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AQUIFER SENSITIVITY MAP OF TAZEWELL COUNTY, ILLINOIS

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INTRODUCTION

The Illinois State Geological Survey (ISGS), with funding from the Tazewell County Board, mapped the near-surface geology of Tazewell County, Illinois. The primary purpose of this mapping was to characterize the potential for aquifer contamination within the county. This map is one of several produced as part of that project. This map classifies areas of the county according to the sensitivity of aquifers to contamination by land burial of municipal waste.

For this study, an aquifer is defined as any geologic material with adequate permeability to conduct groundwater to wells, springs or streams at economically sufficient quantities. These conditions are met when unconsolidated sediments are sufficiently coarse-grained (sand and gravel) and sorted to have relatively high porosity and permeability. Fined-grained, clay-rich materials and clayey diamictons (such as some tills) act as aquitards, units that limit the through-flow of water and act as barriers between aquifer units. Shale bedrock is generally considered to be an aquitard, unless intensely fractured, whereas sandstone and limestone are generally regarded as moderate to high-quality aquifers, depending on porosity and fracture conditions. In Tazewell County, the sandstone and limestone layers in the bedrock are strongly cemented and only slightly fractured and are not considered viable aquifers.

PRINCIPLES OF AQUIFER SENSITIVITY

This map was produced using an aquifer sensitivity classification system developed at the ISGS (Berg, 2001). The system was developed to be adaptable to a variety of land use scenarios, geologic environments, and mapping scales. The classification system identifies geologic units with high aquifer potential, and the properties of materials that overlie them. Thickness of non-aquifer materials overlying aquifers is an important factor controlling the sensitivity of the aquifer to contamination. The resource value of an aquifer and its ability to conduct contaminants is partially controlled by the thickness of the aquifer. For these reasons, a hierarchal classification scheme was created based on depth to the uppermost aquifer and its thickness.

Because of the complex geology of the unlithified glacial deposits in the area, the following generalizations and assumptions were applied to reduce the number of sensitivity classes shown on the map at 1:62,500 scale (McGarry and Grimley 1997, Berg and Abert 1999, Berg 2001).

1: Aquifer materials, defined as layers of unlithified sand and gravel, have a higher sensitivity to contamination than non-aquifer materials.

2: The bedrock under Tazewell County is considered a non-aquifer material. The bedrock that underlies the glacial materials consists primarily of Pennsylvanian-age shale that contains thin beds of cemented sandstone, coal, and limestone (Walker et al. 1965, Willman 1967, and Kempton and Visocky 1992). In the absence of major fracture systems, these bedrock materials generally are not porous and permeable enough to be aquifer material.

3: Thick sand and gravel units have a greater groundwater resource potential than thin units of these materials. Thicker aquifers were therefore assigned to a higher sensitivity class than thinner aquifers due to their relative importance as a water source. Sand and gravel units less than 5 feet thick do not generally supply sufficient water to a well even to supply a single-family home. Sand and gravel aquifers were divided into three main thickness categories: between 5 and 20 feet thick, 20 to 50 feet thick, and greater than 50 feet thick.

4: The depth to aquifer categories are based on the potential for contaminants from a variety of land use practices to move through any overlying non-aquifer materials and infiltrate into an aquifer. Aquifers in the depth category of less than 5 feet are considered to be at greatest risk of contamination from leaching of pesticide, nitrate, or septic wastes applied at the surface. The depth ranges of 5 to 20 feet and 20 to 50 feet below the surface were used because of the typical depths to which landfill trenches are dug in Illinois (20 feet), and the historic practice of separating the bottom of a landfill from groundwater by at least 30 feet of relatively impermeable material to reduce the infiltration of leachate contaminants (Berg 2001). The depth range of 50 to 100 feet was used to define another sensitivity group because of the trend towards increased landfill trench depths and recent studies indicating that contamination of groundwater by agricultural chemicals decreases markedly below 100 feet (Berg 2001).

5: The aquifer sensitivity classes are hierarchical, that is, the aquifer with the greatest sensitivity determines the sensitivity classification shown on the map; a higher-sensitivity class overrides a lower-sensitivity class. As such, a deeper aquifer may not be considered in this classification scheme if a shallower aquifer overlying it has a higher sensitivity.

There are many factors that may affect aquifer sensitivity. Although not all were considered in this study, some factors that should be considered in any future site-specific assessments of aquifer sensitivity at larger scales include:

1) Direct testing of the hydrological characteristics of aquifers within Tazewell County were not part of this study. Sub-surface materials were classified according to their assumed potential to store and conduct water, but no actual measurements or modeling of the groundwater flow regime of Tazewell County were performed. Direct measurements of the hydraulic conductivity of the aquifer materials and the quantity and quality of groundwater resources could be used to refine the aquifer sensitivity map of the county.

2) The ability of different agricultural soil types to speed up or slow down the movement of contaminants to deeper geologic units have been studied (Keefer 1995) and maps have been produced that use these data in aquifer sensitivity modeling (Berg and Abert 1999).

3) Large, economically important aquifers may exist in unconsolidated materials below 100 feet, and their potential for contamination may be affected by the presence of shallower aquifers above them. Although not part of the classification system used on this map, an inset map indicates areas where thick, widespread unconsolidated sand and gravel deposits lie more than 100 feet below the land surface.

4) Although the bedrock under Tazewell County has been mapped as a non-aquifer material, the presence of an extensive fracture pattern or of more porous sandstone or limestone layers may increase the potential for groundwater movement through the bedrock, which may allow contaminants to flow between identified aquifers. This study did not include detailed mapping of the bedrock lithology, which could identify such fracturing or permeable beds.

MAPPING METHODOLOGY

The data to compile this map were collected from the surficial geology (Johnstone 2001a), surface topography (Johnstone and McGarry 2001) and drift thickness (Johnstone 2001b) maps of Tazewell County produced as part of this project. Records from about 4000 water wells, exploration wells, and engineering borings were studied, and over 3000 well records were used to produce a 3-dimensional model of the geology of the unlithified Quaternary materials of Tazewell County. This model identified both aquifer (sand and gravel) and non-aquifer (fine-grained) materials. The depth to the top of the aquifer materials and the thicknesses of aquifer and non-aquifer materials were measured. These data were used to distinguish the following sensitivity categories (see legend for specific category details) using the classification system of Berg (2001):

A1, A2, A3, A4: Very High Sensitivity. These areas contain thick (>20 feet) sand and gravel deposits very close to the land surface (<5 to 20 feet). Contaminants infiltrating into the top 5 feet of the materials can be expected to move downward rapidly into the sand and gravel and affect groundwater quality over a wide area.

B2, B3: High Sensitivity. In these areas, thinner sand and gravel deposits (5 to 20 feet) lie very close to the surface (<5 to 20 feet). The materials are very poorly protected from contamination, but are not as thick and therefore do not have as great a groundwater resource potential as the aquifers in category A. They must still be considered high-sensitivity because they may provide adequate groundwater for domestic or small community wells. Also, these aquifers may form a pathway for the transmission of contaminants to deeper or adjacent aquifers, or to surface water bodies.

C1, C2, C3, C5: Moderately High Sensitivity. These areas contain aquifers at a moderate depth (20 to 50 feet) below the surface. Overlying fine-grained materials provide some protection from contaminants applied at the surface. This protection is significantly compromised where the surface materials are excavated (e.g. under a landfill trench).

D1, D2, D3: Moderate Sensitivity. In these areas, aquifer materials are covered by more than 50 feet of predominantly fine-grained material. These aquifers are well protected from contamination, but these areas may be inappropriate for hazardous or municipal waste disposal.

E2, F3: Low Sensitivity. In these areas there are no extensive aquifer materials within 100 feet of the land surface, or the non-aquifer bedrock lies within 20 feet of the surface and, therefore, there is only a low potential for aquifer contamination. It is important to consider that areas without mappable aquifer units (those exceeding five feet in thickness) in the top 100 feet (E2) may locally contain thin lenses of aquifer material that may connect to larger aquifer units. This classification does not preclude the presence of thick aquifers at depths below 100 feet. Detailed site-specific mapping is recommended even in low sensitivity areas before potentially damaging land use practices are allowed.

Sandy Tills at Land Surface: The stippled overprint pattern shows areas where the glacial tills, normally considered a very low-permeability material, contain a large proportion of sand. Although these tills are not considered aquifer material, they offer less protection to any underlying sand and gravel, due to their increased porosity, than the more common finer-grained tills. These tills (the Vandalia Member of the Glasford Formation) are only outlined where they are mappable at the land surface, and no attempt was made to trace their presence into the subsurface.

Disturbed Land: The cross-hatched overprint pattern denotes areas where there has been extensive human re-working of the land surface. Activities such as quarrying, aggregate extraction, construction of landfills or roads, or intense urbanization may result in heavy modification of the land surface. Aquifer sensitivity may vary greatly in these areas depending on amount or type of materials removed or deposited and the techniques used in modifying the land surface.

The classification names and colors used in this map are consistent with those used in other aquifer sensitivity maps in the state. Some of these standard classes are not found within Tazewell County (i.e. C4, E1, F1, F2) and there designations have been omitted from the following legend for the aquifer sensitivity classes,

SUMMARY

Much of Tazewell County is characterized as having a moderately high to very high aquifer sensitivity. The western part of the county features large areas where glacial outwash of the Henry Formation, which is composed of thick sequences of sand and gravel, is near the land surface. In the eastern part of the county, thick units of fine-grained materials (e.g. low-permeability glacial tills) are present. However in some areas, such as the Mackinaw River Valley, most of the tills have been eroded, removing some of the protection for the underlying sand and gravel layers, and thick terrace deposits in the valley bottom contain local near-surface aquifers. In places, the tills contain discontinuous lenses of sand and gravel, some of considerable thickness and areal extent, which may form local near-surface aquifers. The presence of sandy tills at depth may further increase the aquifer sensitivity in these areas. Although much of the eastern part of Tazewell County is classified as moderate to low aquifer sensitivity, it is here that extensive, thick, and economically important aquifers exist at depths greater than 100 feet. Any land use plan for Tazewell County must address the potential effects of a planned use on these deeper aquifers, especially the regionally important Sankoty-Mahomet aquifer which underlies the southeastern part of the county (Walker et al. 1965, Kempton and Visocky 1992, Herzog et al. 1995).

AQUIFER SENSITIVITY CLASS (From Berg, 2001)

Very High Sensitivity	
A 1	Sand and gravel >50 feet thick within 5 feet of the land surface
A 2	Sand and gravel >50 feet thick between 5 and 20 feet below the land surface
A 3	Sand and gravel 20 to 50 feet thick within 5 feet of the land surface
A 4	Sand and gravel 20 to 50 feet thick between 5 and 20 feet below the land surface
High Sensitivity	
B 1	Sand and gravel between 2 and 20 feet thick within 5 feet of the land surface
B 2	Sand and gravel between 5 and 20 feet thick between 5 and 20 feet below the land surface
Moderately High Sensitivity	
C 1	Sand and gravel >50 feet thick between 20 and 50 feet below the land surface
C 2	Sand and gravel between 20 and 50 feet thick between 20 and 50 feet below the land surface
C 3	Sand and gravel between 5 and 20 feet thick between 20 and 50 feet below the land surface
C 5	Discontinuous sand and gravel possibly present between 20 and 50 feet below the land surface
Moderate Sensitivity	
D 1	Sand and gravel > 50 feet between 50 and 100 feet below the land surface
D 2	Sand and gravel between 20 and 50 feet thick between 50 and 100 feet below the land surface
D 3	Sand and gravel between 5 and 20 feet thick between 50 and 100 feet below the land surface
Low Sensitivity	
E 2	Discontinuous sand and gravel possibly present within 100 feet of the land surface
F 3	Less than 20 feet of fine-grained unconsolidated material overlying bedrock
OTHER UNITS	
	Sandy tills at the land surface
	Disturbed Land

Potential for Deep Aquifers

- Sand not present below 100 feet
- Sand present below 100 feet
- Bedrock at less than 100' depth

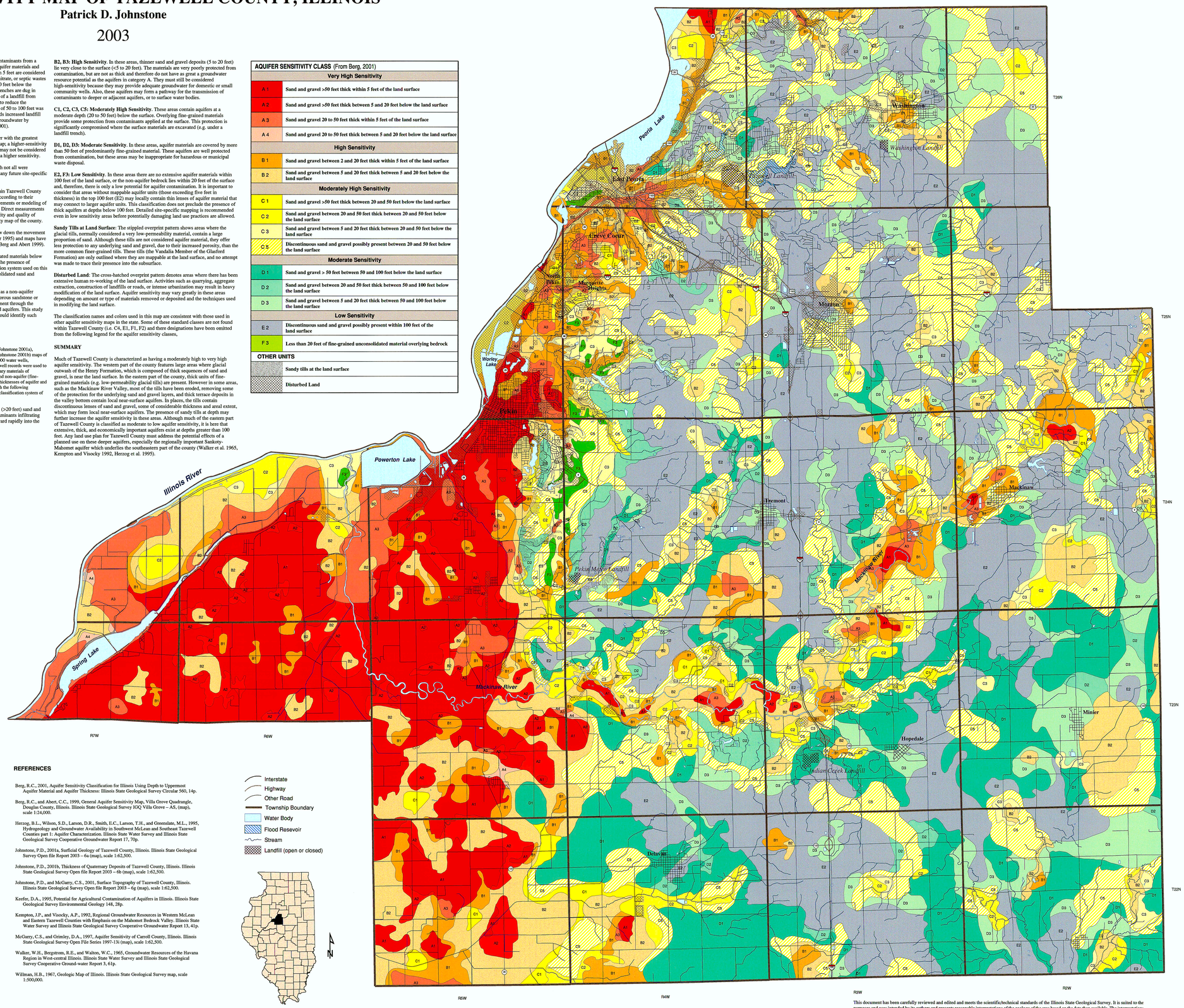
Scale 1 : 250,000
(1 inch equals approximately 4 miles)

Generalized Surficial Geology

- DISTURBED GROUND
- CAHOKIA FORMATION. *ALLUVIUM*
- GRAYSLAKE PEAT. *PEAT AND MUCK*
- PEORIA SILT. *LOESS*
  MAPPED WHERE DEPTH EXCEEDS 5 FEET AND OVERLYING TILLS
- PEORIA AND ROXANA SILTS. *LOESS*
  MAPPED WHERE DEPTH EXCEEDS 5 FEET ONLY BEYOND WISCONSIN EPISODE ICE MARGIN
- PARKLAND FACIES. *AEOLEAN SANDS*
- HENRY FORMATION. *GLACIAL-FLUVIAL*
- TISKILWA FORMATION. *TILL*
- GLASFORD FORMATION. *TILL*

Scale 1 : 250,000
(1 inch equals approximately 4 miles)

Modified from
Johnstone, 2001a.



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- Interstate
- Highway
- Other Road
- Township Boundary
- Water Body
- Flood Resevoir
- Stream
- Landfill (open or closed)

1:62,500
(1 inch equals approximately 1 mile)
0 1 2 3 4 Miles
0 1 2 3 4 5 6 Kilometers

Lambert Conformal Conic Projection

ISGS Illinois State Geological Survey

Illinois Department of Natural Resources

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