

Bedrock Aquifer Systems of Crawford County, Indiana

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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 Crawford 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 for 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 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.

In general, the potential for encountering mineralized or saline ground water in Crawford County increases rapidly for bedrock wells deeper than about 300 feet. Mineralized water is noted in some springs and shallower 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 are identified for Crawford County based on bedrock lithology. They are, from west to east, youngest to oldest: Raccoon Creek Group of Pennsylvanian age; Buffalo Wallow, Stephensport, and West Baden Groups of Mississippian age; and Blue River and Sanders Groups of Mississippian age.

The bedrock aquifer systems extend across Crawford County generally as a series of bands trending north-northwest to south-southeast. In the county, the Mississippian age bedrock was truncated by thousands of years of erosion. Subsequent burial of the erosion surface by sediments during Pennsylvanian time created one of the most widespread

regional unconformities in the world, the Mississippian-Pennsylvanian unconformity. Younger Pennsylvanian age rocks overlap onto progressively older Mississippian age rocks at increasing distances north of the Ohio River.

Bedrock aquifers are used much more than unconsolidated aquifers in most of the county. This is because unconsolidated materials are typically very thin, primarily consisting of weathered bedrock residuum. The exception is the Ohio River valley, where thick deposits of sand and gravel provide abundant ground water.

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.

Pennsylvanian -- Raccoon Creek Group Aquifer System

Aquifers contained within the Pennsylvanian age bedrock have generally low yield potential. However, their value is most significant to the homes and farms using these sources. In general, well depths are greater in the Pennsylvanian rocks than in other aquifer systems in the state, and depths over 200 feet are common. Well casing diameters are usually six inches or greater, indicating the low yield capabilities of these aquifers. Because of the low permeability of the bedrock, the abundance of shale confining zones both above and below aquifer systems, and the limitation in available drawdown, it is seldom possible to divert large volumes of water into any particular pumping center.

The outcrop/subcrop area of the Raccoon Creek Group covers most of the uplands of western Crawford County. The group consists in ascending order of the Mansfield, Brazil, and Staunton Formations. The Staunton Formation and the Brazil Formation are not present in the county. The Mansfield Formation rests unconformably on rocks of late Mississippian age. This erosional contact surface is quite irregular in elevation, resulting in quite variable thickness of Mansfield rocks.

Total thickness of the group in the county ranges from 0 where the younger Mississippian rocks are exposed in the eastern half of the county to about 260 feet on ridge tops in western Crawford County. Shale and sandstone compose approximately 95 percent of the group. Clay, coal, and limestone make up nearly all the rest. Shale is more common than sandstone and it is usually light gray to dark gray in color. The shale may be soft and non-silty, hard and silty, or sandy. The sandstone is mostly fine grained. Where the sandstone is present in the subsurface, it is commonly massive and cross-bedded. Coal beds are typically quite thin, but could be as thick as 5 feet in some areas. Clay beds from 1 to 10 feet thick underlie coal seams. A limestone bed up to 3 feet thick may be present in isolated areas. The lowermost part of the Mansfield commonly contains a

large percentage of sandstone. Much of it is cross-bedded and may contain a quartz-pebble and chert conglomerate.

The depth to the bedrock surface is typically less than 20 feet. Well depths in the Raccoon Creek Group are highly variable, ranging from 32 to 485 feet. However, most are constructed at depths of 75 to 350 feet. The amount of rock penetrated by wells typically ranges from 50 to 300 feet. Several of the deeper wells penetrate through the Raccoon Creek Group Aquifer System into the underlying Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System. Reported static water levels vary from 0 (flowing) to 300 feet below the land surface, but they are commonly 25 to 125 feet below the surface.

In general, the Raccoon Creek Group is considered a dependable ground-water source in the county with many wells producing from the basal Mansfield Formation. Most domestic wells produce between 2 and 10 gallons per minute (gpm) with localized yields of up to 20 gpm. Several dry holes have been reported. Well yields for light industrial, irrigation, farm operation, or small municipal usage of up to 50 gpm may be obtained in isolated areas.

Water quality is generally good. Some water is hard and classified as a calcium-magnesium-bicarbonate type. Some is quite soft and classified as a sodium bicarbonate type. Natural water quality gets progressively worse (more salty) in wells ranging in varying depths from about 200 to 350 feet. The Raccoon Creek Group Aquifer System is not very susceptible to contamination from the land surface because of the typical presence of low-permeability strata above water-bearing zones.

The Raccoon Creek Group is bounded on the east by the Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System of Mississippian age.

Mississippian -- Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System

This Upper Mississippian bedrock aquifer system outcrops primarily in central Crawford County. It also outcrops along the lower slopes in deeper stream valleys of western Crawford County. Many rock units are laterally discontinuous and the system has been truncated northward because of pre-Pennsylvanian erosion. The present near-surface thickness and occurrence of the deposits forming this bedrock aquifer system have been altered by the Mississippian-Pennsylvanian unconformity throughout the county.

This 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.

The West Baden Group consists dominantly of shale and mudstone (40 percent) and thin-bedded to cross-bedded sandstone (35 percent); however, it has limestone beds of variable thickness (25 percent). The Stephensport Group is comprised of limestone (approximately 40 percent), shale (25 percent), and cliff-forming sandstone (35 percent). The Buffalo Wallow Group is primarily shale, mudstone, and siltstone (approximately 75 percent). It also contains prominent beds of sandstone (20 percent) and limestone (5 percent), some of which are laterally extensive. The limestone and sandstone beds, principally in the lower part of the unit, are 1 to 15 feet thick and 5 to 90 feet thick, respectively. This group thins progressively northward in Crawford County. The combined thickness of the West Baden, Stephensport, and Buffalo Wallow in the county ranges from 0 where the older Blue River Group rocks are exposed to a maximum of about 350 feet in the western part of the county where the younger Pennsylvanian rocks occur.

The depth to the bedrock surface is typically less than 20 feet on the uplands, but may be as much as 55 feet in the larger valley bottoms. Well depths in the Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System range from 21 to 423 feet, with most wells completed at depths of about 100 to 300 feet. The amount of rock penetrated by a well typically ranges from about 75 to 275 feet, with a maximum of 419 feet. Several of the deeper 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 or the individual geologic formations used. Static water levels are highly variable in the wells completed in this aquifer system. Reported water levels range from 0 feet to 252 feet below land surface, but are typically between 40 and 140 feet.

The Buffalo Wallow, Stephensport, and West Baden Groups Aquifer System is not regarded as a major ground-water resource in this county. Most domestic wells completed in the system have been tested at less than 5 gpm and several dry holes have been reported. A few wells have been tested as high as 50 gpm. However, very few wells can sustain a pumping rate over 20 gpm. Where the more porous or jointed rock units are overlain by sand and gravel, such as in a river valley, somewhat higher sustained yields may be possible.

In the outcrop/subcrop area of this aquifer system the rock is predominantly shallow and contains numerous, irregular joints. In limited areas, some karst (see Karst Features and the Dissolution of Carbonate Rocks) has developed in the limestone beds. Some water well records describe caves up to five feet high. These conditions warrant considering the aquifer system as a whole to be somewhat susceptible to contaminants introduced at and near land surface.

This aquifer system is bounded on the east by the Blue River and Sanders Groups Aquifer System of Mississippian age.

Mississippian -- Blue River and Sanders Groups Aquifer System

This Middle Mississippian age aquifer system is limited in the outcrop/subcrop to the eastern third of Crawford County, primarily in the valley bottoms of Blue River and Little Blue River and a short distance up the hillsides. The older Sanders group is not exposed in Crawford County, but is exposed about ten miles east in Harrison County. 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 calcareous sandstone.

The total thickness of the Blue River and Sanders Groups ranges from about 250 feet in northeastern Crawford County, to as much as 1050 feet in the western part of the county. The formations thicken considerably 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 sinkholes 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 (a measure of the ability of the rock to transmit water) of these limestones results from the joints that developed after the rock was formed and their subsequent enlargement by the dissolving action of water.

Some well records describe cavities or solution channels up to a few feet thick. 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 those variables at any specific location cannot be predicted with any degree of accuracy. Where the rock is overlain by sand and gravel, such as in a river valley, somewhat higher sustained yields are believed possible. The Division has records for over 130 wells in this aquifer system in the county. The depth to bedrock is typically less than 10 feet on the uplands, but may be as much as 55 feet in the larger valley bottoms and more than 100 feet in the Ohio River valley. Well depths range from about 30 to 410 feet, reported testing rates from 0 to 150 gpm, and static water levels from 1 to greater than 200 feet.

North and east of Crawford County, where more data from well records are available, the Blue River and Sanders Groups Aquifer System is considered a relatively dependable ground-water source. Water quality is generally good. However, because of the shallow rock, open joints, and solution channels, the aquifer system is very susceptible to contamination from the land surface. The natural quality of well water gets progressively more mineralized (commonly changing from a calcium-magnesium-bicarbonate type to a sodium bicarbonate or sodium chloride type) as wells are drilled deeper than about 300 feet and the rock strata dip beneath younger rocks to the southwest.

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