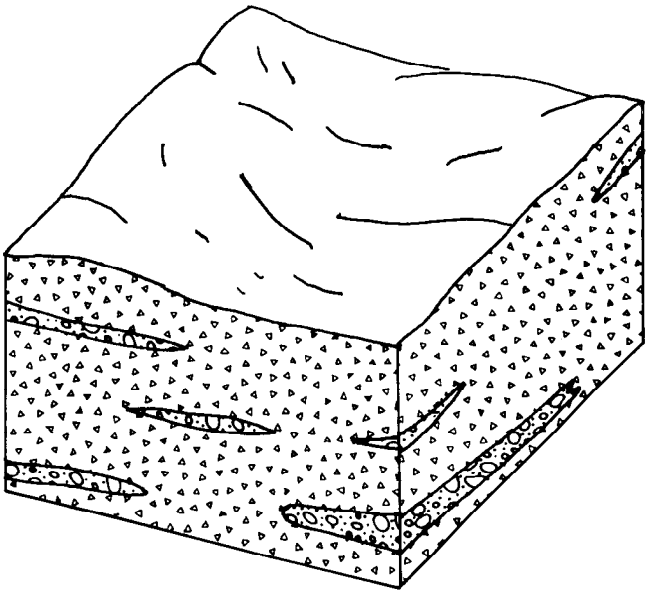
C - Conductivity (Hydraulic) of the Aquifer

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

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

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

Aquifer media represents consolidated or unconsolidated rock material capable of yielding sufficient quantities of water for use. Aquifer media accounts for the various physical characteristics of the rock that provide mechanisms of attenuation, retardation, and flow pathways that affect a contaminant reaching and moving through an aquifer.



7Af Sand and Gravel Interbedded in Glacial Till

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

Figure 1. Format and description of the hydrogeologic setting - 7Af Sand & 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. The process for calculating the Pesticide DRASTIC index is identical to the process used for calculating the general DRASTIC index. However, general DRASTIC and Pesticide DRASTIC numbers should not be compared because the conceptual basis in factor weighting and evaluation significantly differs.

TABLE 1. ASSIGNED WEIGHTS FOR DRASTIC FEATURES

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

TABLE 2. RANGES AND RATINGS FOR DEPTH TO WATER

DEPTH TO WATER (FEET)	
Range	Rating
0-5	10
5-15	9
15-30	7
30-50	5
50-75	3
75-100	2
100+	1
Weight: 5	Pesticide Weight: 5

TABLE 3. RANGES AND RATINGS FOR NET RECHARGE

NET RECHARGE (INCHES)	
Range	Rating
0-2	1
2-4	3
4-7	6
7-10	8
10+	9
Weight: 4	Pesticide Weight: 4

TABLE 4. RANGES AND RATINGS FOR AQUIFER MEDIA

AQUIFER MEDIA		
Range	Rating	Typical Rating
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	

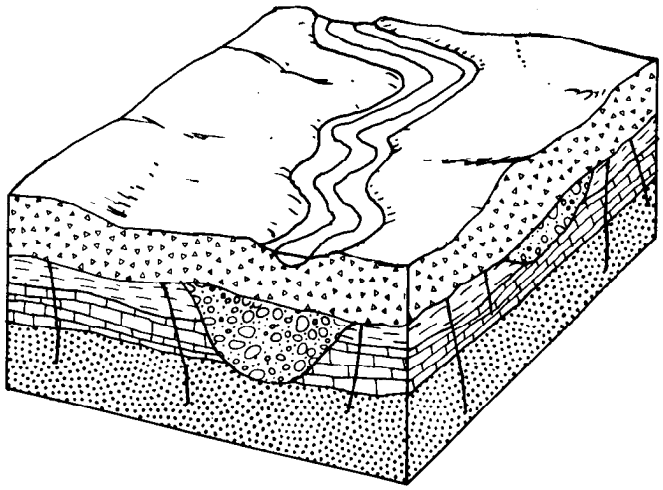
TABLE 8. RANGES AND RATINGS FOR HYDRAULIC CONDUCTIVITY

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, identified in mapping Wood 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 139. 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 Wood County produces settings with a wide range of vulnerability to ground water contamination. Calculated pollution potential indexes for the nine settings identified in the county range from 63 to 198.

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 Wood 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 Wood County is included with this report.



SETTING 7Af1		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	NUMBER
Depth to Water	5'-15'	5	9	45
Net Recharge	4"-7"	4	6	24
Aquifer Media	Sand & Gravel	3	5	15
Soil Media	Aggregated Clay	2	7	14
Topography	0-2%	1	10	10
Impact Vadose Zone	Glacial Till	5	5	25
Hydraulic Conductivity	100-300	3	2	6
		DRASTIC	INDEX	139

Figure 2. Description of the hydrogeologic setting - 7Af1 Sand & 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
139 - 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 (139) 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 WOOD COUNTY

Wood County occupies an area of approximately 618 square miles in northwest Ohio (Figure 3). It is bounded on the north by Lucas County, on the east by Seneca and Sandusky Counties, on the south by Hancock County, and on the west by Henry County. The county seat is Bowling Green. The estimated population of the county in 1994, according to the Ohio Department of Development (1991), was approximently 114,091. Agriculture in 1992 accounted for 73.4 percent of the land use in Wood County (Ohio Department of Agriculture, 1992).

Physiography

The physiography of Wood County consists of a mantle of unconsolidated glacial deposits overlying a sequence of relatively flat-lying sedimentary rocks. The county is located in the generally flat-lying Eastern Lake Plains section of the Central Lowlands physiographic province (Fenneman, 1938), an area characterized by the presence of lake bed sediments deposited by a series of Pleistocene-aged lakes of glacial origin. Topographic relief in the county is nearly level to gently sloping except for a series of hummocky beach ridges occurring across the lake plains.

Drainage and Climate

Surface drainage in Wood County is divided into two major river basins: the Maumee River basin and the Portage River basin. The Portage River basin, including two minor stream drainage basins directly tributary to Lake Erie, is the dominant drainage basin and comprises 68.7% of the county. The Maumee River basin comprises 31.3% of the county (Ohio Department of Natural Resources (ODNR), 1960 and 1966).

The climate of Wood County is typical of the temperate mid-continent region, characterized by a wide range between summer and winter temperatures and moderate amounts of precipitation. The average monthly precipitation at the U.S. Weather Bureau Station at Bowling Green for the thirty year period from 1961 to 1990 ranged between 1.51 inches for February and 3.98 inches for July. The average annual precipitation for the county was 32.77 inches. The average annual temperature range for the same 30 year period was between 31.0º F (January) and 84.6º F (July) with an average annual temperature of 59.6º F (U.S. Department of Commerce, 1992).

Figure 3. Location of Wood County

Glacial Geology

Approximately 2 million years ago, the Pleistocene Epoch commenced with a series of continental glaciers covering the northern half of North America. Four major glacial advances: the Nebraskan (oldest), Kansan, Illinoian, and Wisconsinan (youngest) are known to have occurred in North America during the Pleistocene Epoch. In Ohio, evidence exists for three glacial periods; the Pre-Illinoian which includes Kansan and possibly Nebraskan age deposits but is not reliably dated (Norton et al., 1983); the Illinoian, which occurred at least 120,000 years ago; and the Wisconsinan, which occurred between 70,000 and 10,000 years ago (Fullerton, 1986).

Continental glaciation greatly altered much of Ohio's preglacial landscape by burying its Tertiary topographic relief and drainage systems beneath a mantle of unconsolidated clastic deposits. This mantle consists of both sorted and unsorted deposits of clay, silt, sand, and gravel derived from a number of glacially-related processes. Thickness of the glacial drift varies across Wood County, and depth to bedrock is typically shallow in northeastern Wood County (Peterson, 1985a,b).

Glacial sediments deposited in Wood County consist mainly of three material types: glacial till, lacustrine (lake) and outwash deposits. Glacial till is an unsorted mixture of silt and clay with variable amounts of sand and gravel deposited directly from the glacier upon the ground surface over which the glacier advanced. Till in Wood County was deposited by the Pleistocene glaciation prior to its retreat and the subsequent formation of an extensive glacial lake system in northern Ohio. It is found comprising the majority of clay rich surficial soils in Wood County except for the very northern portions of the county where clay rich lake bed deposits occur.

The lacustrine deposits consist primarily of two landforms: hummocky beach ridges/sand dunes and flat, clay-rich lake bed deposits. As the Wisconsinan glacier retreated from northern Ohio, meltwater from the glacier could not drain south to the Ohio River because of the Great Lakes drainage divide. The meltwater was impounded by the retreating glacier, creating a lake much larger than Lake Erie. As the glacier retreated north, lake levels receded, leaving behind a series of sandy, low-lying beach ridges or strand lines marking the succession of the former lake elevations (Forsyth, 1959).

In Wood County, evidence exists for at least six different episodes of strand line development by successive lake levels during the Pleistocene. Because the lake had different outlines at each of the different stages (each stage being marked by a separate set of beaches at a characteristic elevation), a different name was applied to each stage. The earliest beach ridge development in Wood County was Lake Maumee II, occurring in the very southeastern reaches of the county at an approximate elevation of 760 feet above mean sea level. The beaches of Lake Maumee II were subsequently submerged, scattered, and smoothed by a rise in lake levels creating Lake Maumee III. Subsequent strand lines in Wood County include Lake Arkona, Lake Whittlesey, Lake Warren, Lake Wayne, and Lake Lundy (Forsyth, 1959). Lake Warren is the most prominent strand line in Wood County, forming an extensive deposit of sand in the Bowling Green area.

Evidence for deposition of fine-grained sediment onto the bottom of the former lakes is found in the northern reaches of Wood County where the Toledo soil association commonly occurs. The Toledo soil series is developed upon deposits of

fine-textured, calcareous silt and clay derived from lacustrine processes (Rapparlie, 1966).

Outwash deposits are comprised of sorted sand and gravel formed by the action of meltwater discharging from the glacier. Generally, outwash deposits in the county are encountered at depth, buried beneath younger glacial drift deposits. Often a detrital layer of sand and gravel occurs between the carbonate bedrock and the overlying glacial drift (Forsyth, 1960; de Roche and Breen, 1989).

Bedrock Geology

Wood County is underlain by a relatively flat-lying sequence of Paleozoic sedimentary rocks consisting primarily of dolomite from the Silurian and Devonian Systems. Silurian bedrock beneath Wood County consists of two groups, the Lockport and the Salina. Devonian bedrock in Wood County consists of the Dundee Limestone which overlies the Detroit River group (Table 9).

The Silurian bedrock beneath Wood County is generally comprised of a micro-crystalline brown to gray argillaceous dolomite. Anhydrite and shale is interbedded with the dolomite in certain localities throughout the northwestern region of the state (Janssens, 1977).

The bedrock structure of Wood County was influenced by a large regional structure referred to as the Findlay Arch. The arch, a geologic structure resulting from differential subsidence along two major basinal areas in the region (the Michigan Basin to the northwest and the Appalachian Basin to the Southeast), influenced the present configuration of bedrock formations in Ohio. The Findlay Arch splits from the Cincinnati Arch in west-central Ohio and trends northeast towards Ontario, Canada, passing along the eastern margin of Wood County.

A large northward-trending fault, the Bowling Green Fault, is believed to have formed in response to stresses caused by vertical uplift of the region. The fault appears to start somewhere in southeastern Hancock County and trends north through the county towards Michigan. Near the city of Findlay, displacement of as much as 100 feet is reported to have occurred along the fault, greatly altering the stratigraphic sequence of formations east and west of the fault line (ODNR, 1970).

Table 9. Generalized Stratigraphic Column of Wood County (Modified from Janssen, (1970 ,1977), ODNR Division of Water (1970), and Larson (pers.comm. 1994)).

SYSTEM	GROUP	FORMATION	DESCRIPTION
DEVONIAN		Dundee Limestone	Light to medium buff gray, thin to massive bedded, fossiliferous, gray dolomite at base.
	Detroit River	undifferentiated Detroit River	Dolomite gray, microcrystalline, hard, dense. Limestone layers, becomes sandy at base of unit.
SILURIAN	Salina	undifferentiated Salina	Dolomite gray to brown, thin to massive bedded, shaley layers, contains zones of gypsum and anhydrite.
		Tymochtee Dolomite	Dolomite gray brown, thin bedded. Contains block, shaly, argillaceous zones.
		Greenfield Dolomite	Light gray to buff, very dense, microcrystelline, hard.
	Lockport	undifferentiated Lockport	Dolomite, gray and white, massive, fossiliferous, some porous zones.

Hydrogeology

In northwest Ohio, the thick sequence of Silurian and Devonian carbonate bedrock comprise a vast regional aquifer that serves as the primary source of ground water for the counties in this region (ODNR, 1970). Wood County lies near the northern margin of this regional aquifer.

The hydrogeologic system of Wood County consists of the regional carbonate aquifer buried by deposits of glacial till and lacustrine deposits. The regional carbonate aquifer underlies all of Wood County and serves as a primary source of ground water for much of the county's rural population. Ground water within the dolomite of the carbonate aquifer occurs in a network of interconnected fractures, bedding planes, and solution channels. Yields to individual wells drilled into the carbonate aquifer are highly variable, dependent upon the number of fractures and solution channels intersected by the well bore.

Yields to wells installed into the carbonate aquifer typically range from 10 to 20 gallons per minute; however, yields from 100 to 500 gallons per minute have been produced in certain locations of the county, generally by large municipal or industrial wells (Hallfrisch, 1986).

Potentiometric surface maps of the carbonate aquifer for Wood County (Breen, 1989; Paulson, 1981) show a general northward-trending gradient, indicating regional ground water flow from sources of recharge in northern Ohio towards zones of discharge along Lake Erie and the Maumee River. The potentiometric surface maps also indicate areas of greater recharge to the carbonate aquifer occur where the soil cover is thin or absent. Small groundwater mounds are formed in these areas because precipitation can quickly infiltrate and recharge the aquifer through the thin soil cover. Example areas include Bowling Green, Luckey, Stoney Ridge, and Pemberville.

Overlying the bedrock aquifer of Wood County is a mantle of glacial drift comprised generally of glacial till and lake bed deposits. Generally, these deposits are not considered an aquifer because of their high clay-silt content and low hydraulic conductivity, making them a poor source of ground water. However, weathered glacial till often has an interconnected network of vertical fractures which can impart an enhanced capability for ground water flow or contaminant migration (Ruland, et al., 1991; Hendry, 1982; Williams and Farvolden, 1967). In addition, glacial till often contains intermittent water-bearing pockets of sand and gravel which serve as a source of recharge to the carbonate aquifer and a source of ground water for some domestic wells. Other potential sources of ground water include buried outwash deposits, beach ridges, and alluvial deposits along the various river courses in the county.

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APPENDIX A

DESCRIPTION OF THE LOGIC IN FACTOR SELECTION

Depth to Water

Depth to water was evaluated using information obtained from well logs on file with ODNR, Division of Water and available hydrogeologic investigation reports. In areas where well log data are sparse, water levels were inferred based on surrounding water level patterns, topographic expression of the land, and elevations of nearby surface water bodies.

The depth to water parameter was primarily mapped according to the static water levels of Wood County's domestic water supply wells, most of which were screened in the regional carbonate aquifer. Technically, much of the carbonate aquifer is considered a confined aquifer because static water levels of wells screened in the aquifer are higher in elevation than the overlying clay rich glacial till confining bed-aquifer contact. However, despite the confined nature of the carbonate aquifer, water levels were mapped in lieu of the confining bed thicknesses because many investigations indicate a strong hydraulic connection between the confining glacial deposits and the underlying carbonate aquifer (de Roche and Breen, 1989; Snyder, 1989). This relationship is best illustrated by hydrographs showing the relationship of monitoring well water levels to precipitation trends whereby increasing trends in precipitation generally have subsequent corresponding increasing trends in groundwater level elevations, indicating recharge to the aquifer from above.

Depth to water for the carbonate aquifer generally ranged from 5 to 15 feet (DRASTIC rating: 9) and 15 to 30 feet (7) in eastern Wood County where the carbonate aquifer was shallow with a thin cover of glacial deposits. Depth to water in the carbonate aquifer gradually increased to the northwest with DRASTIC ranges of 30 to 50 feet (5), 50 to 75 feet (3) and 75 to 100 feet (2).

Areas with shallow water levels ranging 0 to 5 feet (10) were encountered along the Maumee River and in eastern Wood County (Freedom and Montgomery Townships) along the Sandusky-Wood County border. Flowing artesian wells have been produced in the latter area (ODNR well logs, Breen, 1989).

Net Recharge

Net recharge rates for Wood County were evaluated based upon a number of sources including soil types (Rapparlie and Urban, 1966), topography, proximity to lakes and rivers, and upon the recharge rates determined for area river basins in Pettyjohn and Henning (1979).

Recharge for much of the lake plains region in Wood County was evaluated as ranging from 2 to 4 inches (3) because of the inherently poor drainage characteristics lake plain soils exhibit when saturated during the rainy season. Areas containing glacial till overlying shallow bedrock such as in eastern Wood County were evaluated as ranging from 4 to 7 inches (6) because of the presence of fractures in the glacial till (Snyder, 1989).

Recharge rates for areas with sandy soils, such as the beach ridges were evaluated as ranging from 7 to 10 inches (8). Wetland areas, though generally considered areas of hydrogeologic discharge, were given a recharge rate of 7 to 10 inches in order to reflect both the presence of porous, permeable decayed vegetation often found comprising wetland soils and also of the condition of continual saturation prevalent to these areas. Recharge to wetlands is not only a function of the quantity of precipitation available to the area and the absorptive capacity of the soil, but also of water level elevations of nearby water bodies and of the local water table occurring beneath the wetland.

Aquifer Media

The majority of Wood County is underlain by an extensive carbonate aquifer consisting of dolomite (Nielsen, 1977; ODNR, 1970; Paulson, 1981). This carbonate aquifer comprised the aquifer media for much of the county except for the southwestern corner of the county where buried sand and gravel outwash deposits are often encountered.

The carbonate aquifer in the county was evaluated as being a massive limestone with a DRASTIC rating of 7 or 8 in order to reflect the greater degree of areal hydraulic conductivity resulting from secondary porosity such as fracturing, jointing, and minor solution channels often found in the dolomitized carbonates of this region. Areas designated as having higher potential well yields (Hallfrisch, 1986) were given the higher rating of 8.

For the southwestern corner of the county, the aquifer media was shifted to emphasize sand and gravel deposits contained in the drift. Sand and gravel deposits interbedded in glacial till are listed on many well logs throughout the county and a sand and gravel stratum of outwash commonly occurs on top of the bedrock basement (ODNR well logs). Outwash deposition in this area appears to be related to the occurrence of both a north-south trending buried valley in western Wood

County plus the occurrence of thick sand and gravel deposits south of Hoytville in northwestern Hancock County (ODNR well logs; Paulson, 1981). The sand and gravel aquifer of southwestern Wood County was given a DRASTIC rating of 5 in order to emphasize the intermittent water-bearing sand and gravel lenses occurring in the glacial till or on top of the bedrock surface.

Soil Media

The classification of the soils is based upon the dominant soil properties as described in the soil survey for Wood County (Rapparlie and Urban, 1966). The majority of soils in Wood County have developed on the clay-rich lake plain deposits and consist primarily of the Hoytville-Nappanee-Toledo soil association. The Hoytville, Nappanee, and Toledo series were classified as being a shrinking / aggregated clay: with a DRASTIC rating of 7 because of their high shrink-swell potential, their low sand and gravel composition, and their high plastic indexes (Rapparlie and Urban, 1966). Although these soils are typically characterized as being clay-rich, nearly level, and very poorly drained with a seasonally high water table, the soils are subject to extensive cracking and fracturing during the summer months (Keim, 1989) that permit easy access for surficially spilled contaminants to infiltrate into the subsurface.

Soils developed upon the abandoned beach ridges and sand dunes of Wood County were evaluated as being either a sandy loam soil (6) or a sand soil (9), depending upon the quantity of silt and clay material occurring in the soil type of interest as listed in Rapparlie and Urban (1966). Soil types such as Belmore, Kibbie, Rimer, and Tedrow were evaluated as being sandy loams, whereas, soil types such as Dunbridge, Ottokee, and Spinks were evaluated as being sand.

Clay-rich soils developed upon glacial till or lakebed deposits with lesser shrink-swell potentials were classified as being clay loam soils with a DRASTIC rating of 3. Soils comprised of silt loams (4) and loams (5) were generally associated with the beach ridges of river alluvium deposits.

Three soil series - Joliet, Ritchey, and Romeo - were classified as "thin or absent" with a DRASTIC rating of 10 because of the shallow proximity of bedrock to the ground surface. The high rating of 10 reflects the fact that the thin or absent nature of these soils offer little attenuative protection against the influx of surficially introduced contaminants into the underlying carbonate aquifer. These soil series are commonly found in clusters associated with bedrock knolls and rock outcrops protruding through the glacial drift deposits throughout much of Wood County (Stith, 1973). These protrusions appear to be the result of the erosion of overlying clay-rich glacial drift by wave activity during the presence of the former Pleistocene lakes. Often there are sandy soil associations occurring around the bedrock knolls, deposited by the former wave activity.

Topography

The topography of Wood County was evaluated using a combination of U.S. Geological Survey topographic maps and the county soil survey manual (Rapparlie and Urban, 1966).

Generally the topography in Wood County is flat to gently-rolling with slopes ranging from 0% to 2% (10) dominating the county. The low relief is a result of Wood County occurring within an extensive Pleistocene glacial lake complex that extends across much of northern Ohio. The flat topography appears to be the result of a combination of glacial advancement and deposition which buried the former pre-glacial topography followed by a period of wave activity and sediment deposition associated with the glacial lake complex.

Some topographic relief does occur in areas where rivers and streams have cut down into the lake plain deposits, producing topographic slopes commonly ranging from 2% to 6% (9). However, considerable relief does occur along the Maumee River where erosion associated with successive lake stages have produced a series of steep river terraces (Klotz, 1981). Slope ratings along the Maumee River included 6% to 12% (5), 12% to 18% (3) and 18+% (1).

Other sources of topographic relief in Wood County occur along the beach ridges and sand dunes where slope ranges of 2% to 6% were often encountered on the best developed land forms.

Impact of the Vadose Zone Media

The vadose zone is defined as that zone between the ground surface and the water table which is unsaturated or discontinuously saturated. The impact of the vadose zone in retarding contaminant migration is generally determined by the type of material comprising the zone. Depending upon the depth to ground water in any particular hydrogeologic setting, the vadose media can be comprised of a single geologic media, such as glacial till or a combination of geologic media, such as glacial till overlying limestone or shale. To reflect this variability in vadose media, the dominant vadose media of the area in question may be given a range of rating values in order to assess the ratio of lower permeability media to higher permeability media.

For instance, glacial till is a common material comprising the vadose media in many parts of Wood County. For those areas where glacial till comprises all of the material between ground surface and the water table, a low rating of 2 or 3 was given to the media. However, for areas where glacial till comprises only a fraction of the vadose media between ground surface and the water table, the remainder being comprised by a second media such as sand and gravel or the bedrock aquifer media of the area, a higher rating such as 4 or 5 was given to the vadose media.

The vadose media for areas containing clay-rich lake bed deposits was evaluated as being "silt and clay" with ratings ranging from2 to 5 depending upon site-specific criteria such as vadose homogeneity, thickness, and depth to water.

Beach ridges and sand spits in Wood County were evaluated as being either a "sand and gravel" vadose media or a "sand and gravel with significant silt and clay" media. The rating given was dependent upon the extent of development the landform of interest had in terms of sand thickness, soil types present, and degree of topographic expression. The majority of beach ridges and sand spits were evaluated as being a "sand and gravel" vadose media with DRASTIC ratings ranging from 6 to 8. Loamier sand deposits were evaluated as being a "sand and gravel with significant silt and clay" vadose media and given ratings of either 6 or 7. Information used to evaluate the beach ridges was obtained from well logs on file with ODNR, Division of Water; Forsyth (1959); and Rapparlie and Urban (1966).

Vadose media for rivers and streams in Wood County were generally evaluated as being either a "silt and clay" media, a "sand and gravel with significant silt and clay" media, or a "sand and gravel" media depending upon the degree of maturity observed for the stream or river section in question. Small, upland streams were evaluated as being a "silt and clay" media with ratings of 4 or 5. Streams of greater maturity were evaluated as being "sand and gravel with significant silt and clay" with ratings from 5 to 7. The most mature river settings in terms of sediment thickness and sorting, such as along the Maumee River (Herdendorf, 1970), were evaluated as being a "sand and gravel" vadose with a rating of 8.

Hydraulic Conductivity

The hydraulic conductivity of an aquifer is a measure of its ability to transmit ground water as a function of the media comprising the aquifer (i.e. sand and gravel, sandstone, limestone, etc...). Aquifers with significant silt and clay have low hydraulic conductivities, whereas aquifers that are porous and permeable (such as clean sands and gravels) or highly fractured and solutioned (such as cavernous or karst limestone bedrock) have high hydraulic conductivities.

Available data characterizing the hydraulic conductivity of the various aquifer medias, such as pump test data are generally sparse for much of Wood County. Some information is available from a series of test wells installed as part of ODNR's 1970 carbonate aquifer study for northwestern Ohio. Where the data are sparse, hydraulic conductivity was estimated using a combination of available information regarding the physical nature of the aquifer media and from published conductivity ranges presented in Table 2.2 entitled "Range of Values of Hydraulic Conductivity and Permeability", from Freeze and Cheery (1979).

In Wood County, an extensive carbonate aquifer occurs throughout the entire county and was mapped as the principle aquifer media except for a few localities where an overlying unconsolidated sand and gravel aquifer was selected. The hydraulic conductivity for much of the county was evaluated as 100 to 300 gpd/ft^2

with a DRASTIC rating of 2. Although this rating is somewhat higher than the hydraulic conductivities calculated from reported transmissivity valves in literature available on the subject (ODNR, 1970; Paulson, 1981; de Roche and Breen, 1989), it was assumed that the upper portion of the carbonate aquifer is sufficiently weathered and fractured enough to produce hydraulic conductivities in this range. Areas mapped as having higher well yields (Hallfrisch, 1986) were evaluated as having a hydraulic conductivity range of 300 to 700 gpd/ft^2 with a DRASTIC rating of 4.

The hydraulic conductivity of sand and gravel aquifers in Wood County was estimated as ranging from 100 to 300 gpd/ft^2 depending upon the thickness and textural maturity of sediments comprising the aquifers as described in ODNR well logs. These rating ranges correspond closely to typical values for silty sands to clean sands as presented in Table 2.2 of Freeze and Cherry (1979).

APPENDIX B

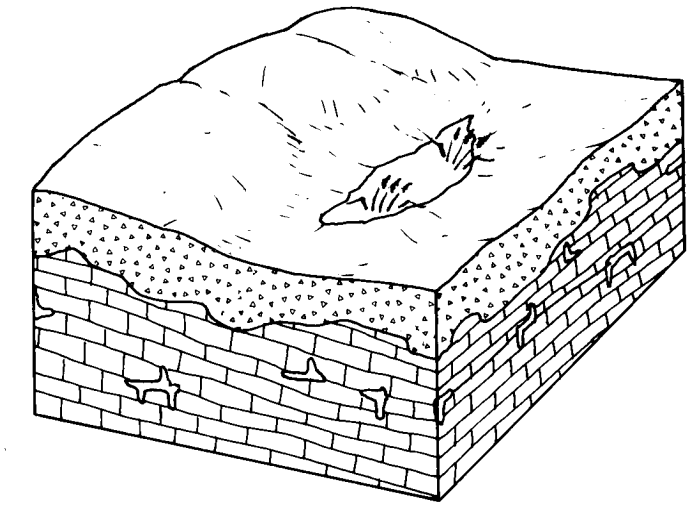
DESCRIPTION OF HYDROGEOLOGIC SETTINGS AND CHARTS

During the pollution potential mapping of Wood County, nine hydrogeologic settings with the Glaciated Central Region were identified. The list of these settings, the range of pollution potential index calculations, and the number of pollution potential index calculations for each setting are provided in Table 10. Computed pollution potential index values range from 63 to 198.

Table 10. Hydrogeologic Settings Mapped in Wood County, Ohio

Hydrogeologic Settings	Range of GWPP Indexes	Number of Index Calculations
7Ac - Glacial Till Over Solution Limestone	91 - 149	28
7Af - Sand & Gravel Interbedded in Glacial Till	121 - 139	5
7Eb - River Alluvium w/o Overbank Deposits	198	1
7Ec - Alluvium Over Sedimentary Rock	134-186	8
7Ed - River Alluvium Over Glacial Till	114 - 186	13
7F - Glacial Lake Plain Deposits	63 - 112	16
7Gb - Thin Till Over Glacial Till	163 - 178	7
7H - Beaches, Beach Ridges and Sand Dunes	132 - 176	38
71 - Marshes and Swamps	160	1

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.



7Ac Glacial Till Over Solution Limestone

This hydrogeologic setting is characterized by low topography and solution limestone which is covered by varying thicknesses of glacial till. The till is principally unsorted deposits which may be interbedded with loess or localized deposits of sand and gravel. Surficial deposits have usually weathered to a clay loam. Although ground water occurs in both the glacial deposits and in the underlying limestone, the limestone, which typically contains solution cavities, generally serves as the principal aquifer. The limestone is in direct hydraulic connection with the glacial till and the glacial till serves as a source of recharge for the underlying limestone. Although precipitation is abundant in most of this region, recharge is moderate because of the relatively low permeability of the overlying glacial till. Depth to water is extremely variable depending in part on the thickness of the glacial till, but is typically moderately deep.

GWPP index values for the hydrogeologic setting of glacial till over solution limestone range from 91 to 149 with the total number of GWPP index calculations equaling 28.

Setting: 7Ac1		**GENERAL**		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15' - 30'	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Aggregated Clay	2	7	14
Topography	0-2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	130

Setting: 7Ac2		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5' - 15'	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Aggregated Clay	2	7	14
Topography	0-2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	140

Setting: 7Ac3		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5' - 15'	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Loam	2	5	10
Topography	0-2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	136

Setting: 7Ac4		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5' - 15'	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Loam	2	5	10
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	135

Setting: 7Ac5		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5' - 15'	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Clay Loam	2	3	6
Topography	0-2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	132

Setting: 7Ac6		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15' - 30'	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Clay Loam	2	3	6
Topography	0-2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	122

Setting: 7Ac7		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Aggregated Clay	2	7	14
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	139

Setting: 7Ac8		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	0’ - 5’	5	10	50
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Aggregated Clay	2	7	14
Topography	0-2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	145

Setting: 7Ac9		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Loam	2	5	10
Topography	0-2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	126

Setting: 7Ac10		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Aggregated Clay	2	7	14
Topography	0-2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	149

Setting: 7Ac11		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Loam	2	5	10
Topography	0-2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	145

Setting: 7Ac12		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
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 of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	120

Setting: 7Ac13		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	50’ - 75’	5	3	15
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Aggregated Clay	2	7	14
Topography	0-2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	110

Setting: 7Ac14		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	30’ - 50’	5	5	25
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Aggregated Clay	2	7	14
Topography	0-2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	120

Setting: 7Ac15		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	30’ - 50’	5	5	25
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Aggregated Clay	2	7	14
Topography	0-2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	129

Setting: 7Ac16		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Aggregated Clay	2	7	14
Topography	0-2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	139

Setting: 7Ac17		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Clay Loam	2	3	6
Topography	18+%	1	1	1
Impact of Vadose Zone	Glacial Till	5	2	10
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	91

Setting: 7Ac18		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Clay Loam	2	3	6
Topography	18+%	1	1	1
Impact of Vadose Zone	Glacial Till	5	3	15
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	99

Setting: 7Ac19		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Clay Loam	2	3	6
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	121

Setting: 7Ac20		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Clay Loam	2	3	6
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	121

Setting: 7Ac21		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Loam	2	5	10
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	300 - 700	3	8	24
		GWPP	INDEX	147

Setting: 7Ac22		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	30’ - 50’	5	5	25
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Loam	2	5	10
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	300 - 700	3	8	24
		GWPP	INDEX	137

Setting: 7Ac23		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Clay Loam	2	3	6
Topography	12 - 18%	1	3	3
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	103

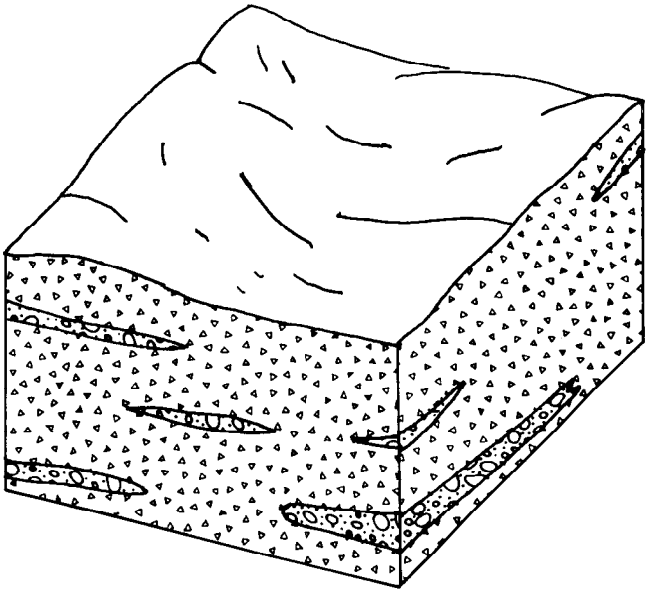
Setting: 7Ac24		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Clay Loam	2	3	6
Topography	6 - 12%	1	5	5
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	105

Setting: 7Ac25		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Clay Loam	2	3	6
Topography	6 - 12%	1	5	5
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	114

Setting: 7Ac26		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Clay Loam	2	3	6
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	140

Setting: 7Ac27		**GENERAL**		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	30’ - 50’	5	5	25
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Aggregated Clay	2	7	14
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	3	15
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	109

Setting: 7Ac28		**GENERAL**		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Aggregated Clay	2	7	14
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	3	15
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	119



7Af Sand and Gravel Interbedded in Glacial Till

This hydrogeologic setting is characterized by low relief within the till plains (ground moraine) and moderate relief with rolling, hummocky topography in areas of end moraines. The till is primarily unsorted silt and clay with minor amounts of sand and gravel. Soils are typically clay loams. Ground water occurs in both the till and sand and gravel deposits; however, the sand and gravel serves as the principle aquifer. The sand and gravel may exist as relatively thin and discontinuous lens-shaped bodies, or as thick lenses or sheets that cover a large area. These units are sometimes confined to common horizons within the till. Areas containing appreciable amounts of sand and gravel within the till generally are located adjacent to buried valleys or bedrock highs; they are not typically associated with end moraines. Recharge is from percolation through the till and is highly dependent upon fracturing and the amount of sand and gravel above the zone of saturation. Depth to the water table is highly variable, but usually ranges between 30 to 50 feet.

GWPP index values for the hydrogeologic setting of sand and gravel interbedded in glacial till range from 121 to 139 with the total number of GWPP index calculations equaling 5.

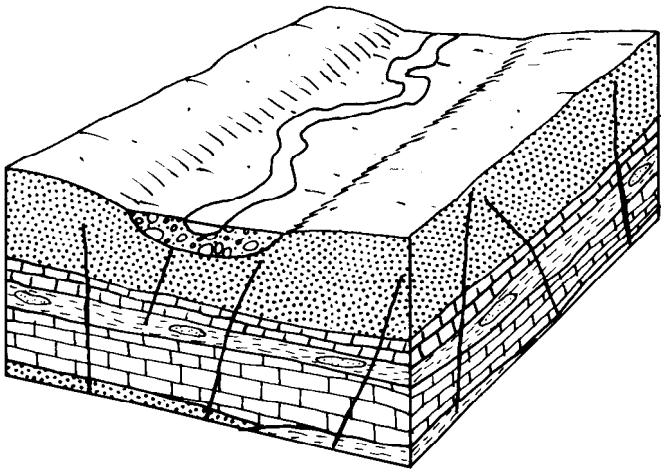
Setting: 7Af1		**GENERAL**		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5' - 15'	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Sand & Gravel	3	5	15
Soil Media	Aggregated Clay	2	7	14
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	5	25
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	139

Setting: 7Af2		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Sand & Gravel	3	5	15
Soil Media	Aggregated Clay	2	7	14
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	5	25
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	129

Setting: 7Af3		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Sand & Gravel	3	5	15
Soil Media	Clay Loam	2	3	6
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	5	25
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	121

Setting: 7Af4		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Sand & Gravel	3	5	15
Soil Media	Silt Loam	2	4	8
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel with Silt & Clay	5	5	25
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	123

Setting: 7Af5		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
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 of Vadose Zone	Sand & Gravel with Silt & Clay	5	5	25
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	125

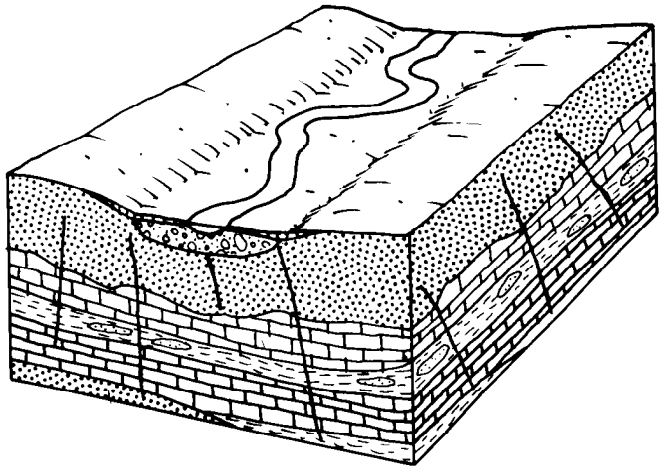


7Eb River Alluvium Without Overbank Deposits

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

The GWPP index value for the hydrogeologic setting of river alluvium without overbank deposits is 198 with a GWPP index calculation equaling 1.

Setting: 7Eb1		**GENERAL**		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	0' - 5'	5	10	50
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Sand & Gravel	3	8	24
Soil Media	Sand	2	9	18
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	8	40
Hydraulic Conductivity	1000 - 2000	3	8	24
		GWPP	INDEX	198



7Ec Alluvium Over Sedimentary Rock

This hydrogeologic setting is characterized by low relief with thin to moderate thicknesses of modern, stream-deposited alluvium. The alluvium is composed of silt, sand, gravel, and clay. Depth to water is shallow, and the stream is usually in hydraulic contact with the alluvial deposits. The alluvial deposits are underlain by fractured sandstone, limestone, shale, or bedded sedimentary sequences. It is usually the upper, weathered portion of the bedrock that serves as the principal aquifer with the alluvial deposits serving as a source of recharge to the bedrock in this setting. Soils are typically silty loams.

GWPP index values for the hydrogeologic setting of alluvium over sedimentary rock range from 134 to 186 with the total number of GWPP index calculations equaling 8.

Setting: 7Ec1		**GENERAL**		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	0' - 5'	5	10	50
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Sand	2	9	18
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	8	40
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	186

Setting: 7Ec2			**GENERAL**	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	0’ - 5’	5	9	50
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Loam	2	5	10
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel with Silt & Clay	5	7	35
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	164

Setting: 7Ec3			**GENERAL**	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Silt Loam	2	4	8
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel with Silt & Clay	5	6	30
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	152

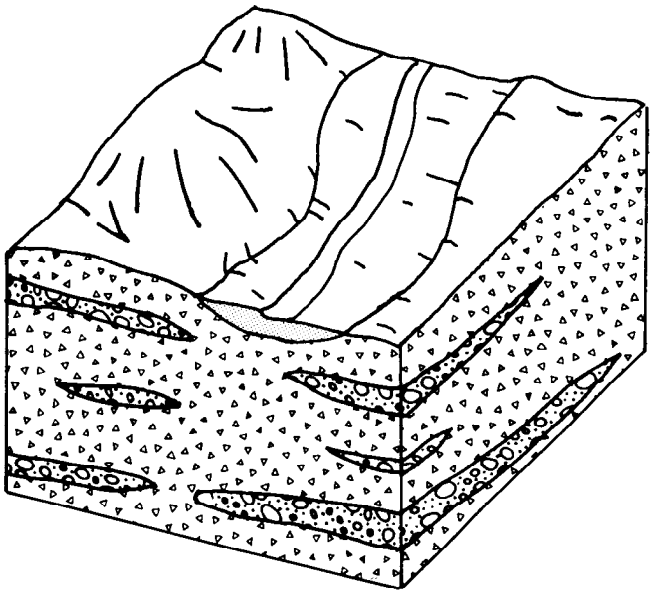
Setting: 7Ec4			**GENERAL**	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	0’ - 5’	5	10	50
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Loam	2	5	10
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	5	25
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	154

Setting: 7Ec5			**GENERAL**	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Silt Loam	2	4	8
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	4	20
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	134

Setting: 7Ec6			**GENERAL**	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Silt Loam	2	4	8
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel with Silt & Clay	5	6	30
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	148

Setting: 7Ec7		**GENERAL**		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	0’ - 5’	5	10	50
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Silt Loam	2	4	8
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	8	40
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	167

Setting: 7Ec8		**GENERAL**		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	0’ - 5’	5	10	50
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Sand	2	9	18
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	8	40
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	180



7Ed Alluvium Over Glacial Till

This hydrogeologic setting is characterized by low relief with thin to moderate thicknesses of modern, stream-deposited alluvium overlying glacial till. The alluvium is composed of silt, sand, gravel, and clay. The underlying sand and gravel lenses within the till serve as the aquifer. The depth to the water table is shallow, and the stream is usually in hydraulic connection with the alluvial deposits. Soils are typically classified as silty loams. The alluvial deposits serve as a source of recharge for the sand and gravel lenses within the till. Recharge is moderately high.

GWPP index values for the hydrogeologic setting of alluvium over glacial till range from 114 to 186 with the total number of GWPP index calculations equaling 13.

Setting: 7Ed1		**GENERAL**		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	0' - 5'	5	10	50
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Silt Loam	2	4	8
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel with Silt & Clay	5	6	30
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	157

Setting: 7Ed2		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5' - 15'	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Sand & Gravel	3	5	15
Soil Media	Silt Loam	2	4	8
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel with Silt & Clay	5	6	30
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	146

Setting: 7Ed3		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5' - 15'	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Silt Loam	2	4	8
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel with Silt & Clay	5	6	30
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	152

Setting: 7Ed4		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15' - 30'	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Sand & Gravel	3	5	15
Soil Media	Silt Loam	2	4	8
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel with Silt & Clay	5	6	30
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	136

Setting: 7Ed5		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15' - 30'	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Sand & Gravel	3	5	15
Soil Media	Sandy Loam	2	6	12
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel with Silt & Clay	5	6	30
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	140

Setting: 7Ed6		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5' - 15'	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Silt Loam	2	4	8
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel with Silt & Clay	5	6	30
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	161

Setting: 7Ed7		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Silt Loam	2	4	8
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	124

Setting: 7Ed8		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	30’ - 50’	5	5	25
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Silt Loam	2	4	8
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	4	20
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	114

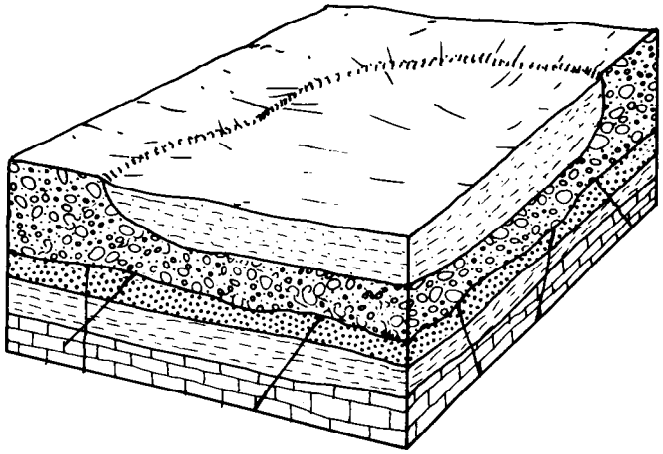
Setting: 7Ed9		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	30’ - 50’	5	5	25
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Silt Loam	2	4	8
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Silt & Clay	5	4	20
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	122

Setting: 7Ed10		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Silt Loam	2	4	8
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Silt & Clay	5	4	20
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	132

Setting: 7Ed11		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Silt Loam	2	4	8
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel with Silt & Clay	5	5	25
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	147

Setting: 7Ed12		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	0’ - 5’	5	10	50
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Sand	2	9	18
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	8	40
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	186

Setting: 7Ed13		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Clay Loam	2	3	6
Topography	6 - 12%	1	5	5
Impact of Vadose Zone	Sand & Gravel with Silt & Clay	5	5	25
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	141



7F Glacial Lake Deposits

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

GWPP index values for the hydrogeologic setting of glacial lake deposits range from 63 to 112 with the total number of GWPP index calculations equaling 16.

Setting: 7F1		**GENERAL**		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	50' - 75'	5	3	15
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Aggregated Clay	2	7	14
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	2	10
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	88

Setting: 7F2			GENERAL	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	75’ - 100’	5	2	10
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Aggregated Clay	2	7	14
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	2	10
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	83

Setting: 7F3			GENERAL	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	50’ - 75’	5	3	15
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Loam	2	5	10
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	2	10
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	84

Setting: 7F4			GENERAL	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	50’ - 75’	5	3	15
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sandy Loam	2	6	12
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	2	10
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	86

Setting: 7F5			GENERAL	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	30’ - 50’	5	5	25
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Aggregated Clay	2	7	14
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	2	10
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	98

Setting: 7F6			GENERAL	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	75’ - 100’	5	2	10
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Loam	2	5	10
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	2	10
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	79

Setting: 7F7			GENERAL	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	75’ - 100’	5	2	10
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sandy Loam	2	6	12
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	2	10
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	81

Setting: 7F8			GENERAL	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	50’ - 75’	5	3	15
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Aggregated Clay	2	7	14
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	2	10
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	97

Setting: 7F9			GENERAL	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	30’ - 50’	5	5	25
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Aggregated Clay	2	7	14
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	2	10
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	107

Setting: 7F10			GENERAL	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	75’ - 100’	5	2	10
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Aggregated Clay	2	7	14
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	2	10
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	92

Setting: 7F11			GENERAL	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	50’ - 75’	5	3	15
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Clay Loam	2	3	6
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	2	10
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	89

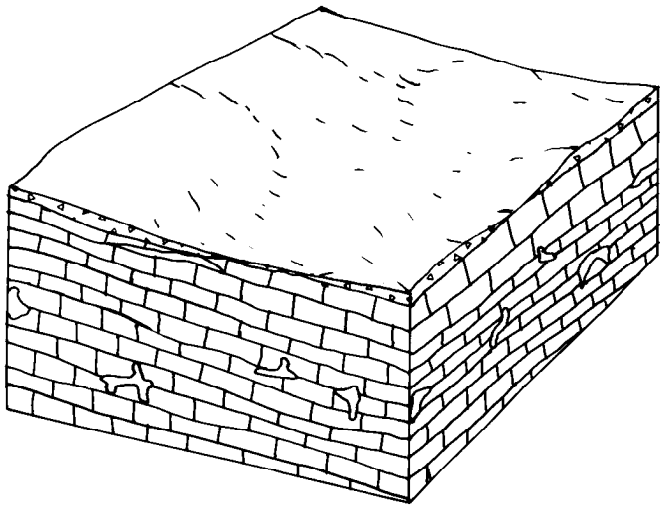
Setting: 7F12		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	50’ - 75’	5	3	15
Net Recharge	0" - 2"	4	1	4
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Clay Loam	2	3	6
Topography	18+%	1	1	1
Impact of Vadose Zone	Silt & Clay	5	2	10
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	72

Setting: 7F13		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	30’ - 50’	5	5	25
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Aggregated Clay	2	7	14
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Silt & Clay	5	3	15
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	112

Setting: 7F14		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	50’ - 75’	5	3	15
Net Recharge	0" - 2"	4	1	4
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Clay Loam	2	3	6
Topography	12 - 18%	1	3	3
Impact of Vadose Zone	Silt & Clay	5	2	10
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	74

Setting: 7F15		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	50’ - 75’	5	3	15
Net Recharge	0" - 2"	4	1	4
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Clay Loam	2	3	6
Topography	18+%	1	1	1
Impact of Vadose Zone	Silt & Clay	5	2	10
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	63

Setting: 7F16		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	30’ - 50’	5	5	25
Net Recharge	2" - 4"	4	3	12
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Clay Loam	2	3	6
Topography	6 - 12%	1	5	5
Impact of Vadose Zone	Silt & Clay	5	2	10
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	85



7Gb Thin Till Over Limestone

This hydrogeologic setting is characterized by thin deposits of glacial till overlying limestone bedrock. In some areas the limestone is directly overlain by shale. The till and soil are usually very thin or absent in areas of steep relief. Till consists primarily of clay with little, if any, sand and gravel and does not serve as a source of water. Ground water is obtained from the upper, weathered, and solutioned portion of the limestone. Recharge is generally low due to the steep relief and the presence of restrictive shale. Depth to water is fairly shallow where the shale is absent, but deepens with increased thickness of shale.

GWPP index values for the hydrogeologic setting of thin till over limestone range from 163 to 178 with the total number of GWPP index calculations equaling 7.

Setting: 7Gb1			**GENERAL**	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5' - 15'	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Thin or Absent	2	10	20
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Massive Limestone	5	7	35
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	169

Setting: 7Gb2			**GENERAL**	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5' - 15'	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Thin or Absent	2	10	20
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Massive Limestone	5	7	35
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	168

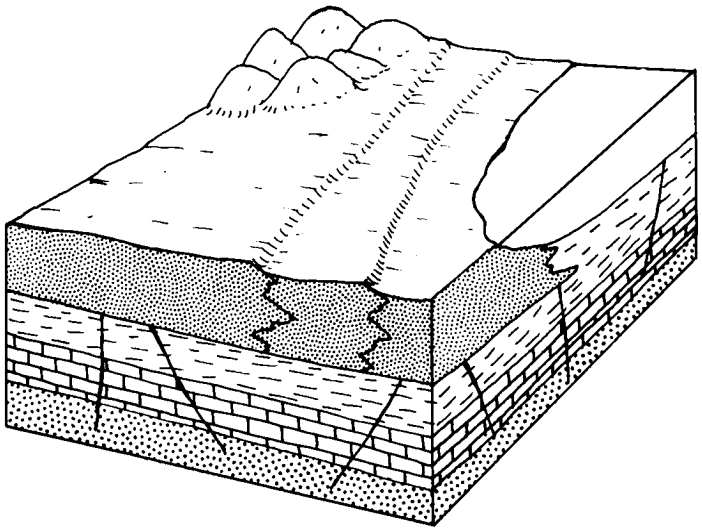
Setting: 7Gb3		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Thin or Absent	2	10	20
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Massive Limestone	5	6	30
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	164

Setting: 7Gb4		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Thin or Absent	2	10	20
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Massive Limestone	5	6	30
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	163

Setting: 7Gb5		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Thin or Absent	2	10	20
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Massive Limestone	5	8	40
Hydraulic Conductivity	100-300	3	2	6
		GWPP	INDEX	164

Setting: 7Gb6		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Thin or Absent	2	10	20
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Massive Limestone	5	7	35
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	178

Setting: 7Gb7		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ 30’	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Thin or Absent	2	10	20
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Massive Limestone	5	8	40
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	163



7H Beaches, Beach Ridges and Sand Dunes

This hydrogeologic setting is characterized by low relief, sandy surface soil that is predominantly silica sand, extremely high infiltration rates, and low sorptive capacity in the thin vadose zone. The water table is very shallow beneath the beaches bordering the Great Lakes. These beaches are commonly ground water discharge areas. The water table is slightly deeper beneath the rolling dune topography and the vestigial inland beach ridges. All of these areas serve as recharge sources for the underlying sedimentary bedrock aquifers, and they often serve as local sources of water supply.

GWPP index values for the hydrogeologic setting of beaches, beach ridges and sand dunes range from 132 to 176 with the total number of GWPP index calculations equaling 38.

Setting: 7H1		**GENERAL**		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5' - 15'	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sandy Loam	2	6	12
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	155

Setting: 7H2		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sandy Loam	2	6	12
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	145

Setting: 7H3		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sandy Loam	2	6	12
Topography	2 - 6%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	156

Setting: 7H4		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Sand & Gravel	3	8	24
Soil Media	Sandy Loam	2	6	12
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	8	40
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	151

Setting: 7H5		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Sand & Gravel	3	8	24
Soil Media	Clay Loam	2	3	6
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel with Silt and Clay	5	7	35
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	150

Setting: 7H6		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Sand & Gravel	3	5	15
Soil Media	Sandy Loam	2	6	12
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	150

Setting: 7H7		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Sand & Gravel	3	8	24
Soil Media	Sandy Loam	2	6	12
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	158

Setting: 7H8		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Sand & Gravel	3	8	24
Soil Media	Loam	2	5	10
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	8	40
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	155

Setting: 7H9		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Sand & Gravel	3	8	24
Soil Media	Sandy Loam	2	6	12
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	8	40
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	165

Setting: 7H10		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Sand & Gravel	3	8	24
Soil Media	Sandy Loam	2	6	12
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel	5	8	40
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	164

Setting: 7H11		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Sand & Gravel	3	8	24
Soil Media	Clay Loam	2	3	6
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	8	40
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	151

Setting: 7H12		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Sand & Gravel	3	5	15
Soil Media	Sandy Loam	2	6	12
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	149

Setting: 7H13		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Sand & Gravel	3	5	15
Soil Media	Sandy Loam	2	6	12
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	139

Setting: 7H14		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Sand & Gravel	3	5	15
Soil Media	Sandy Loam	2	6	12
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	132

Setting: 7H15		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sand	2	9	18
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	7	35
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	167

Setting: 7H16		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Loam	2	5	10
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Glacial Till	5	4	20
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	136

Setting: 7H17		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sand	2	9	18
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel	5	7	35
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	166

Setting: 7H18		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sandy Loam	2	6	12
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	7	35
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	151

Setting: 7H19		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sandy Loam	2	6	12
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	146

Setting: 7H20		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sand	2	9	18
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel	5	8	40
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	161

Setting: 7H21		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	0’ - 5’	5	10	50
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sandy Loam	2	6	12
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	161

Setting: 7H22		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sand	2	9	18
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel with Silt & Clay	5	6	30
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	144

Setting: 7H23		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	0’ - 5’	5	10	50
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sand	2	9	18
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel with Silt & Clay	5	7	35
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	171

Setting: 7H24		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sand	2	9	18
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	7	35
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	159

Setting: 7H25		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sand	2	9	18
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel	5	7	35
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	158

Setting: 7H26		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sandy Loam	2	6	12
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	7	35
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	161

Setting: 7H27		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Sandy Loam	2	6	12
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	165

Setting: 7H28		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Sand	2	9	18
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel	5	7	35
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	175

Setting: 7H29		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Sandy Loam	2	6	12
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	164

Setting: 7H30		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Sand	2	9	18
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel	5	7	35
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	165

Setting: 7H31		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Sand & Gravel	3	5	15
Soil Media	Sandy Loam	2	6	12
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	140

Setting: 7H32		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sand	2	9	18
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel	5	7	35
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	156

Setting: 7H33		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sandy Loam	2	6	12
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel with Silt & Clay	5	6	30
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	137

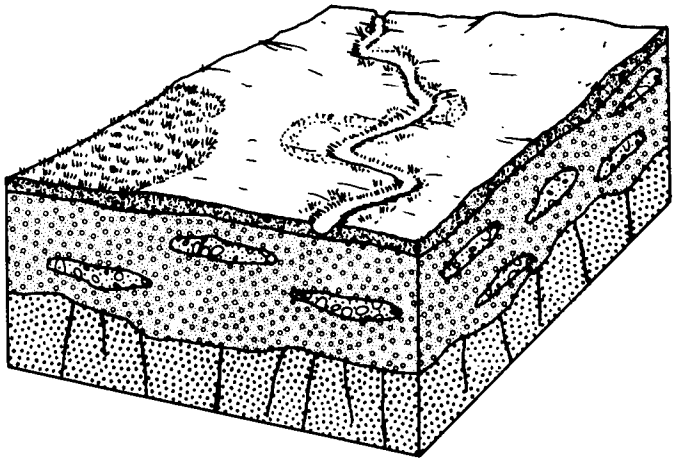
Setting: 7H34		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sand	2	9	18
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	7	35
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	157

Setting: 7H35		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Sandy Loam	2	6	12
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	155

Setting: 7H36		GENERAL		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	15’ - 30’	5	7	35
Net Recharge	4" - 7"	4	6	24
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Loam	2	5	10
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	145

Setting: 7H37		**GENERAL**		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	8	24
Soil Media	Sand	2	9	18
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	7	35
Hydraulic Conductivity	300 - 700	3	4	12
		GWPP	INDEX	176

Setting: 7H38		**GENERAL**		
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5’ - 15’	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Massive Limestone	3	7	21
Soil Media	Sandy Loam	2	6	12
Topography	2 - 6%	1	9	9
Impact of Vadose Zone	Sand & Gravel	5	7	35
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	160



7I Swamp / Marsh

This hydrogeologic setting is characterized by low topographic relief, high water levels, and high organic silt and clay deposits. These wetlands occur along the courses of floodplains and in upland areas as a result of vertically restricted drainage. Common features of upland wetlands include those characteristics attributable to glacial activity such as filled-in glacial lakes, potholes, and cranberry bogs. Recharge is moderate in most of the region due to restriction by clay-rich soils and limited by precipitation. The swamp deposits very rarely serve as significant aquifers but frequently recharge the underlying sand and gravel or bedrock aquifers.

The GWPP index value for the hydrogeologic setting of river alluvium without overbank deposits is 160 with a GWPP index calculation equaling 1.

Setting: 7I1			**GENERAL**	
FEATURE	RANGE	WEIGHT	RATING	INDEX
Depth to Water	5' - 15'	5	9	45
Net Recharge	7" - 10"	4	8	32
Aquifer Media	Sand and Gravel	3	7	21
Soil Media	Peat	2	8	16
Topography	0 - 2%	1	10	10
Impact of Vadose Zone	Sand & Gravel	5	6	30
Hydraulic Conductivity	100 - 300	3	2	6
		GWPP	INDEX	160

Ground Water Pollution Potential of WOOD COUNTY

by

Kelly C. Smith and Thomas P. Sabol

ERM-Midwest, Inc.

Prepared in cooperation with

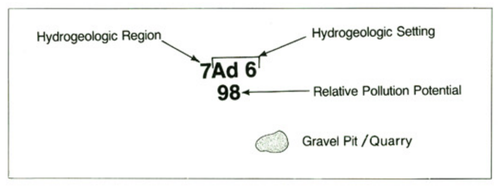
Ohio Department of Natural Resources, Division of Water

1 0 1 2 Miles

1 0 1 2 Kilometers

CONTOUR INTERVAL 5 FEET

Description of Map Symbols



County Line

Township Line

Incorporated City Limit

Pollution Potential Index Range

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

Hydrogeologic Settings

- 7Ac - Glacial Till Over Solution Limestone
- 7Af - Sand & Gravel Interbedded in Glacial Till
- 7Eb - River Alluvium w/o Overbank Deposits
- 7Ec - Alluvium Over Sedimentary Rock
- 7Ed - River Alluvium Over Glacial Till
- 7F - Glacial Lake Plain Deposits
- 7Gb - Thin Till Over Limestone
- 7H - Beaches, Beach Ridges and Sand Dunes
- 7I - Marshes and Swamps

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).

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 Wood County," GWPP Report No. 21, Ohio Department of Natural Resources, Division of Water.

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