Ground Water Resources of Henry County, Indiana

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Introduction

Purpose and Scope. A study of water problems in headwater areas in Indiana led to the study of ground water resources of Henry County. This county derives almost all its water from precipitation which falls within its borders, and ground water is used almost to the exclusion of surface water supplies for municipal, industrial, domestic, and livestock purposes. It is the purpose of this paper to present the results of the survey of these ground water resources.

The present report is preliminary in scope. Field investigations of the ground water resources and geological features of the county were made in the fall of 1947. Heretofore little attention has been given to the geology of Henry County. Since there is a direct relationship between the character of rock formations and the presence of ground water a study of the thickness and important lithologic characteristics of each formation was imperative. The geology of the county as well as an account of the sub-surface water supplies is discussed herein.

Location. Henry County is located in east-central Indiana, approximately half way between Indianapolis and the Indiana-Ohio state boundary. Its length from north to south is 20.0 miles and its width is 19.5 miles. It covers an area of 389.4 square miles according to planimetric calculations. Henry County is bounded on the north by Delaware County, on the east by Randolph and Wayne counties, on the south by Fayette and Rush counties, and on the west by Hancock and Madison counties. New Castle, the county seat, is located approximately in the geographic center of the county, at the longitude of 85 degrees 20 minutes west and latitude of 39 degrees 56 minutes north.

U. S. Highways 35, 36, and 40, and Indiana Highways 3, 38, 103, 109, 234, and 236, all hard surfaced roads cross the county. There are numerous other roads of various degrees of improvement.

The Pennsylvania, New York Central, Nickel Plate, and Chesapeake and Ohio railroads also serve Henry County.

Acknowledgements. In addition to the information collected in the field, numerous persons and publications were consulted for data incorporated in this report. Publications referred to are listed in the bibliography. Many well records and much general information was

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secured from active and retired well drillers in the area. Well owners throughout the county and several county officials contributed much information regarding water conditions in specific areas. This report would not have been possible without the cooperation of all these people.

Physiography

Topography. Physiographically, Henry County lies entirely in the Tipton Till Plain. The Tipton Till Plain, which merges imperceptibly on the south with the Muscatatuck Regional Slope, is characteristically a slightly modified glacial ground moraine plain and over wide areas is monotonously flat. The chief inherent irregularities of the plain are the terminal moraines and their associated features. These are features of glacial construction superimposed on the till plain. Only where the till plain is marked by terminal moraines and where it is cut by trough-like valleys of the main streams does it exhibit a diversified topography. Bedrock exposures are limited to a single small area on Blue River. Elsewhere there lies beneath the glacial drift a diversified erosion surface hidden from view by a considerable cover of glacial drift. It is not unlikely that in preglacial times the relief of this area was comparable to that of parts of southern Indiana at the present time. Well records indicate a maximum bedrock relief of over 500 feet.

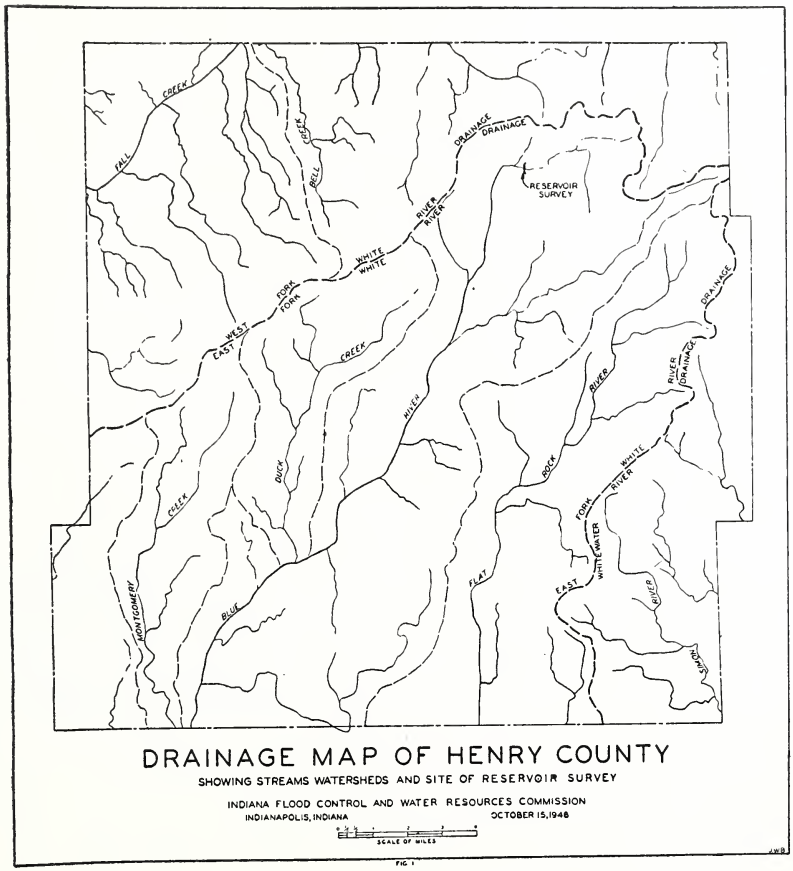
Much of Henry County is characterized by glacial morainic belts. In northern Henry County, in the vicinity of Mt. Summit, a system of ridges and knolls rises rather abruptly 75 to 100 feet above the bordering glacial sluiceway near the headwaters of Blue River. This morainic mass is thickly strewn with boulders and is characterized by sloughs and shallow basins between the sharp ridges and knolls. The morainic tracts in southern Henry County are somewhat subdued and are nowhere as prominent as the northeastern area.

A moraine traverses the county from southwest to northeast, passing west and north of New Castle, which constitutes the divide between the East and West forks of White River. On the eastern border of the county there is a moraine with a gently undulating surface which forms the divide between the East Fork of White River and the Whitewater River systems.

The maximum elevation in Indiana centers around an area in the east-central part of the state, which includes part of Henry County. It is reported that the average altitude of Henry County is 1040 feet above mean sea level; this is second only to adjacent Randolph County on the east. The maximum altitude of Henry County is reported to be 1150 feet, the minimum altitude to be 880 feet, and the maximum local relief to be 100 feet (Malott (10), p. 81).

Drainage. Henry County is a headwaters county which lies almost entirely within the drainage basin of the Wabash River. By far the greatest part of the water of Henry County is derived from precipitation within the borders of the county. It is estimated that less than 5

percent of the water fed into Henry County streams is derived from sources outside of the county.



Henry County can be divided conveniently into three main drainage areas (figure 1). The largest of these drainage areas is that of the East Fork of White River which covers about 237.3 square miles or a little more than 60 percent of Henry County. The north and northwest tributaries of West Fork of White River drain approximately 101.7 square miles. The remainder of the county, some 40.4 square miles, is drained by tributaries of the Whitewater system which in turn empties into the Miami River northwest of Cincinnati, Ohio.

The Tipton Till Plain, as a constructional feature in the zone of ice wastage, was a plain without valleys, but as the ice melted from the region the older and first exposed portion of it was subject to overflow by the waters coming from the ice of the portion still under construction. Consequently, there are broad valleys leading southward and south-

westward across the plain. Most of these glacial waterways are now occupied at least partially by streams, though in all cases very small and feeble compared with their Pleistocene ancestors which, during the melting periods, occupied the whole of the valley and excavated it practically as it is today. Blue River, Flat Rock River, and Fall Creek valleys are valleys which owe their existence largely to the work done by glacial waters. The streams which now occupy these valleys have modified them very little since the close of the glacial period and are but feeble representatives of their mighty progenitors.

The headwaters of Blue River flow into a wide glacial sluiceway on the east side of Section 12, T. 18 N., R. 10 E., about 3 miles northeast of Mt. Summit, and then flow in a south and southwesterly direction in a valley which is approximately one-half mile wide. Buck Creek and part of its tributaries occupy the upper part of this sluiceway and instead of flowing south into Blue River they flow northwest and north to join the West Fork of White River at Yorktown, Delaware County. Similarly, part of Bell Creek (a north flowing tributary of Buck Creek) and the headwaters of Fall Creek occupy a continuous southwesterly trough in western Henry and Delaware counties.

Stratigraphy

The bedrock stratigraphy of Henry County has long been a challenging and puzzling problem. Little can be learned from the poor exposures at the surface, and most well records contain insufficient data from which to accurately determine the bedrock sequence. The following generalized stratigraphic succession is an attempted interpretation of formations encountered based on field observations, information obtained from drillers, and older geological reports.

Quaternary
- Recent alluvium—0-30 ft.
- Pleistocene glacial drift—0-535 ft.

Silurian—0-200 ft.

Ordovician
- Cincinnatian Series—650-785 ft.
- Trenton limestone—150 ft.
- *Back River group—320 ft.
- *Glenwood-St. Peter formations—35 ft.

*Cambro-Ordovician Series—1330 ft.
- *Prairie du Chien (Lower Ordovician)
- *Trempealean (Upper Cambrian)

*Cambrian
- *Eau Clair sandstone—610 ft.
- *Mt. Simon sandstone—320 ft.

*Pre-Cambrian—30 ft. plus

*After Bieberman and Esarey (1)

Quaternary. The Quaternary includes all the unconsolidated sediments overlying the bedrock surface. These sediments consist of valley inwash deposits which occupy parts of buried bedrock valleys, all types

of glacial drift, and fluvio-glacial deposits, all Pleistocene age, and of Recent alluvial materials.

The Recent alluvial deposits in Henry County are confined to flood plains and alluvial fans. They are chiefly sand and silts. No towns and relatively few homes are located in the broad valleys of Henry County streams consequently there is little dependence on the alluvial deposits for water supply.

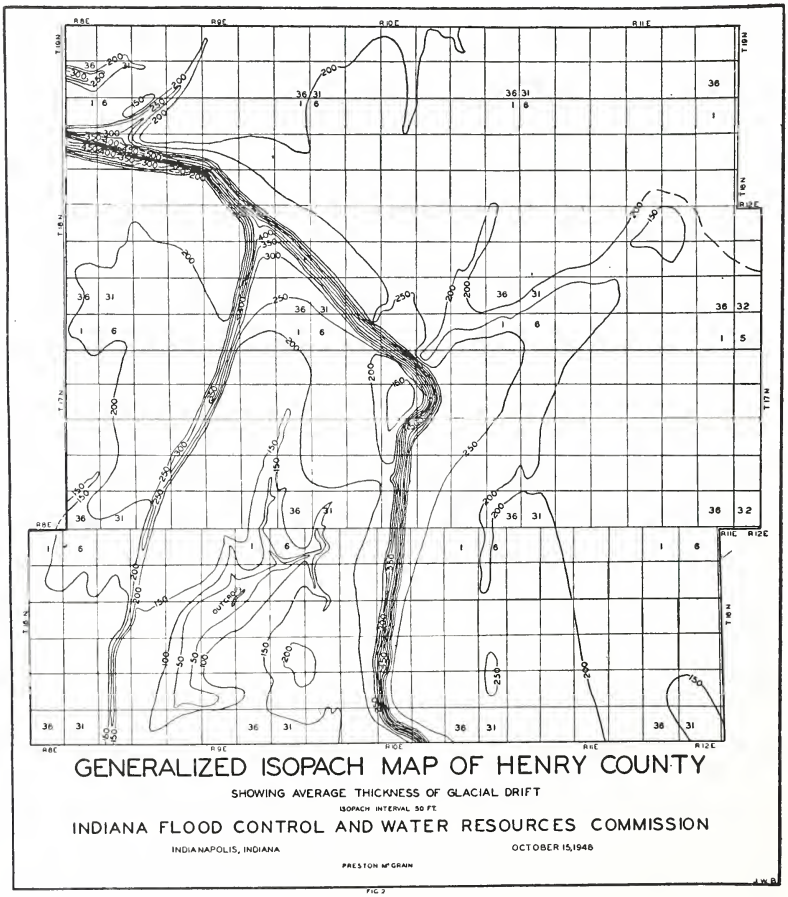
Two periods of glaciation have been recognized in Indiana. In Henry County the Wisconsin drift completely hides the older Illinoian drift which may be interpreted only from well logs and samples. The glacial material may be divided into three general types. The first type is terminal moraine material which is ridge-like accumulations of debris made at the end or edge of an ice sheet, especially where its end or edge has remained stationary for a considerable time. The moraines consist of a heterogeneous mixture of glacial debris varying in size and composition from minute clay particles to massive limestone and granite boulders. With the unsorted drift and till are lenses or pockets of more or less stratified sands and gravels which are interbedded in an uncertain and unsystematic manner. Basins and other depressions between the ridges have often been filled with silt and frequently are marshy or swampy areas.

The second type of glacial deposit recognized in Henry County is ground moraine material. The ground moraine consists of all the drift deposited beneath the advancing glacier and drift deposited from the base of the ice during its recession through melting. The ground moraine is made up of a compact, impervious, clayey material containing scattered sand, gravel, pebbles, and boulders. The till of the ground moraine areas contains more clay and is generally more compact and impervious than the till of the terminal moraine areas, which is more sandy and which sometimes includes isolated permeable masses of gravel. It, like the terminal areas, may be deduced largely from the surface topography.

The third type of glacial material recognized is that deposited by meltwater from the ice. The fluvio-glacial materials in Henry County consist of outwash plains and some valley train-like material which is found principally in the valley of Blue River. The outwash plans are large, relatively flat topographic features constructed of all detrital material swept out of the melting glacier by meltwater streams. The material consists largely of more or less imperfectly sorted and stratified sand, gravel, and silt.

In view of the fact that the Wisconsin is the younger of the two glacial deposits it is the one which is represented by the above glacial materials. The presence of the Illinoian drift is recognized in subsurface investigations by the presence of an old soil or a leached or oxidized zone well below the surface of the ground. (Thornbury (11), p. 45) has indicated that the average depth of leaching of Wisconsin drift in Henry County is 30.3 inches.)

The thickness of the blanket of glacial drift varies from zero (at one locality in the bed of Blue River) to a reported depth of over 500 feet near New Castle (Leverett (7), p. 30) and (Harrell (4), p. 256). Buried bedrock valleys and other irregularities of the bedrock surface account for the unusual thickness. In some of the literature bearing on the problem it has been suggested that the material occupying the "deep drives" in Henry County is composed of glacial drift similar to the materials at the surface, but it is here suggested that these former northward flowing tributaries to the great Teays valley were blocked by the southward advance of the Pleistocene ice sheet and at least partially filled with stillwater accumulations, such as muds and silts, thus forming poor water-bearing material. (The Teays 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 West Virginia, Ohio, Indiana, and Illinois. It is believed to have dis-



charged 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.)

The presence of deeply buried bedrock valleys in Henry County has been suggested in several of the older geological reports on the region and is considered common knowledge among water well drillers in that area. To this writer's knowledge no previous attempt has been made to trace these features or describe their extent in Henry County. Records of over 450 wells were gathered and studied.

An isopach map with intervals of 50 feet showing the average thickness of glacial drift in Henry has been prepared (figure 2). The thickness of the glacial drift is the combined result of the topography of the buried bedrock surface, the amount of glacial deposition, and the depth of subsequent stream dissection. For the purpose of this map all unconsolidated sediments are interpreted as glacial material. The degree of accuracy will vary in different areas with the availability of well data and the local topography. Generally, it is unnecessary to drill much over 100 feet for water in Henry County. No topographic maps of Henry County are available; also, time did not permit a topographic survey in conjunction with this phase of the study. Consequently, the thickness of the glacial drift must of necessity be generalized and considered average for any particular locality. Further, the isopach map is based only on well records in which the location could be determined with some degree of accuracy.

Silurian. Very little is actually known about the bedrock which underlies Henry County's 389 square miles. Bedrock formations come to the surface in the bed of Blue River just south of the bridge at Stone Quarry Mill, 1¾ miles west of Spiceland. The quarries, reported by Kindle ((6), p. 427), have long since been inactive and their location can be determined only by the presence of deep pools or ponds of water north of the bridge and west of the present saw mills. Cumings and Shrock ((2), p. 172) describe rock from one of the quarries, present in the foundation of one of the mills, to be Silurian in age. The present writer believes that this rock and other rock fragments scattered in the vicinity of the abandoned quarries to be partially altered by burning for lime.

Local residents report that stone was exposed for a few hundred yards in the bed of Blue River a short distance below the bridge when this stream was dredged some 15 or 16 years ago. Now, however, alluvial sand and gravel covers most of this area and rock is seen only when the water is low and clear. This stone is a slabby, grayish to tan or light brown, granular, somewhat porous dolomitic limestone. Occasional imperfectly preserved casts of brachiopods represented the only faunal evidence observed. Lithologically this stone resembles some of the beds of Huntington dolomite which outcrops much farther north.

Another opportunity to view the type of stone which might be present beneath the glacial drift in this area is at a stone culvert under the road opposite the northeast corner of the Spiceland School lot. It was reported to the writer that the slabby, cherty, gray limestone used in the construction of this culvert originally came from one of the now abandoned quarries at Stone Quarry Mill to the west. The abundance of chert in these tabular pieces of stone suggest the Liston Creek formation; however, neither the stratigraphic position nor the faunal characteristics could be determined from surface examination of the area.

A few cuttings from a water well at the southwest end of Indiana Highway 3 overpass just west of Dunreith were observed by the writer. These cuttings, which came from the top of the bedrock at a depth of 152 feet, consisted of hard, very fine grained, grayish white, somewhat dolomitic limestone.

Ordovician and Cambrian. No outcrops of Ordovician or older rocks are known to be present in Henry County. In the past many wells have been drilled to the Trenton for gas or oil and, at the present, a few wells in the vicinity of Knightstown are producing small quanities of natural gas.

Bieberman and Esarey ((1), Pl. 1) describe a deep test drilled by the Ohio Oil Company in the SE ¼ of the NE ¼ of Section 12, T. 16 N, R. 11 E., near New Lisbon which was drilled into granite. The total depth was 3670 feet. Limestone belonging to the Cincinnatian Series (Upper Ordovician) was first encountered beneath the 180 feet of glacial drift which blankets that particular area. This extends the previously known areal extent of the Ordovician. Besides the formations of the Cincinnatian Series, the Trenton and Black River limestones, and Glenwood, St. Peter, and Prairie du Chien formations, all Ordovician, and the Trempealean formation and Eau Claire sandstone, Cambrian, were tentatively identified and correlated by Bieberman and Esarey ((1), Pl. 1).

Samples from oil test on the S. L. Roof farm, in the SW¼ of the SW ¼ of Section 18, T. 17 N., R. 10 E., some 4 miles west of New Castle, drilled in 1948, were studied by the writer. In this case the rock was first encountered at 229 feet. No samples of the glacial material were saved. A description of some of the rock encountered follows.

SILURIAN

229-237—White to tan, crystalline, dolomitic limestone.
237-242—Red clayey material; decomposed limestone.
242-252—Light gray, finely crystalline dolomite with chert and glauconite.

ORDOVICIAN

252-257—Soft blue-gray, calcareous shale; "Little Break" of well drillers.
257-272—Gray, very fine grained, dolomitic limestone.
272-325—Soft blue-gray, calcareous shale; "Big Break" of well drillers.
325-363—Gray to white, fine to carsely crystalline, dolomitic limestone and dolomite.

Pre-Cambrian. The above mentioned Ohio Oil Company test near New Lisbon was drilled 30 feet into Pre-Cambrian before being abandoned. The Pre-Cambrian at this point consisted of red granite.

Structure

The regional structure of Henry County is directly controlled by the presence of the northwestern prong of the Cincinnati Arch, which enters Indiana from the southeast. This anticlinal structure, which enters the county from the southeast, is broad and rather flat-topped. Logan ((9), P. 347) reported that the upper surface of the Trenton limestone in the central and southeastern portions of the county is 100 feet above sea level, and is 50 feet above sea level in the northwestern part of the county.

Ground Water

Source and Storage. If the water-bearing materials of Henry County were uniformly porous, permeable, and homogenous, ground water problems could probably be solved by hydraulic data, and the studies of the geologic nature of the water-bearing materials would have been unnecessary. However, as pointed out previously, the materials below the ground in Henry County are heterogenous and their geologic characteristics are varied. It is these variations that control the distribution, quantity, and quality of the ground water. The satisfactory solution of many ground water problems usually involves the putting down of either prospect or test holes, or both, sooner or later.

The formations which underlie the surface of Henry County are saturated with water below a level known as the water table, which ranges greatly in depth. By definition the water table is the upper surface of the zone of saturation in ordinary permeable soil or rock. It is necessary for wells to penetrate the water table if they are to be productive, and even then other factors may prevent the well from being a source of water. The water table is deepest in some of the highest parts of the upland areas and is shallowest in the lowlands. In marshes the water table lies continuously or intermittently above the surface of the ground. The water table does not occupy a fixed position at any given place but fluctuates with rainfall and drouth, being highest just after a period of prolonged precipitation and lowest at the end of a long drouth. The water table has irregularities comparable with and related to those of the land surface, although it is less accentuated. The ground water horizon, if underlain by an impervious layer may be separated from the main body of ground water by an unsaturated or partially saturated rock. The upper limit of a relatively high isolated and local body of saturated material may be referred to as a perched water table.

By far the greatest part of the ground water of Henry County is derived from precipitation within the borders of the county. Practically the whole county is covered from several feet to several hundred feet

by glacial drift. Therefore, rainwater which falls on the surface has a chance to penetrate the glacial covering, provided the precipitation is slow and other factors are favorable. In this manner it is believed that precipitation reaches the sand and gravel horizons, the bedrock surface, and the deeper formations. When formations appear at the surface the precipitation has an opportunity to penetrate the strata directly, provided they are porous, and such water may go down the dip of the formations. Similarly, water may move along bedding planes, joints, and other fractures of the rock formations.

Aquifers. An aquifer is a geological formation that transmits water in sufficient quantity to supply pumping wells or springs. An aquifer may be local or widespread. The most important source of water supply in Henry County is from local aquifers in glacial drift. The occurrence of the aquifers in the glacial drift is subject to much variation both locally and regionally. During the course of this survey many reports of the variations in depths of wells came to the attention of the writer. A good example of such a variation is the situation at a group of houses near the junction of Indiana Highways 38 and 234, four miles west of New Castle, where a well, drilled in 1947, is producing water at a depth of 26 feet in glacial drift while neighboring wells had to go 182 to 191 feet to limestone for sufficient water to supply needs for home use.

Water supply in glacial drift will vary depending whether or not the material is glacial till, moraine, or glacio-fluviatile deposits. Wells drilled into till are seldom water-bearing, as till masses are so close textured or so compact that they will not furnish water fast enough to supply the wells. Usually satisfactory supplies must encounter sand or gravel deposits in the glacial drift. In many cases a looser textured bed is found with deeper drilling though in some localities such beds do not exist. If satisfactory supplies are not found in the glacial drift, the well must penetrate the bedrock if the formations are known to be water-bearing.

Lenses and pockets of sand and gravel are the chief water horizons of terminal moraines. Their occurrences in the moraines are uncertain and unsystematic. Therefore, any well drilled in a moraine area must take this fact into account. As in the case of till areas the quantity of water secured from these sand or gravel lenses depends upon their vertical and horizontal extent. The contact between the piled-up terminal moraines and the underlying ground moraine is often an excellent water horizon, especially where deposition of sands and gravels has occurred on top of the ground moraine. Those portions of terminal moraines which consist primarily of boulder clay are low in permeability and yield little water.

Outwash plains composed of water sorted sands and gravels are closely related to the moraines next to which they occur. Such plains are not found adjacent to every moraine or all parts of any moraine. Outwash plains receive much of their water directly from precipitation and from the adjacent moraines by seepage and regular flow of ground

water into them. Ground water is found in the coarser deposits of the outwash material usually some depth below the surface.

The contact between the glacial drift and bedrock is frequently an excellent horizon for local water supplies. For some distance along Blue River valley between Greensboro and Knightstown a six-inch bed of coarse, water-bearing gravel occurs at the top of the underlying limestone. It is not to be construed that ground water will be found in all wells at the contact between the drift and the bedrock, for in many cases clay or very fine sand rests on the rock.

In view of the fact that the glacial drift is very thin in the southwestern part of Henry County, especially just northeast of Knightstown, and that the glacial drift interval anywhere in the county may be occupied by clay till and/or very fine sand, it is not an uncommon occurrence to have to search for ground water supplies in the bedrock. The upper portion of the bedrock, particularly that which is in contact with the glacial drift, is often porous and serves as an aquifer satisfactory for domestic water supply. This water is generally potable but salt water was reported to have been encountered in one well in Silurian limestone at the State Epileptic Village north of New Castle. In Wayne and Spiceland townships bedrock wells are common. Municipal supplies for the towns of Knightstown and Spiceland are secured from wells in limestone. Water also occurs frequently in the joints, crevices, and bedding planes of the Silurian limestone.

In the southeastern corner of Henry County and along the bottoms of the deeply buried bedrock channels the shales and shaly limestones of the Cincinnatian Series (Upper Ordovician) occur beneath the glacial drift. Little or no water is present in these strata.

Records of wells into the Trenton formation (Middle Ordovician) indicate that water in that formation is usually salty. An earlier writer, however, reported that some fresh water was found in the Trenton at Knightstown. Artesian flow of fresh water was observed by the writer to be coming from abandoned gas wells near Maple Valley in southwestern Henry County, but the water horizon could not be determined. The town water supply for Shirley on the Henry-Hancock county line is from an abandoned gas test but again the aquifer could not be ascertained since the casing in old wells will deteriorate after a period of years and the water might come from any of several potential water horizons. There is no information on water horizons deeper than the Trenton.

Methods of Recovery. Ground water in Henry County is recovered from springs, dug wells, driven wells, and drilled wells, the latter method of recovery being the most widely used at the present time.

Springs and seeps are usually quite common in morainal areas and Henry County is no exception. Springs are particularly plentiful along the more deeply entrenched streams where the valley has intercepted beds of water-bearing sand or gravel. Such sources of water occur along

the valley sides of Blue River, Montgomery Creek, Fall Creek, and Buck Creek. The community of Springport was settled because of the presence of excellent water supply from this source. At the present time an estimated 100 or more small artesian wells and springs provide the local water needs.

The earliest wells in the county were dug by hand usually to a depth of 10 to 30 feet. Generally they were considered adequate at that time but many of these shallow wells did not produce large quantities of water. Water was usually raised by small hand pumps or by buckets.

Driven wells 1¼ to 2 inches in diameter have also been used to secure ground water. This method was often used because an individual could drive a shallow well with little or no assistance. However, the very nature of this method made it impossible to learn much about the nature of the rock materials encountered. Most of the houses in the community of Honey Creek obtain water from 1¼ inch driven wells at a depth of 18 to 26 feet. These wells are reported capable of producing approximately 120 gallons each per hour.

The most widely used method of securing subsurface water in Henry County at the present time is by drilling. Most wells are 4 inches in diameter; however, larger wells, 6, 8, and 10 inches in diameter, are drilled for industrial and municipal uses. Only on the rarest occasion is anything smaller than a 4 inch well currently drilled.

A great many factors over and above the varied geological conditions affect the depth of the well and the amount of water which it will produce. The depth of these 4 inch water wells ranges from less than 30 feet to more than 200 feet. The initial capacities of the wells range from 200 to 900 gallons per hour, generally about 500 to 600 gallons per hour. These tests are considered a minimum rather than maximum capacity. What is considered a satisfactory water supply often is dependent upon the interpretation of the driller on the job and the owner of the well. The determination of a suitable aquifer and satisfactory pumpage varies with the individual. One driller will pass up a water bearing horizon when the sand or gravel will not stand up in the hole, while another driller will use a screen for the same condition. (It should be noted that the use of screens in wells also varies with the individual driller. Some drillers will equip every well with a screen while other drillers will not make a well in a water-bearing horizon if a screen is necessary; the latter contends that a screen may often clog up and the well will require periodic servicing.) In the case of a well in glacial drift, gravel the size of wheat grains is considered minimum requirements for a well. Even though a bed or lens of sand might carry a copious supply of water, sand has a tendency to be carried upward and thus clog the hole. Still other aquifers contain so much fine silt and clay that the water never becomes clean and, consequently, is not satisfactory for domestic use. Wells for water supply for livestock use does not have to meet as strict requirements as those for homes, businesses, etc.

Wells into the limestone of Henry County do not encounter the varied conditions found in glacial sand and gravel; consequently, the personal factor is not as pronounced. Drilling in the limestone is continued until a sufficient quantity of water is reached or until the potential water-bearing formation has been penetrated. Limestone wells are drilled, not dug or driven, and the water is usually encountered in the upper parts of the formation.

No limestone springs occur in Henry County because of the restricted outcrop area. However, artesian flow from wells drilled in limestones is encountered occasionally because the aquifer is fed from a higher elevation.

Local Ground Water Problems. Considerable interest and concern in the subsurface water supply has been shown by the citizens of Henry County in recent years. The writer believes that the concern over the conditions is due primarily to the greatly increased domestic and farm use and the increased suburban and urban population. The advent of the rural electrification program brought in larger, electrical driven pumps and subsequently running water throughout the suburban and farm homes. It is estimated that the household and farm consumption in such cases has been increased at least 3 or 4 times and in some cases up to 20 times. Consequently, the relatively shallow, hand-dug, and driven wells do not meet these increased demands. Also, the capacity of the new pumps exceeds the flow from the shallow aquifer. In these cases drilled wells have been necessary to supplement or replace the dug wells. Local residents informed the writer that there has been an increase during the past few years in livestock. This, in turn, has increased the demand for water. A third factor that has stimulated water well drilling in recent years is the concentration of home building in suburban areas out of reach of municipal supplies. The deepening of drainage lines and construction of new drains has undoubtedly lowered the water level in some shallow wells. However, it is believed that many of these wells would not meet the current increased demand for water had other factors remained unchanged. Increased runoff due to deforestation has possibly had minor influence upon the water table but this loss probably would not equal the greatly increased consumption. Recession of a water table may be caused also by decrease in precipitation. Although no records have been kept within this area as to the relationship of rainfall to the ground water level, the fact that less than 5 per cent of the water fed into the Henry County streams is derived from sources outside of the county indicated how closely the water supplies are dependent upon precipitation.

Local ground water supplies in the New Castle area appear adequate for individual suburban wells. However, the prospects for the city for the future are not as promising. If the city continues to grow as rapidly as it has during recent years the present municipal and industrial water supply may have to be supplemented by a surface reservoir or wells located some distance from the city. The same is true, but to a lesser extent, for Knightstown.

Conclusions

Henry County is a headwaters area which depends almost entirely upon precipitation within the bounds of the county for a continual supply of surface and subsurface waters. Municipal, industrial, domestic, and livestock water supplies are derived almost entirely from ground water sources. The principal source of ground water in Henry County is local aquifers in the thick mantle of glacial drift which blankets more than 97 per cent of the county to a depth of 100 feet or greater. Where the glacial cover is thin or composed of impervious clay till, domestic and agricultural supplies of water may be obtained from Silurian limestones and dolomites which underly most of the county. Water in these rocks usually occurs in the upper 20 to 30 feet of the limestones. Geological formations older than Silurian can not be relied upon to yield adequate potable water supplies. Shales and shaly limestones of the Cincinnatian Series (Upper Ordovician), immediately under-lying the Silurian limestones and dolomites, are neither porous nor permeable and, consequently, do not make satisfactory aquifers. The Trenton limestone (Middle Ordovician) frequently yields copious quantities of water, but in general this water is highly mineralized.

It is thought that no actual over-depletion of ground water reserves exists as yet for Henry County as a whole. Ample supplies of water for domestic and agricultural purposes may be secured below a depth of 40 to 50 feet. Municipal and industrial supplies, particularly in the New Castle Area, may have to be derived from wells located some distance from that city or from surface supplies resulting from the construction of a dam and reservoir. Excellent water-bearing gravels are known to exist along Duck Creek about 4 miles a little north of west of New Castle's pumping station.

Local recession of the ground water level in Henry County is believed to be the result of a combination of several factors, the foremost of which is the greatly increased consumption of water for domestic, industrial, and agricultural purposes.

Buried bedrock valleys are known to exist in Henry County. From data gathered in the field and our knowledge of other buried valley systems in Indiana, it is postulated that the buried valleys in Henry County are tributaries of the great Teays system which once crossed northern Indiana from east to west. Wells drilled for water along these valleys in Henry County have not encountered satisfactory supplies of water. The character of the material encountered in these tests suggests that the valleys were blocked by the advance of Pleistocene ice and subsequently were filled with fine silts and clays which are neither sufficiently porous nor permeable to yield ground water consistently.

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