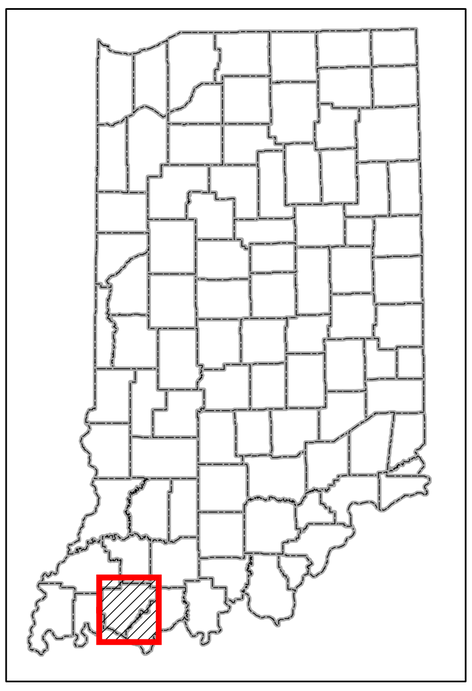
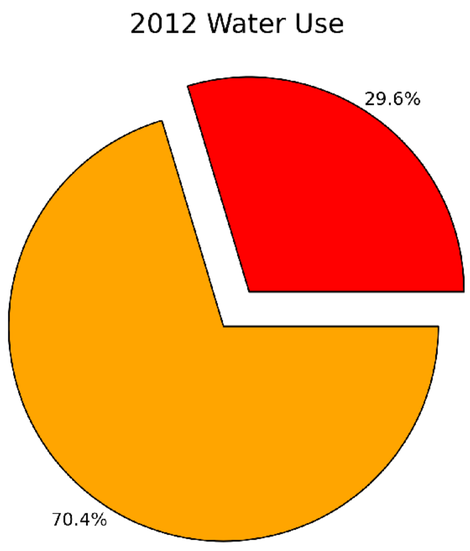
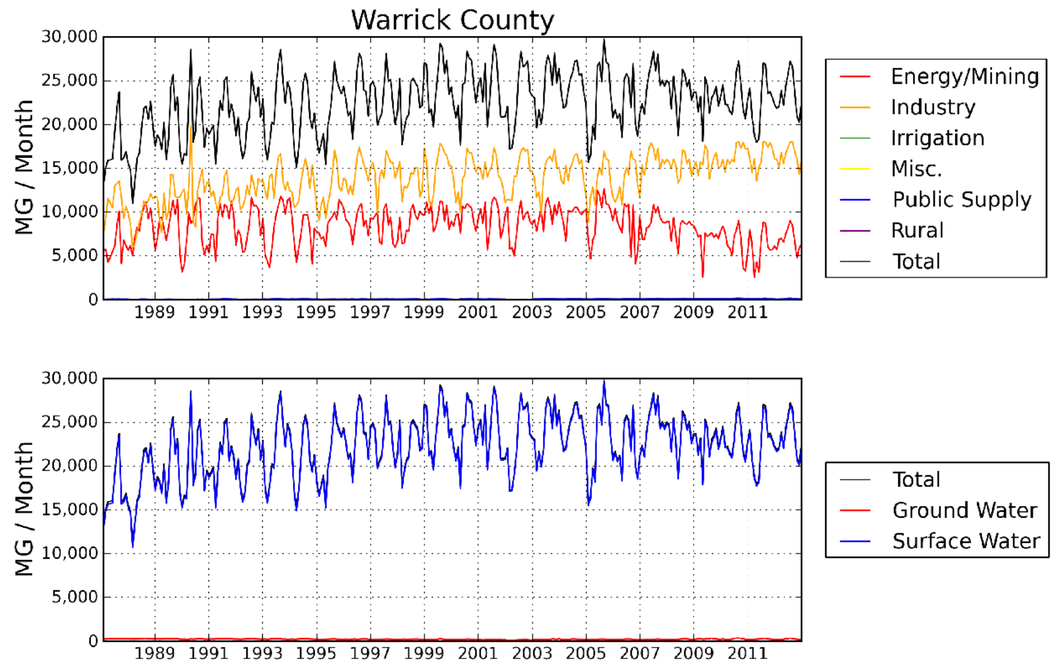
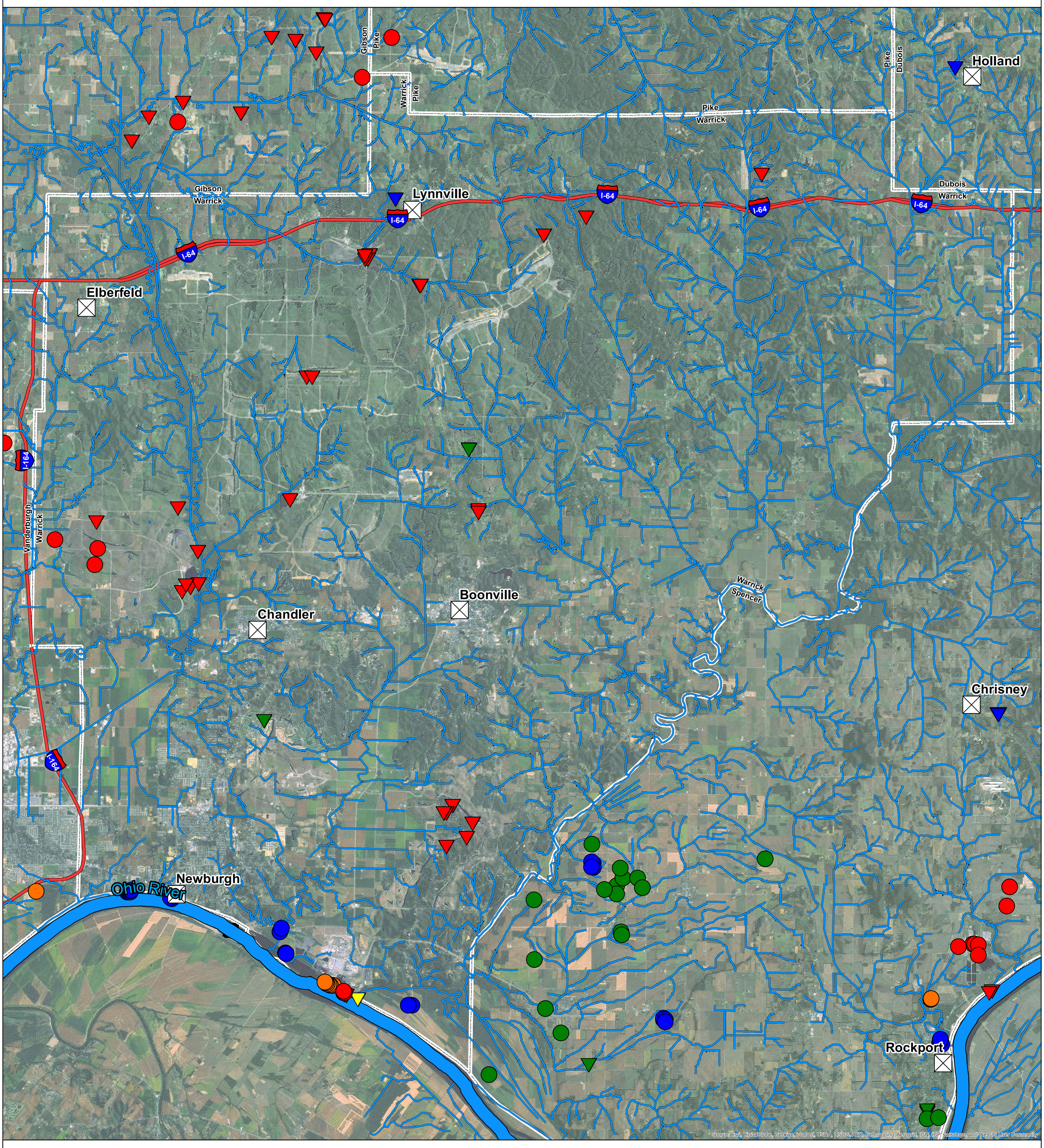




Average Daily Use: 772.3 MGD





Water Resources and Use in Warrick County

Data Sources: U.S. Geological Survey and Indiana Department of Natural Resources

Withdrawal Location

WELL INTAKE

- Energy/Mining
- Industry
- Irrigation
- Misc.
- Public Supply
- Rural Use

River

7Q2 Flow (MGD)

- <10 MGD
- 10 - 50 MGD
- 50 - 100 MGD
- 100 - 500 MGD
- > 500 MGD

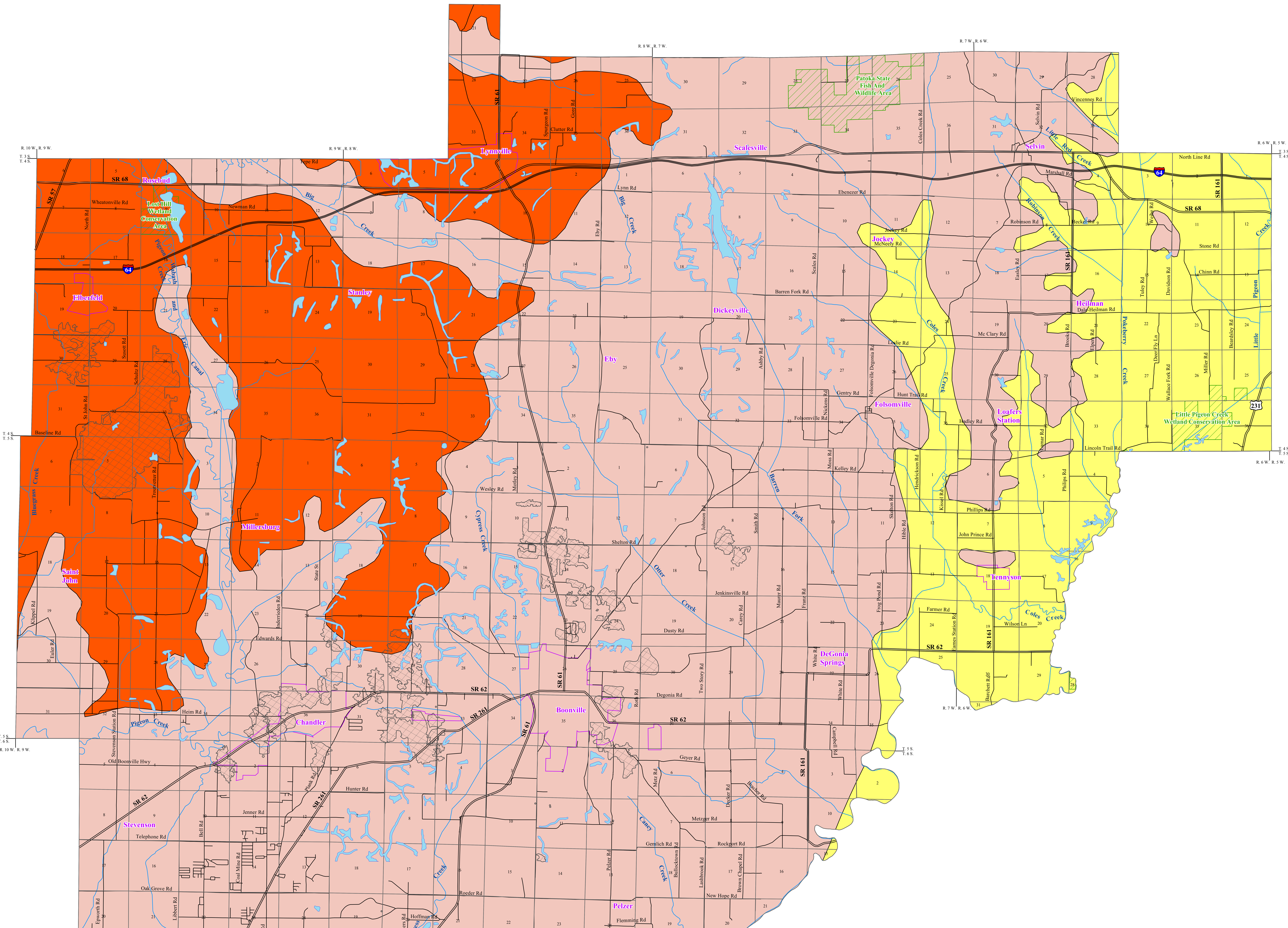
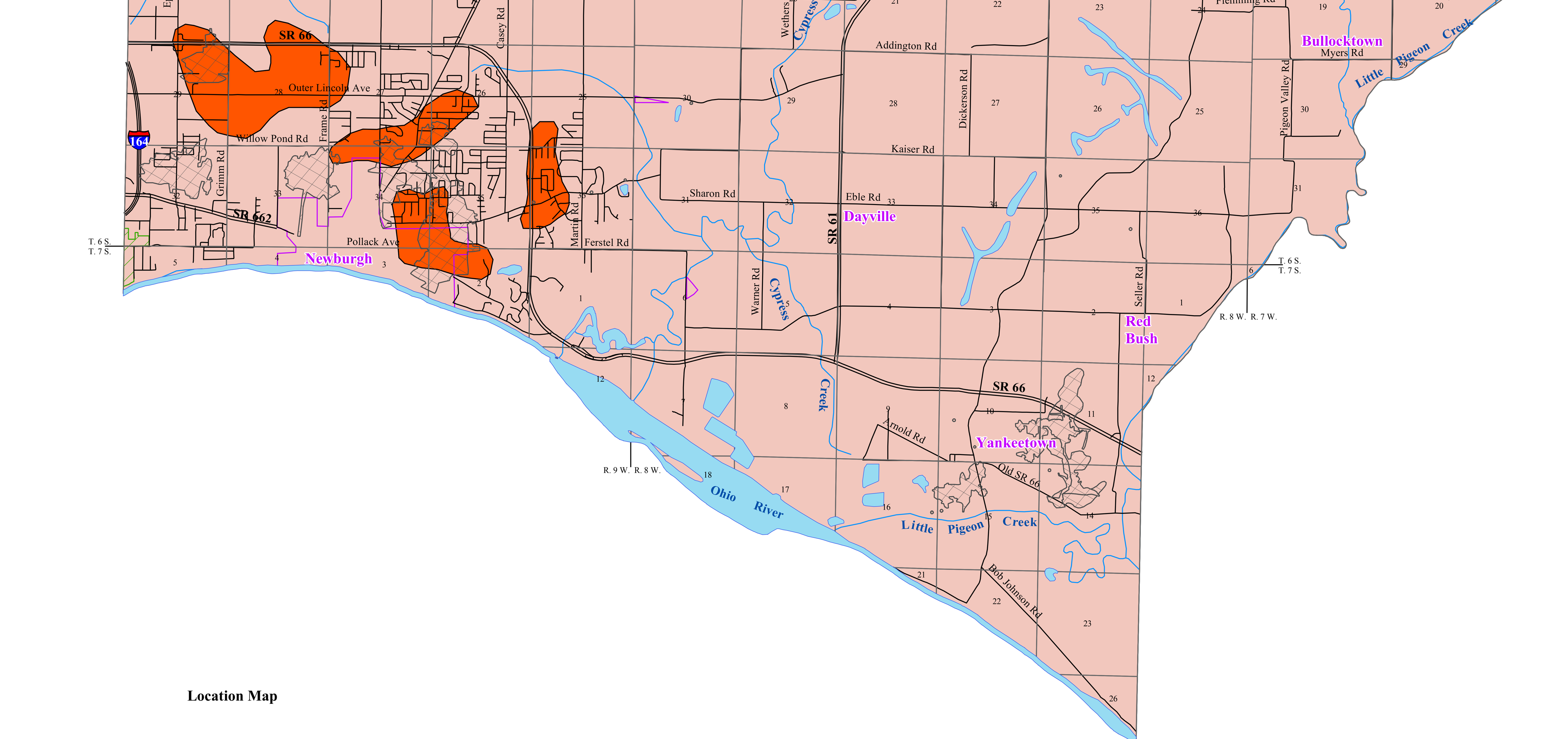
- Major Lakes
- Interstate
- County
- City

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

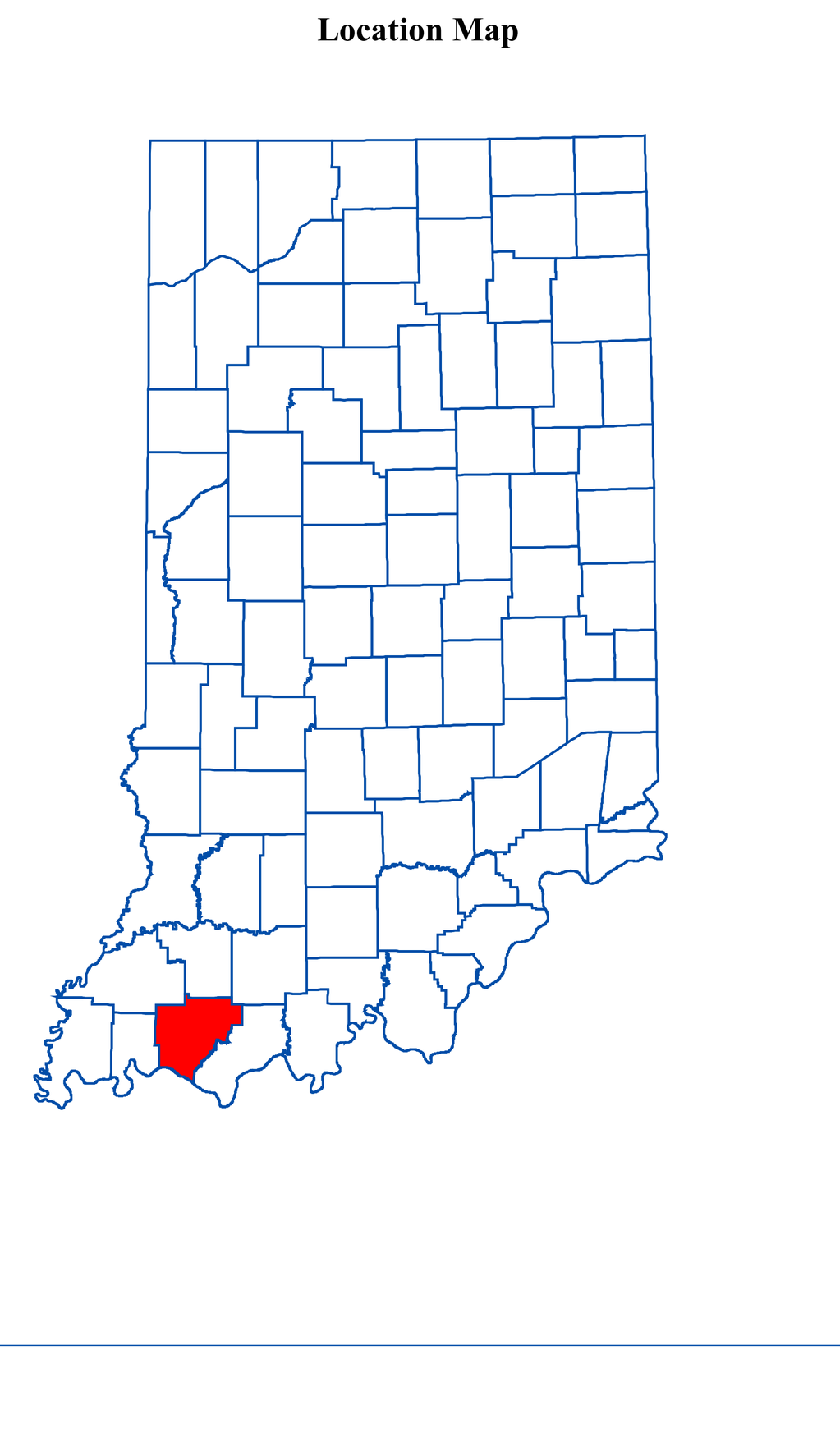
NORTH

0 1 2 4 Miles

BEDROCK AQUIFER SYSTEMS OF WARRICK COUNTY, INDIANA

Location Map



EXPLANATION

- Stream
- County Road
- State Road & US Highway
- Interstate
- Municipal Boundary
- State Managed Property
- Lake & River

1 0.5 0 1 Mile

1 0.5 0 1 Kilometer

The occurrence of bedrock aquifers depends on the original composition of the rocks and subsequent changes which influence the hydraulic properties. Post-depositional processes, which promote jointing, fracturing, and solution activity of exposed bedrock, generally increase the hydraulic conductivity (permeability) of the upper portion of bedrock aquifer systems. Because permeability in many places is greatest near the bedrock surface, bedrock units within the upper 100 feet are commonly the most productive aquifers.

Unconsolidated deposits of varying thickness overlie bedrock aquifer systems in Warrick County. Most of the bedrock aquifers in the county are under confined conditions. In other words, the potentiometric surface (water level) in most wells completed in bedrock rises above the top of the water-bearing formation.

The yield of a bedrock aquifer depends on its hydraulic characteristics and the nature of the overlying deposits. Shale and glacial till act as aquitards, restricting recharge to underlying bedrock aquifers. However, fracturing and/or jointing may occur in aquitards, which can increase recharge to the underlying aquifers. Hydraulic properties of the bedrock aquifers are highly variable.

The susceptibility of bedrock aquifer systems to surface contamination is largely dependent on the type and thickness of the overlying sediments. Because the bedrock aquifer systems have complex fracturing systems, once a contaminant has been introduced into a bedrock aquifer system, it will be difficult to track and remediate.

Three bedrock aquifer systems are identified for Warrick County. They are, from west to east, youngest to oldest: the McLeansboro Group of Pennsylvanian age; the Carbondale Group of Pennsylvanian age; and the Raccoon Creek Group of Pennsylvanian age.

Pennsylvanian -- McLeansboro Group Aquifer System

The McLeansboro Group outcrop/subcrop area is primarily located in the northwest part of the county with a few isolated areas to the southwest. Thickness of the McLeansboro Group ranges from less than 1 foot to about 160 feet. This aquifer system consists in ascending order of the Shelburn, Patoka, Bond, and Mattoon Formations. However, in Warrick County only the Shelburn and Patoka Formations are present.

The Patoka Formation consists primarily of shale and sandstone with clay, limestone, and coal. The underlying Shelburn Formation consists of shale siltstone, sandstone, coal, and limestone. Two important members of the Shelburn Formation include the West Franklin Limestone at the top of the formation and the Busseron Sandstone at the base. These are the primary aquifer units within the McLeansboro Group Aquifer System.

Few wells are reported in the McLeansboro Group Aquifer System in Warrick County. The depth to the bedrock surface ranges from 5 feet to 25 feet with well depths ranging from 30 to 100 feet. The amount of rock penetrated generally ranges from 1 to 30 feet, with a maximum of 90 feet. Most domestic wells produce less than 10 gallons per minute (gpm) with a few (pumped) dry holes reported. Static water levels range from 5 to 75 feet below surface.

Most of the McLeansboro Group Aquifer System contains fine-grained materials that limit the movement of ground water. However, in some areas alluvial and lacustrine materials directly overlie the bedrock surface. Therefore, the aquifer system is considered low to moderate risk to contamination.

Pennsylvanian -- Carbondale Group Aquifer System

The Carbondale Group Aquifer System outcrop/subcrop area covers the largest areal extent of the bedrock aquifer systems in Warrick County. The group consists in ascending order of the Linton, Petersburg, and Dugger Formations. Bedrock deposits include mostly shale and sandstone with some limestone and commercially important coal. Thickness of the Carbondale Group in Warrick County ranges from 0, where it is in contact with the underlying Raccoon Creek Group, to about 350 feet.

Depth to the bedrock surface is typically from 10 to 60 feet below surface. Well depths range from 50 to 320 feet with most completed at depths between 70 and 150 feet. The amount of rock penetrated ranges from 1 to 250 feet. The Carbondale Group is considered a minor ground-water source with domestic wells typically pumping less than 10 gpm. Static water levels in the wells vary from 5 to 140 feet below the land surface, but are typically between 5 and 30 feet below the surface.

Most wells produce from the thicker sandstone and coal units in the upper formations of the Carbondale Group. Localized yields are greater in areas where outwash and alluvial sands and gravels directly overlie bedrock. A few (pumped) dry holes have been reported. However, one discontinued coal mine dewatering well in nearby Vanderburgh County is completed in a deeper sandstone near the base of the Linton Formation. This well reports a yield of 200 gpm. Water quality, however, from the deeper bedrock units is highly mineralized.

In areas where overlying clay materials are present, the Carbondale Group Aquifer System is at low risk to contamination. However, in some areas outwash, alluvial, and lacustrine materials directly overlie the bedrock surface. These areas are at moderate to high risk from surface contamination.

Pennsylvanian -- Raccoon Creek Group Aquifer System

In Warrick County the Raccoon Creek Group Aquifer System outcrops/subcrops primarily in the northeastern part of the county. The group consists in ascending order of the Mansfield, Brazil, and Staunton formations. The basal formation of the group, the Mansfield Formation, rests unconformably on the Mississippian rocks. Bedrock consists of mostly sandstone and shale with minor amounts of mudstone, coal, and limestone. Thickness of the Raccoon Creek Group in Warrick County ranges from about 250 to 700 feet as it dips beneath younger strata.

Few well records are available in the Raccoon Creek Group Aquifer System in Warrick County. Most wells produce from the upper formations of the Raccoon Creek Group. However, the Mansfield Formation is considered a moderately dependable ground water resource. The upper contact of the Mansfield Formation ranges from about 240 to 300 feet below surface. The depth to the bedrock surface is typically less than 30 feet and completed wells range from 50 to 320 feet below surface. Domestic well production ranges from 1 to 15 gpm with a few (pumped) dry holes reported. Static water levels are generally 5 to 90 feet below surface. In general, water quality from deeper bedrock units is more mineralized than upper units.

In areas where overlying clay materials are present, the Raccoon Creek Group Aquifer System is at low risk to contamination from the surface or near surface. However, in some areas outwash, alluvial, and lacustrine materials directly overlie the bedrock surface. These areas are at moderate to high risk from surface contamination.

Underground Mine Areas

In Warrick County various coal seams within the Carbondale Group have been removed by underground mining methods. In underground mines, approximately 50 percent of the coal seam was typically removed, leaving the potential for storage of substantial amounts of water in the larger mines. Although the Division has no records of wells drilled into these mines, yields of a few hundred gpm are possible. A limitation on use of the water could be its more mineralized nature.

Map generated by Joseph L. Phillips, Jennifer K. McMillan, and Adam B. Watts
IDNR, Division of Water, Resource Assessment Section

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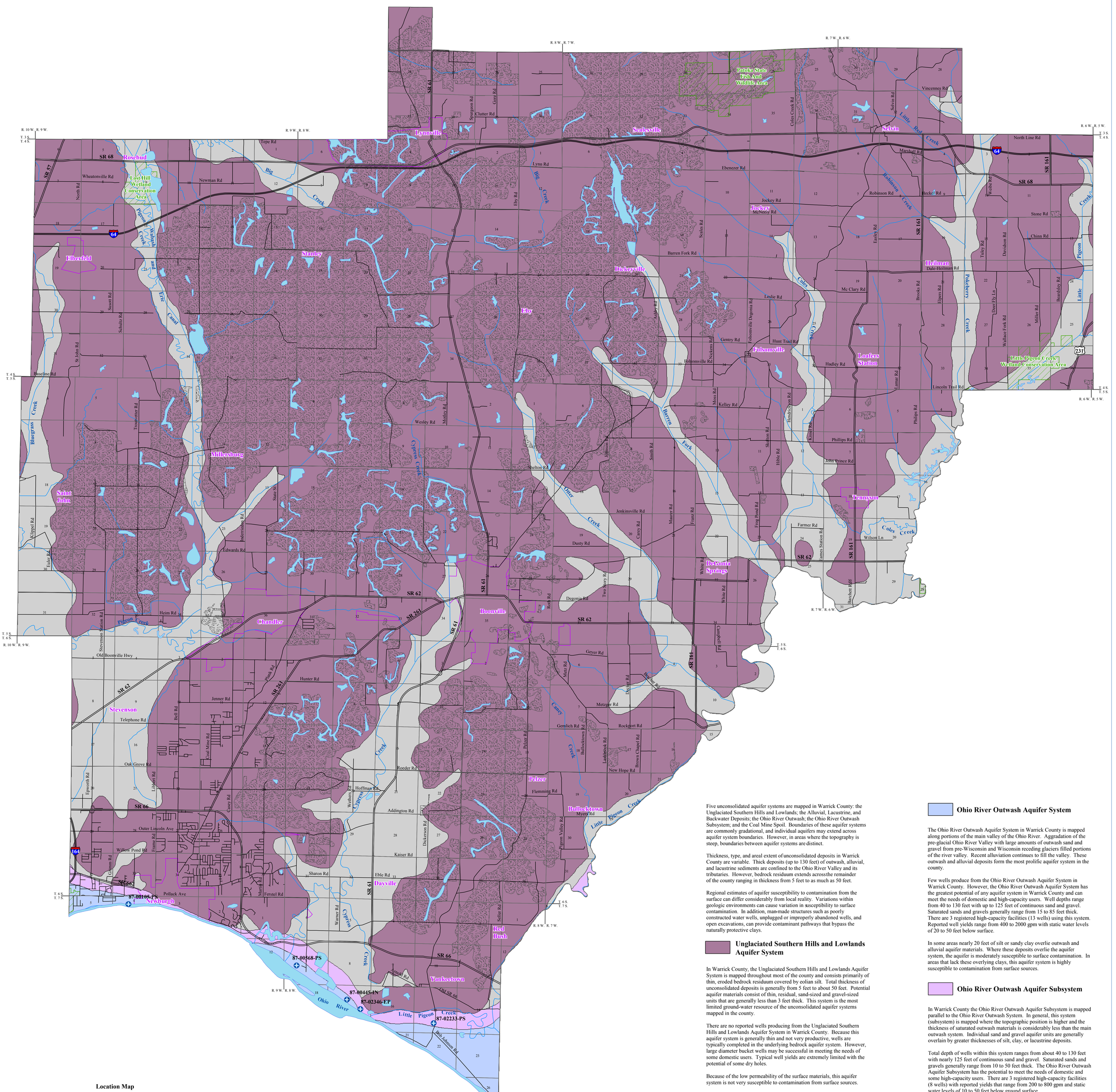
This map was created from several existing shapefiles. Underground Coal Mines in Southwestern Indiana (polygon shapefile, 20001002), Township and Range Lines of Indiana (line shapefile, 20020621), Land Survey Lines of Indiana (polygon shapefile, 20020621), and County Boundaries of Indiana (polygon shapefile, 20050621) were all from the Indiana Geological Survey and based on a 1:24,000 scale, except the Bedrock Geology of Southwestern Indiana (polygon shapefile, 20001124), which was at a 1:500,000 scale. Draft road shapefiles, System1 and System2 (line shapefiles, 2003), were from the Indiana Department of Transportation and based on a 1:24,000 scale. City Areas in Southwestern Indiana (polygon shapefile, 1999) was from ESRI and based on a 1:100,000 scale. Streams27 (line shapefile, 20000420) was from the Center for Advanced Applications in GIS at Purdue University.

Bedrock Aquifer Systems of Warrick County, Indiana

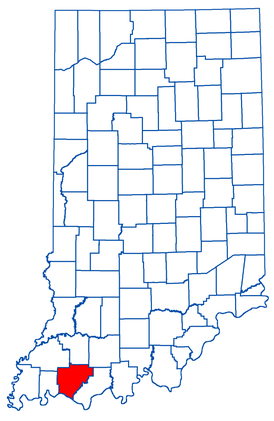
by
Randal D. Maier
Division of Water, Resource Assessment Section

May 2006

UNCONSOLIDATED AQUIFER SYSTEMS OF WARRICK COUNTY, INDIANA



Location Map



1 0.5 0 1 Mile

1 0.5 0 1 Kilometer

EXPLANATION

- Registered Significant Ground-water Withdraw Facility
- Stream
- County Road
- State Road & US Highway
- Interstate
- Municipal Boundary
- State Managed Property
- Lake & River

Five unconsolidated aquifer systems are mapped in Warrick County: the Unglaciated Southern Hills and Lowlands; the Alluvial, Lacustrine, and Backwater Deposits; the Ohio River Outwash; the Ohio River Outwash Subsystem; and the Coal Mine Spoil. Boundaries of these aquifer systems are commonly gradational, and individual aquifers may extend across aquifer system boundaries. However, in areas where the topography is steep, boundaries between aquifer systems are distinct.

Thickness, type, and areal extent of unconsolidated deposits in Warrick County are variable. Thick deposits (up to 130 feet) of outwash, alluvial, and lacustrine sediments are confined to the Ohio River Valley and its tributaries. However, bedrock residuum extends acrossthe remainder of the county ranging in thickness from 5 feet to as much as 50 feet.

Regional estimates of aquifer susceptibility to contamination from the surface can differ considerably from local reality. Variations within geologic environments can cause variation in susceptibility to surface contamination. In addition, man-made structures such as poorly constructed water wells, unplugged or improperly abandoned wells, and open excavations, can provide contaminant pathways that bypass the naturally protective clays.

Unglaciated Southern Hills and Lowlands Aquifer System

In Warrick County, the Unglaciated Southern Hills and Lowlands Aquifer System is mapped throughout most of the county and consists primarily of thin, eroded bedrock residuum covered by eolian silt. Total thickness of unconsolidated deposits is generally from 5 feet to about 50 feet. Potential aquifer materials consist of thin, residual, sand-sized and gravel-sized units that are generally less than 3 feet thick. This system is the most limited ground-water resource of the unconsolidated aquifer systems mapped in the county.

There are no reported wells producing from the Unglaciated Southern Hills and Lowlands Aquifer System in Warrick County. Because this aquifer system is generally thin and not very productive, wells are typically completed in the underlying bedrock aquifer system. However, large diameter bucket wells may be successful in meeting the needs of some domestic users. Typical well yields are extremely limited with the potential of some dry holes.

Because of the low permeability of the surface materials, this aquifer system is not very susceptible to contamination from surface sources.

Alluvial, Lacustrine, and Backwater Deposits Aquifer System

The Alluvial, Lacustrine, and Backwater Deposits Aquifer System in Warrick County is mapped extensively along several north-south trending tributaries of the Ohio River and along portions of the Ohio River floodplain. This system consists of deposits that come from two primary sources. The first is alluvium deposited by streams along with colluvium eroded from valley walls and upland areas. The second is from pre-Wisconsin and Wisconsin age fine-grained glaciolacustrine deposits formed in relatively static lake water. Typical materials include fine sand, silt, and clay deposits that are generally greater than 25 feet thick. Aquifer materials commonly include thin sand seams that are generally less than a few feet thick.

This system is a limited resource and few wells produce from these deposits in Warrick County. Because this aquifer system is generally not very productive, wells are typically completed in the underlying bedrock. However, a few wells are adequate to meet the needs of some domestic users. Total well depths range from 20 to 90 feet with aquifer materials commonly less than 3 feet in thickness. Yields are generally less than 5 gallons per minute (gpm) with static water levels 10 to 40 feet below surface. However, several coal mine dewatering wells along Bluegrass Creek indicate potential yields ranging from 5 to 75 gpm.

Thick deposits of silt and clay that have a low susceptibility to surface contamination generally mark this aquifer system. The susceptibility is greater in areas where the surficial silt and clay deposits are thin and directly overlie sand deposits.

Ohio River Outwash Aquifer System

The Ohio River Outwash Aquifer System in Warrick County is mapped along portions of the main valley of the Ohio River. Aggradation of the pre-glacial Ohio River Valley with large amounts of outwash sand and gravel from pre-Wisconsin and Wisconsin receding glaciers filled portions of the river valley. Recent alluviation continues to fill the valley. These outwash and alluvial deposits form the most prolific aquifer system in the county.

Few wells produce from the Ohio River Outwash Aquifer System in Warrick County. However, the Ohio River Outwash Aquifer System has the greatest potential of any aquifer system in Warrick County and can meet the needs of domestic and high-capacity users. Well depths range from 40 to 130 feet with up to 125 feet of continuous sand and gravel. Saturated sands and gravels generally range from 15 to 85 feet thick. There are 3 registered high-capacity facilities (13 wells) using this system. Reported well yields range from 400 to 2000 gpm with static water levels of 20 to 50 feet below surface.

In some areas nearly 20 feet of silt or sandy clay overlie outwash and alluvial aquifer materials. Where these deposits overlie the aquifer system, the aquifer is moderately susceptible to surface contamination. In areas that lack these overlying clays, this aquifer system is highly susceptible to contamination from surface sources.

Ohio River Outwash Aquifer Subsystem

In Warrick County the Ohio River Outwash Aquifer Subsystem is mapped parallel to the Ohio River Outwash System. In general, this system (subsystem) is mapped where the topographic position is higher and the thickness of saturated outwash materials is considerably less than the main outwash system. Individual sand and gravel aquifer units are generally overlain by greater thicknesses of silt, clay, or lacustrine deposits.

Total depth of wells within this system ranges from about 40 to 130 feet with nearly 125 feet of continuous sand and gravel. Saturated sands and gravels generally range from 10 to 50 feet thick. The Ohio River Outwash Aquifer Subsystem has the potential to meet the needs of domestic and some high-capacity users. There are 3 registered high-capacity facilities (8 wells) with reported yields that range from 200 to 800 gpm and static water levels of 10 to 50 feet below ground surface.

In some areas 10 to 50 feet of silt, clay, or sandy clay overlie outwash and alluvial aquifer materials. Areas within this aquifer system that have overlying clay or silt deposits are moderately susceptible to surface contamination; whereas, areas that lack overlying clay or silt deposits are highly susceptible to contamination.

Coal Mine Spoil Aquifer System

The Coal Mine Spoil Aquifer System includes several large areas of central and western Warrick County. This aquifer system is formed through the process of mining coal by surface-mining methods. Typically, overburden is broken up by blasting and moved aside to uncover the desired coal seam. These deposits, therefore, became a heterogeneous mixture that can contain considerable amounts of water.

In Warrick County, one test well reports a yield of 20 gpm and two discontinued dewatering wells report yields of 300 gpm each from the Coal Mine Spoil Aquifer System.

In general, it is expected that older spoil areas are not graded and capped with compacted soil and are highly susceptible to surface contamination, whereas new spoil areas benefiting from modern reclamation methods are likely to be moderately susceptible. The general quality of ground water in this system is probably less desirable than before mining took place.

Map generated by Joseph L. Phillips, Jennifer K. McMillan, and Adam B. Watts
IDNR, Division of Water, Resource Assessment Section

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Unconsolidated Aquifer Systems of Warrick County, Indiana

by
Randal D. Maier
Division of Water, Resource Assessment Section

May 2006

Warrick County