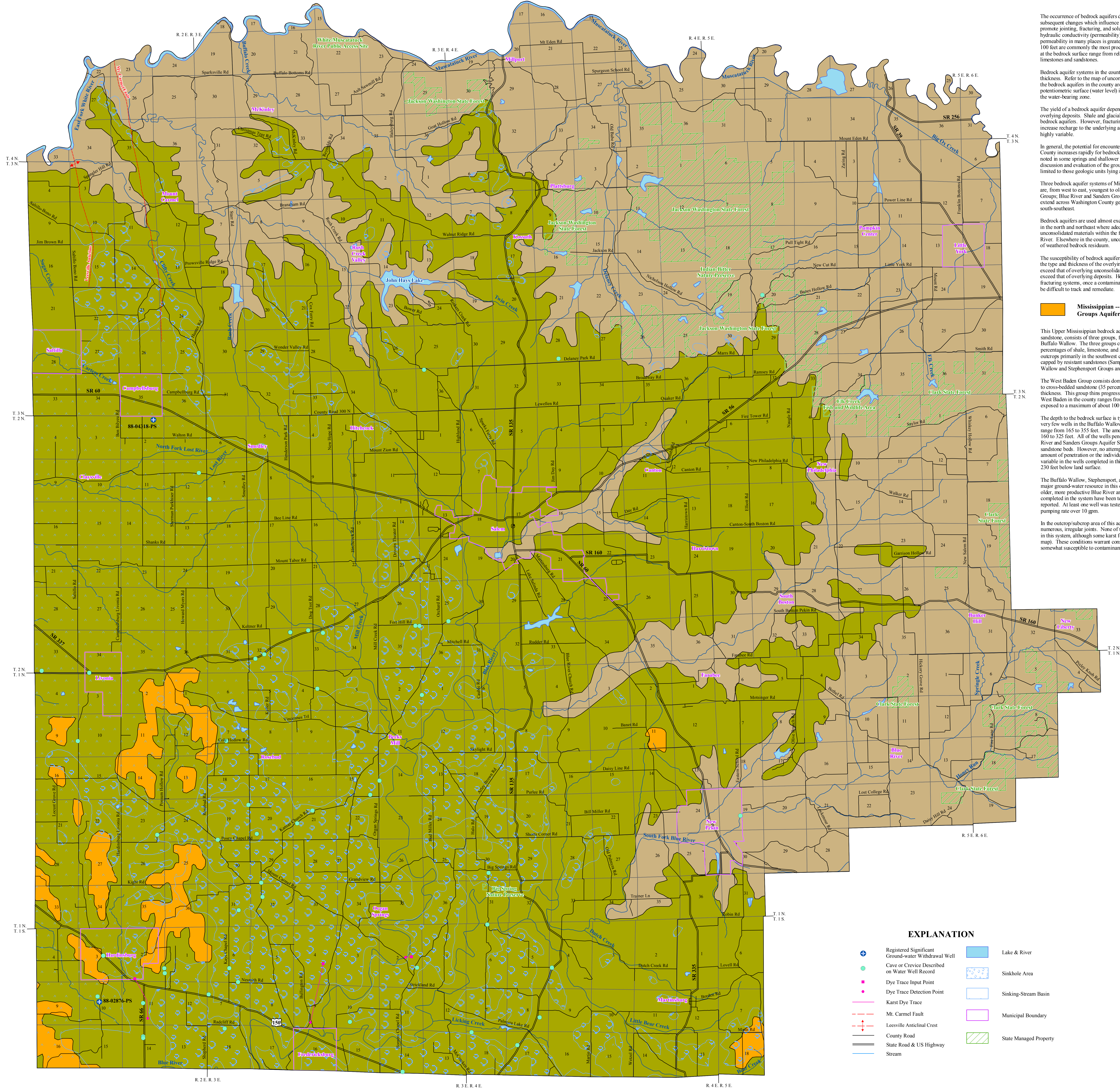


# BEDROCK AQUIFER SYSTEMS OF WASHINGTON COUNTY, INDIANA



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. In Washington County, rock types exposed at the bedrock surface range from relatively unproductive shales to moderately productive limestones and sandstones.

Bedrock aquifer systems in the county are overlain by unconsolidated deposits of varying thickness. Refer to the map of unconsolidated aquifer systems for more information. 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 zone.

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

In general, the potential for encountering mineralized or saline ground water in Washington County increases rapidly for bedrock wells deeper than a few hundred feet. Mineralized water is noted in some springs and shallow wells, particularly in low-lying areas. Therefore, the discussion and evaluation of the ground-water potential of the bedrock aquifers is essentially limited to those geologic units lying above the expected limits of nonpotable water.

Three bedrock aquifer systems of Mississippian age are identified for Washington County. They are, from west to east, youngest to oldest: Buffalo Wallow, Stephensport, and West Baden Groups, Blue River and Sanders Groups, and Borden Group. The bedrock aquifer systems extend across Washington County generally as a series of bands trending north-south to south-southeast.

Bedrock aquifers are used almost exclusively in Washington County. One exception is an area in the north and northeast where aquiferous ground water is generally available from shallower unconsolidated materials within the floodplains of the East Fork White River and Muscatatuck River. Elsewhere in the county, unconsolidated materials are relatively thin, primarily consisting of weathered bedrock residuum.

The susceptibility of bedrock aquifer systems to surface contamination is largely dependent on the type and thickness of the overlying sediments. Just as recharge for bedrock aquifers cannot exceed that of overlying unconsolidated deposits, susceptibility to surface contamination will not exceed that of overlying deposits. However, 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.

**Mississippian – Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System**

This Upper Mississippian bedrock aquifer system, composed primarily of shale, limestone, and sandstone, consists of three groups, from oldest to youngest: West Baden, Stephensport, and Buffalo Wallow. The three groups comprising this bedrock aquifer system differ in their percentages of shale, limestone, and sandstone. In Washington County this aquifer system outcrops primarily in the southwest corner of the county, where many of the ridge tops are capped by resistant sandstones (Sample Formations) of the West Baden Group. The Buffalo Wallow and Stephensport Groups are not present in the county.

The West Baden Group consists dominantly of shale and mudstone (40 percent) and thin-bedded to cross-bedded sandstone (55 percent); however, it has limestone beds (25 percent) of variable thickness. This group thins progressively eastward in Washington County. The thickness of the West Baden in the county ranges from 0 feet where the older Blue River Group rocks are exposed to a maximum of about 100 feet in the western part of the county.

The depth to the bedrock surface is typically less than 20 feet on the uplands. Well depths of the very few wells in the Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System range from 165 to 355 feet. The amount of rock penetrated by a well typically ranges from about 160 to 325 feet. All of the wells penetrate through this aquifer system into the underlying Blue River and Sanders Groups Aquifer System. Most of the water will be found in the limestone and sandstone beds. However, no attempt has been made in this report to correlate yields with the amount of penetration of the individual geologic formations used. Static water levels are highly variable in the wells completed in this aquifer system. Reported water levels range from 40 to 230 feet below land surface.

The Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System is not regarded as a major ground-water resource in this county, thus most drillers prefer to finish the wells in the older, more productive Blue River and Sanders Groups Aquifer System. Most domestic wells completed in the system have been tested between 0 and 10 gpm and a few dry holes have been reported. At least one well was tested as high as 25 gpm. However, very few wells can sustain a pumping rate over 10 gpm.

In the outcrop/subcrop area of this aquifer system the rock is predominantly shallow and contains numerous, irregular joints. None of the very few water well records describes caves or crevices in the system, although some karst features (sinkholes) are noted on topographic maps (see map). These conditions warrant considering the aquifer system in Washington County to be somewhat susceptible to contaminants introduced at and near land surface.

**Mississippian – Blue River and Sanders Groups Aquifer System**

This Middle Mississippian age aquifer system outcrops primarily in the western two-thirds of the county. The older Sanders group is exposed roughly in a diagonal from the northwest corner to the southeast corner of Washington County and its sandstone and limestone walls of the southern portion of Blue River and its larger tributaries. The Sanders Group consists in ascending order of the Harrodsburg and Salem limestone formations. These are primarily limestone but contain some dolomite. The Blue River Group includes in ascending order the St. Louis, Ste. Genevieve, and Paoli limestone formations. These formations are primarily limestone, but they may contain significant amounts of gypsum, anhydrite, shale, chert, and calcarenite. The Blue River Group outcrops/subcrops primarily on the plateaus and lowland of the western portion of the county and generally on the uplands further east.

The combined thickness of the Blue River and Sanders Groups ranges from 0 feet where they are eroded in the eastern third of Washington County, to over 400 feet in the southwestern part of the county. The formations thicken as they dip to the west-southwest. Limestones within the Blue River Group are especially noted for development of karst features on the land surface where the bedrock is quite shallow. Some of the karst features in the county include caves, sinkholes, collapsed sinkholes, sinking streams, stream rises, and springs. These features are produced by the action of ground water dissolving the limestone, primarily along planes or zones of weakness. Weak zones include vertical or nearly vertical joints, nearly horizontal bedding planes between limestone units, and zones within the formations that are more easily dissolved. Most of the permeability is a measure of the ability of the rock to transmit water; these limestones result from the joints that developed after the rock was formed and their subsequent entanglement by the dissolving action of water.

Some well records describe cavities or solution channels up to 15 feet in height (see map for location of these wells). Not surprisingly, the yields of wells tapping this aquifer system are quite variable. Yields should vary roughly in proportion to the number, size, depth, and degree of interconnection of joints and solution channels. However, the effects of these variables at any specific location cannot be predicted with any degree of accuracy. Where the rock is overlain by sand and gravel, or broken limestone such as in a river valley or on the uplands of the central portion of the county (Mitchell Plateau), somewhat higher sustained yields are believed possible. The Division has records for over 600 wells in this aquifer system. The depth to the top of solid bedrock is typically between 20 and 60 feet on the uplands of the central portion of the county (Mitchell Plateau), but may be as much as 80 feet where broken limestone and clay are eroded due to extensive weathering and/or karstification. In this area, sand and gravel seams up to 5 feet thick may be present in the valley bottoms of Lost River and/or Blue River. Additionally, isolated thin sand and gravel seams may be present in the carwash terraces along the major forks of Blue River, particularly the South Fork Blue River. However, these terraces are unlikely to have much saturated thickness. Well depths range from about 25 to 325 feet, with most wells completed at depths of about 85 to 150 feet. Reported test rates for water wells vary between 0 and 200 gpm. The registered significant ground-water withdrawal facilities with wells completed in this system are reported to have pumping capacities ranging from 50 to 120 gpm. Most domestic wells completed in the system have been tested between 1 and 20 gpm and a few isolated dry holes have been reported. Reported water levels range from 0 to 225 feet below land surface, but are typically between 30 and 80 feet.

In Washington County, the Blue River and Sanders Groups Aquifer System is considered a very dependable ground-water source. Water quality is generally good, except for several wells reporting a sulfur odor, which may be due to chemical reactions associated with gypsum deposits in the Blue River Group. Because the rock is generally quite shallow, and contains numerous fractures, open joints, and solution channels, the aquifer system is considered very susceptible to contamination from the land surface.

**Mississippian – Borden Group Aquifer System**

The outcrop/subcrop area of the Mississippian age Borden Group Aquifer System includes the eastern third of Washington County, especially the valleys of East Fork White River, Muscatatuck River, and their tributaries. This bedrock aquifer system is composed mostly of siltstone and shale, but fine-grained sandstones are common. Carbonates are rare, but do occur as discontinuous interbedded limestone lenses, mostly in the upper portion of the group.

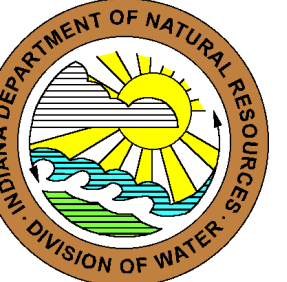
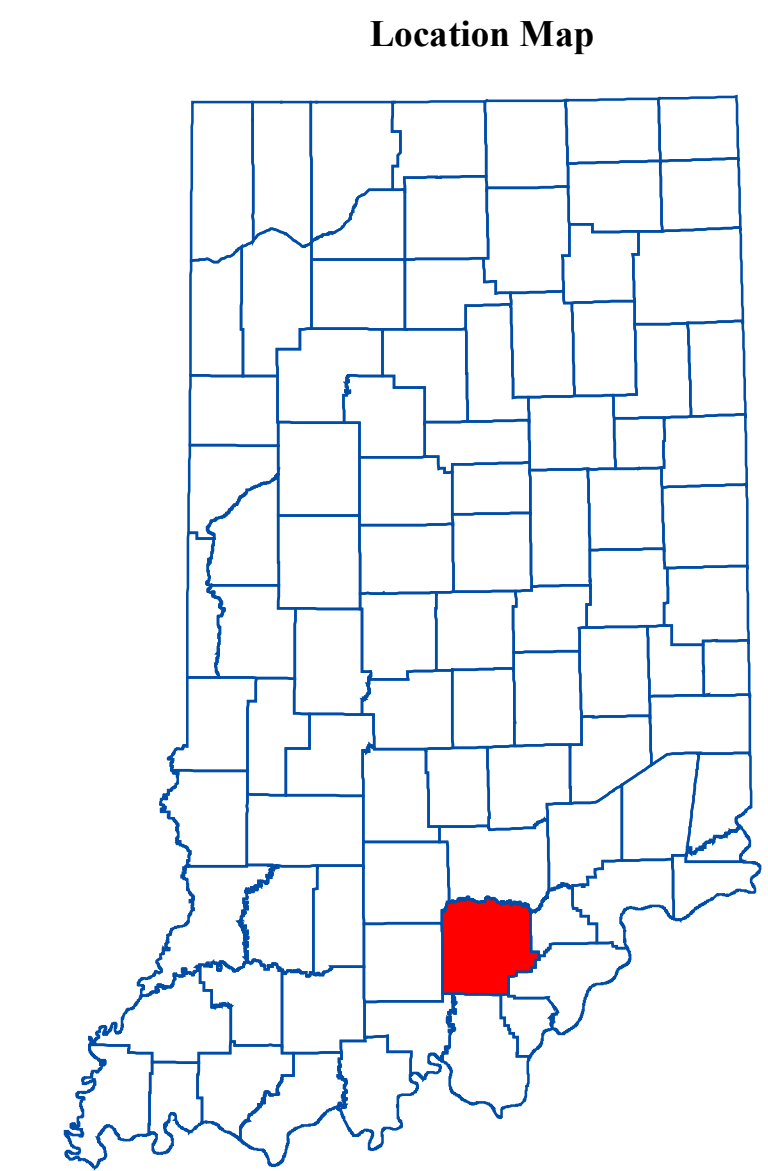
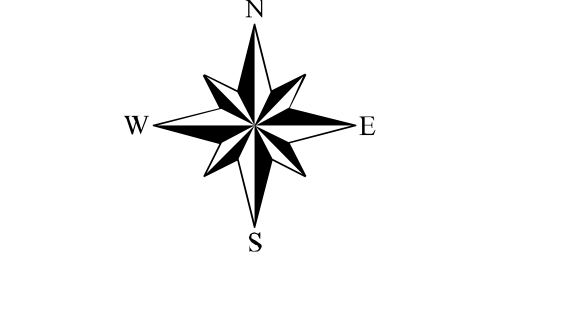
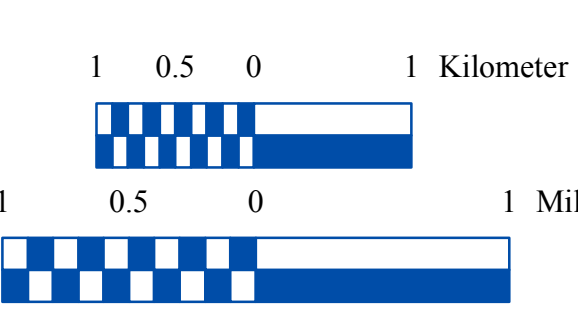
The Borden Group in Washington County is up to 600 feet thick. Well depths in the Borden Group Aquifer System range from 20 to 220 feet. However, most wells are completed at depths of 90 to 100 feet. Reported static water levels in the wells completed in this aquifer system range from 0 to 80 feet below land surface, but are commonly between 15 and 40 feet.

Because the Borden Group is generally not very productive, it is typically used only where overlying deposits do not contain an aquifer. The Borden Group is often described as an aquifer and yields of wells completed in it are usually quite limited. Many wells, however, are able to produce sufficient water for domestic purposes by relying on extra well-bore storage created by drilling relatively large diameter and relatively deep wells. Most domestic wells completed in the group have reported test rates of less than 5 gpm and many dry holes have been reported. A few wells have been tested at rates greater than 50 gpm in the New Pekin area along the South Fork Blue River. The higher capacity wells likely occur along significant bedrock fractures. Overlying alluvium in the river valley may help recharge the fractures. However, it is doubtful that many wells could sustain high pumping rates for very long. There have been several dry holes reported within a few hundred feet of these higher capacity wells. Overall, there is little chance for development of high-capacity wells in the Borden Group Aquifer System in Washington County.

The Borden Group is composed primarily of fine-grained materials that limit the movement of ground water to fractures, joints, and along the bedrock surface. This, along with the overlying, typically fine-grained clay materials, puts most of the Borden Group Aquifer System at low risk to contamination from the surface or near surface. However, in areas where coarse-grained alluvium overlies the fractured and jointed rock, there is a high risk of contamination from surface or near-surface sources.

### EXPLANATION

- Registered Significant Ground-water Withdrawal Well
- Cave or Crevice Described on Water Well Record
- Dye Trace Input Point
- Dye Trace Detection Point
- Karst Dye Trace
- Mt. Carmel Fault
- Leesville Anticline Crest
- County Road
- State Road & US Highway
- Stream
- Lake & River
- Sinkhole Area
- Sinking-Stream Basin
- Municipal Boundary
- State Managed Property



### Map Use and Disclaimer Statement

We request that the following agency be acknowledged in products derived from this map: Indiana Department of Natural Resources, Division of Water. This map was compiled by staff of the Indiana Department of Natural Resources, Division of Water using data believed to be reasonably accurate. However, a degree of error is inherent in all maps. This product is distributed "as is" without warranty of any kind, either expressed or implied. This map is intended for use only at the published scale.

This map was created from several existing shapefiles. Township and Range Lines of Indiana (line shapefile, 20020621), Land Survey Lines of Indiana (polygon shapefile, 20020621), Selected Subsurface Dye Traces in Parts of Southern Indiana (line shapefile, 20000225), Input and Detection Points for Selected Subsurface Dye Traces in Parts of Southern Indiana (point shapefile, 20001124) and County Boundaries of Indiana (polygon shapefile, 20020621), were all from the Indiana Geological Survey and based on a 1:24,000 scale, except the Bedrock Geology of Indiana (polygon shapefile, 20020118), 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. Populated Areas in Indiana 2000 (polygon shapefile, 20021000) was from the U.S. Census Bureau and based on a 1:100,000 scale. Structural Features of Indiana (line shapefile, 20020718) was from the Indiana Geological Survey and based on various scales. Stream27 (line shapefile, 20000420) was from the Center for Advanced Applications in GIS at Purdue University. Managed Areas 96 (polygon shapefile, various dates) was from DNR. Sinkhole Areas and Sinking-Stream Basins in Part of Southern Indiana (polygon shapefile, 20001124) were also from the Indiana Geological Survey, but based on a 1:126,720 scale.

### Bedrock Aquifer Systems of Washington County, Indiana

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