# Ground Water Provinces of Indiana

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Ground water supplies are found in most parts of Indiana, but owing to the diversified character of the water bearing materials, the manner of occurrence is not the same. The purpose of this report is to present for the first time a regional classification of ground water resources in Indiana based upon areas characterized by a general similarity of the principal occurrences. Such a classification is of value for comparative and descriptive purposes. The distinctive features of the water bearing formations are described for each province. The limits of each division set forth herein are based primarily upon one or more of the following conditions: (a) the extent of the important surficial water bearing formations, (b) the extent of the important bedrock water bearing formations, (c) physiographic and topographic conditions. Also, the sources of the public water supplies of over 350 cities and towns, logs of several thousand water, oil, and gas wells, information gathered from questionnaires sent to over 500 water well drillers in the state, and personal observations were used in determining the location and extent of the provinces and their subdivisions.

Ground water provinces for the United States have been delimited and described by several writers. Fuller (1, p. 35-40) described only the eastern United States. Ries and Watson (4, p. 330-337) divided the United States into 8 provinces. However, later revisions of their text book incorporated Meinzer's (3, p. 193-309) 21 provinces. Tolman (5, p. 499-555), while accepting most of Meinzer's (3, p. 193-309) classification, modified it by dividing the Pacific Coast belt into three provinces. All these classifications are based upon the presence of one important group of aquifers in a subdivision or province, or, where more than one of the principal groups of aquifers occur, on the coexistence of two or more of the most important groups as a means of delineating the province.

Indiana, under the Meinzer (3, p. 201-244, 283-291) classification, would fall into two of the provinces. The largest part of the state would lie in the North-central Drift-Paleozoic province and would encompass all of glaciated Indiana. The remainder, about one-sixth of the area of Indiana, or the unglaciated region, is included in the South-central Paleozoic province. As the names suggest, the above division was made on the basis of the ground water supplies being obtained from glacial sands and gravels or from Paleozoic sandstones and limestones.

The classification proposed herein for Indiana also divides the state

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into two main ground water provinces, but differs from the above classification on boundary and subdivides these two provinces into a total of eight sections in which similar conditions exist (Fig. 1). The provinces with their subdivisions are:

I. Northern Indiana Glacial province
   a. Lake and Moraine section
   b. Northern Till Plain section
   c. Southern Till Plain section

II. Southern Indiana Bedrock province
   a. Ordovician Limestones and Shales section
   b. Silurian and Devonian Limestones section
   c. Devonian and Mississippian Siltstone and Shales section
   d. Mississippian Limestones section
   e. Mississippian and Pennsylvanian Sandstones section

I. *Northern Indiana Glacial province.* The Northern Indiana Glacial province is in the area of the Wisconsin glaciation. In general the southern margin of the Shelbyville moraine marks the boundary between the Northern Indiana Glacial province and the Southern Indiana Bedrock province. A deviation from the Wisconsin glacial boundary is made in the southeastern part of the province, specifically in Bartholomew, Shelby, Decatur, Rush, Franklin, Fayette, and Union counties, because of the fact that here the glacial cover is thin and contains relatively little water bearing sand and gravel, and bedrock formations are more important as aquifers. Ground water supplies are derived from sands and gravels associated with glacial drift and limestones and sandstones of the Paleozoic System. The thickness of the surficial materials varies greatly, and the source of supply in a great many cases depends upon the proximity of bedrock to the surface of the ground. Flowing wells, either in glacial drift or the underlying bedrock strata, are not uncommon. The best ground water supplies are found associated with glacial outwash material such as valley trains, filled valleys, and outwash plains. Waters from bedrock formations or from glacial gravel are generally hard since the most common bedrock aquifer encountered in northern Indiana is Silurian limestone, and the glacial gravels contain a high percentage of limestone pebbles and fragments. Waters from deeper bedrock sources are usually mineralized and, consequently, are not potable.

a. *Lake and Moraine section.* The ground water region designated here as the Lake and Moraine section approximates the Northern Moraine and Lake physiographic region of Malott (2, p. 112-124). It is characterized by a thick blanket of glacial drift which generally exceeds 150 to 200 feet or more. The thickness of the drift in Steuben County is reported to exceed 500 feet. Morainic masses containing much sand and gravel are common. These sands and gravels are the sources of many local supplies of ground water but vary greatly in depth, The areas between the massive morainic masses are frequently occupied by lakes, marshes, and lacustrine plains. In these low areas water supplies

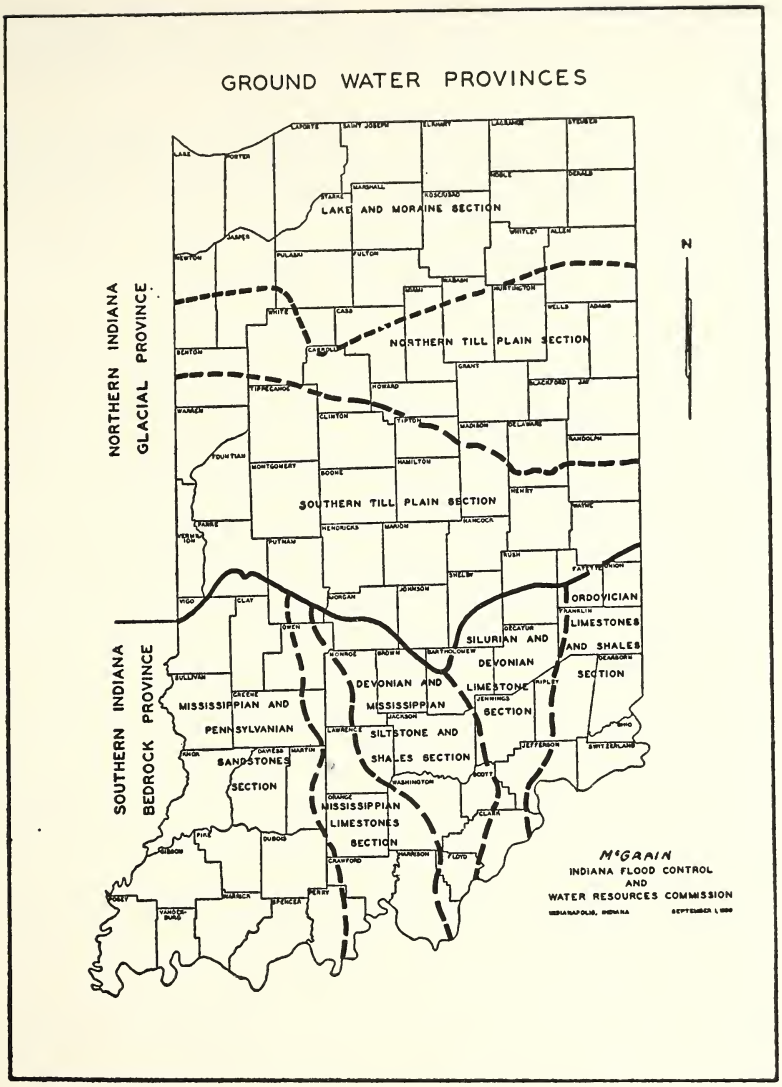


Fig. 1. Map of Indiana showing location of ground water provinces and sections.

are obtained from sands and gravels for domestic and livestock purposes at shallow depths. Great areas of sand are present along the Kankakee, Iroquois, and upper Tippecanoe valleys. Except on the sand hills water supplies are generally acquired at shallow depths from dug wells or from driven well points. Buried bedrock valleys are known to exist along the south-central portion of this area. These channels

usually contain copious quantities of water bearing sands and gravels. Glacial sluiceways and valley trains, particularly along Eel River in Whitley, Wabash, and Miami counties, are excellent sources of ground water.

Locally the glacial drift may be clay till, clay, or marl, and water supplies are difficult to locate. Good supplies of ground water are spotty in parts of Noble, Fulton, and Pulaski counties, Madison and Penn townships in St. Joseph County, and around Black Oak and East Gary in Lake County.

Hammond, East Chicago, Whiting, Gary, and Michigan City depend upon Lake Michigan for public water supplies.

b. *Northern Till Plain section.* As the name implies the Northern Till Plain section is located in the northern part of the Tipton Till Plain physiographic province of Indiana. It is differentiated from the Lake and Moraine section on the north and the Southern Till Plain section by having a relatively thin blanket of glacial drift over a dissected, limestone upland plain. Exposures of bedrock in Indiana in the region of Wisconsin glaciation are not common but are most abundant in the Northern Till Plain section, particularly along the trough-like valleys of the major streams. The section is a slightly modified ground moraine and over wide areas is monotonously flat. The glacial cover over most of the area varies in thickness from 20 to 70 feet and consists primarily of a clayey till. Small isolated pockets of sand and gravel in this till provide insignificant amounts of water for domestic and livestock purposes. The most common source of ground water in the Northern Till Plain section is from the Silurian limestone and dolomite formations which immediately underlie the glacial drift in most of the region. Where the limestone beds are thin of particularly tight the water supplies are poor. In the west central part of the section shales are sometimes found overlying the limestone sequence and have apparently prevented the recharge of the underlying beds.

Although the bedrock formations are generally not far beneath the surface of the ground in this section great local variations do occur in the thickness of the glacial drift. Thicknesses from nothing to more than 450 feet have been encountered. These variations are due primarily to the presence of a former major drainage system, the trunk stream of which was the Teays (=Kanawha). The Teays (=Kenawha) valley is a high level valley which rose in Tertiary time in the Blue Ridge Mountains in North Carolina and flowed west and northwest across Virginia, West Virginia, Ohio, Indiana, and Illinois. It is believed to have discharged into the Gulf Embayment through bedrock valleys now generally occupied by the present Illinois and Mississippi rivers. That portion of the valley in western Ohio, Indiana, and Illinois is buried beneath glacial drift and its route across this area has been traced by means of well records. In Indiana a variety of materials fill the buried channel and its tributaries. In general, however, where the tributaries of the main valley flowed in a southerly direction water bearing sands and gravels are generally present in quantities. On the

other hand where the tributaries of the main valley were north flowing, the valleys are generally filled with fine grained sediments which are poor aquifers.

c. *Southern Till Plain section.* The name Southern Till Plain section is proposed for the southern portion of the Northern Indiana Glacial province. The boundary between the Southern Till Plain section and the Northern Till Plain section is somewhat arbitrary. However, a careful analysis of the sources of public water supplies, as well as supplies in rural and suburban areas, reveal a pattern that can not be ignored. The area is a flat to gently undulating glacial plain. The trough-like valleys of the major streams and low morainic ridges provide the greatest diversity of relief. The most important sources of ground water in this region are lenses of sand and gravel in the glacial drift and outwash material along the glacial sluiceways. Excellent deposits of water bearing sand and gravel are known to exist along Wabash and White rivers, Fall Creek, and other smaller streams. The average thickness of the glacial materials over most of the area exceeds 100 feet. Maximum thickness is known to be 400 feet or more. Little is known about the character of the bedrock surface except locally. Channels and other irregularities typical of an old erosion surface have been encountered by oil and gas wells and an occasional deep test for water, but little effort has been made to date to obtain a regional picture of an older drainage system. Beds, lenses, and pockets of more or less stratified sands and gravels interbedded in the drift in an uncertain and unsystematic manner provide most of the water supplies.

Where the drift is thin or dominantly clay till, water supplies are spotty and erratic and wells must go to the bedrock formations for adequate supplies. Of the bedrock aquifers in this area, Silurian limestone formations are the most widespread and most reliable. Devonian and Mississippian limestones and the Mansfield sandstone, basal member of the Pennsylvanian in Indiana, yield ground water in the western part of the Southern Till Plain section. Bedrock formations in Fayette, southeastern Henry, and southern Wayne counties, where the section is underlaid by Ordovician formations, are poor aquifers.

II. *Southern Indiana Bedrock province.* The Southern Indiana Bedrock province occupies about 41 percent of Indiana. The boundary between this ground water province and the Northern Indiana Glacial province has already been discussed. Paleozoic limestones and sandstones and glacial outwash materials in the valleys of the larger streams are the most important aquifers. The presence of the variety of bedrock formations in the Southern Indiana Bedrock Province is the result of the structural effect of the Cincinnati Arch, the axis of which passes north-northwest from the vicinity of Cincinnati, Ohio. Strata on the western flank of this uplift dip at an average rate of 25 to 30 feet to the mile toward the synclinal basin in south-central Illinois.

Pockets of sand and gravel in Wisconsin glacial drift carry minor amounts of water and are used only locally for domestic water supplies.

The Illinoian glacial drift is generally a thin, impervious, clay till, and is relatively unimportant as a source of ground water. Also, in this province are numerous filled valleys which may be described as two general types. The first type consists of the valleys which served as discharge routes for glacial melt waters and which contain great thicknesses of water bearing sands and gravels. These valleys are used extensively for public water supplies. The Ohio, Wabash, White, and Whitewater river valleys are but a few examples. The second type consists of the valleys which were blocked by the advancing Illinoian glacier and in this ponded condition were filled largely with lacustrine deposits. Only small supplies of water can be obtained from these fine grained sediments. Bean Blossom, Bridge, McCormick's, and Mill creek valleys are examples of this latter type of filled valley.

That portion of Indiana which was not subjected to glaciation lies wholly in the Southern Indiana Bedrock province. Here ground water supplies are obtained from wells in Paleozoic limestones and sandstones, wells in alluvial sands and gravels, and from springs.

a. *Ordovician Limestones and Shales section.* The Ordovician Limestones and Shales ground water section lies almost wholly within the Dearborn Upland physiographic province. The area is characterized by being the main outcrop area of the Ordovician formations in Indiana. The Ordovician strata are in aggregate about half shales of non-resistant character to weathering, the remainder being rather resistant limestones of a flaggy nature intercalated with the soft shales. These bedrock formations are impervious to downward percolation of meteoric water and can not be considered as potential aquifers for anything except very meager supplies. Waters in the deeper formations are generally mineralized and are not potable.

The entire Ordovician Limestones and Shales section has been subjected to glaciation. In the extreme northern part of the region small quantities of water for domestic or livestock purposes are locally obtained from lenses or pockets of gravel and sand in the Wisconsin drift. The Illinoian drift is thin, varying in thickness from an average of 30 or 40 feet on the north to only a few feet on the south. The Illinoian drift is dominantly till and the water supplies from it are not large.

Some of the valleys, particularly those of the Ohio and Whitewater rivers, were glacial sluiceways and are deeply filled with water bearing sands and gravels. Public water supplies of many communities located along these streams come from these aquifers.

b. *Silurian and Devonian Limestones section.* The Silurian and Devonian Limestones ground water section is that area in southern Indiana in which these geological formations are exposed at the surface of the ground or are but a short distance beneath the surface. These strata are both limestones and dolomites and are the principal aquifers in the region. These formations, where encountered beneath the glacial drift, are reliable aquifers for most domestic and livestock purposes and

for some of the smaller public and industrial uses, but they are generally hard. Water is found in the upper part of the rock strata. Some of the larger cities in the region have had some difficulty in obtaining a sufficient supply from these aquifers to meet the increasing demand for water. Deeply entrenched streams in this region have permitted water in the limestone and dolomite formations to drain away in many cases, thus increasing the difficulty in securing ground water supplies. Springs are frequently found along the steeper slopes but none of these supplies are known to be very large.

Glacial deposits are of sufficient thickness in the northern half of the Silurian and Devonian Limestones section to have water in sand and gravel lenses. These supplies are usually limited to domestic and livestock uses. The Ohio River valley, parts of Muscatatuck River valley and the valleys of some of the other streams have alluvial and fluvio-glacial deposits of sufficient thickness to be important locally.

c. *Devonian and Mississippian Siltstone and Shales section.* The Devonian and Mississippian Siltstone and Shales section is in the main area of outcrop of the Borden Group (Lower Mississippian in age) and the New Albany shale (which has been recognized as both Mississippian and Upper Devonian) of Indiana. The section is characterized by the general absence of ground water supplies throughout the region. The bedrock strata lack both porosity and permeability, lithologic features which are requisite for a good aquifer. A few springs are present in the area but these are relatively unimportant. Silurian and Ordovician water bearing formations which underlie this area at depth generally carry mineralized waters and are not potable.

The most important aquifers are alluvial and fluvio-glacial sands and gravels which are found along the major streams. The valleys of Ohio, White, and Muscatatuck rivers contain copious quantities of water bearing sand and gravel.

Illinoian glacial drift was deposited on an old erosion surface over much of this area. At the present time the drift deposits are thin or absent over large areas. Where the drift is of sufficient thickness, supplies of ground water may be obtained from lenses and pockets of sand and gravel interbedded in the till. These waters are only of local importance and are not known to be adequate for public supplies of any of the larger cities in the section.

d. *Mississippian Limestones section.* The Mississippian Limestones ground water section is in the area of outcrop of the limestone formations in the middle and upper parts of the Mississippian sequence. Most of the area is unglaciated. The several limestone formations which are exposed in this section are the main aquifers. The area characteristically is a karst region with many springs and caves and hundreds of thousands of sinkholes. The cavernous condition of these limestone formations permit water to drain away and shallow wells are frequently difficult to obtain. By the same token there is an excellent chance for surface pollution at shallow depths. Water in the limestone is usually

found associated with bedding planes, joints, and other fractures. Occasionally cavities are penetrated which yield an abundant supply of water. The contact between the St. Louis and Salem limestones and the contact between the Harrodsburg and Edwardsville (upper formation of the Borden Group) are usually reliable horizons for securing water supplies. In the western part of this area wells in the Mississippian limestones may yield mineral waters such as those found in the French Lick and West Baden area. Waters encountered below the Mississippian limestones in this section are almost certain to be mineralized.

Natural springs are abundant in the Mississippian Limestones section. They are associated with almost every limestone formation in the area. All of the large springs are outlets of subterranean solution channels, and often serve as the mouths of caves. These waters may come from a short or very long distance and a continued flow through all seasons is dependent upon the size of the gathering area. During most of the year waters discharging from these springs are clear but following heavy rains they yield great volumes of unfiltered, muddy storm waters. In the outcrop area of the Chester (Upper Mississippian) formations the Beech Creek limestone is an important spring horizon, and is characterized by hundreds of springs of excellent water. None of the springs, however, are of large size, being on the order of 10,000 gallons daily.

Only the extreme northern part of the Mississippian Limestones ground water section has been subjected to glaciation. This area is so small that water supply from glacial sands and gravels constitute a very minor part of the ground water resources of the section.

Alluvial deposits in the valleys of the major streams and fluvioglacial fill in the Ohio River valley are water bearing but have not been developed to any extent in the section.

e. *Mississippian and Pennsylvanian Sandstones section.* The Mississippian and Pennsylvanian Sandstones ground water section lies in the southwestern part of Indiana and includes the outcrop area of the coal producing formations and that part of the Chester outcrop area where the main Chester sandstones are buried beneath the surface of the ground. The section is characterized by the fact that sandstone formations are the most widespread aquifers in the area. This is the only ground water section in the state where sandstone aquifers are widespread or used extensively. Although the section is characterized by them, these formations are not always reliable aquifers. Locally any one of the Mississippian or Pennsylvanian sandstones yields a pretty good supply of water, but a particular formation can not be considered dependable, as many of the standstones are known to become shaley or entirely shale down dip from the outcrop. Even the well known Mansfield formation experiences facies changes within very short distances and can not be relied upon to be water bearing everywhere that it may be tested. Waters are also found in joints and fractures of coal formations, but these are generally insignificant. The public water supply for Jasonville in northwestern Greene County is reportedly from a well 10

inches in diameter, 90 feet deep, which penetrates an abandoned coal mine workings of several hundred acres, in which an adequate supply of water is impounded. This water, like all water associated with coal in Indiana, is mineralized; it is potable but not particularly palatable. Where any of the sandstone formations are deeply buried, generally 400 feet or more, the waters can be expected to be saline or otherwise mineralized and not potable. Pennsylvanian limestone formations are not of sufficient thickness to be of any significance for ground water.

The best aquifers in the Mississippian and Pennsylvanian Sandstones section are the sands and gravels associated with the deeply filled valleys of the Ohio, Wabash, White, and Eel rivers.

Many of the tributary streams in this section were blocked by glacial meltwaters flowing down the trunk streams as well as the ice front itself and, as a result, became filled with silts and other fine grained sediments. Occasionally sufficient water bearing sands and gravels are present in the tributary valleys to provide limited supplies of water. Some of these latter valleys are used as sources of public water supplies, even though they are located some distance from the cities they serve.

The Illinoian glacial drift, like that in other parts of the Southern Indiana Bedrock province, is dominantly till. Water supplies associated with pockets or lenses of sand and gravel in the till are of local importance only.

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