HYDROGEOLOGY AND GROUNDWATER ASSESSMENT OF THE WATER DISTRIBUTION AREA OF THE TOWN OF HODGES WATER DEPARTMENT, FRANKLIN AND MARION COUNTIES, ALABAMA

By
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INTRODUCTION

Two relatively shallow, small capacity wells and a spring currently serve as the water-supply sources for the Town of Hodges Water Department (herein, "HWD", or "Hodges"), whose service area includes a large portion of north-central Marion County and southern Franklin County in northwestern Alabama (fig.1). In May 2012, HWD requested that the Geological Survey of Alabama (GSA) evaluate the potential for development of additional public water supplies to supplement its current water sources. In June 2012, GSA entered into a contractual agreement with HWD to conduct a hydrogeologic assessment of its water system distribution area for the purpose of selecting possible sites for test well drilling. This report summarizes data collected and analyzed and presents interpretations of hydrogeological characteristics of the assessed area along with recommendations for possible test well drilling sites.

PURPOSE AND SCOPE

Within its overall service area, HWD seeks to locate and develop groundwater supplies that are in close proximity to existing 6-inch diameter water lines of its water distribution system. The primary purposes of this investigation were to assess the availability of groundwater in the area through delineation of the hydrogeology and to determine localized prospective areas for consideration by Hodges for further evaluation by test well drilling. Collection and analysis of data for the investigation extends to areas beyond the boundaries of the primary area of interest, however, in order to adequately evaluate the HWD service area within the context of the geologic, hydrologic, and geochemical setting and to provide a more comprehensive study. The investigation

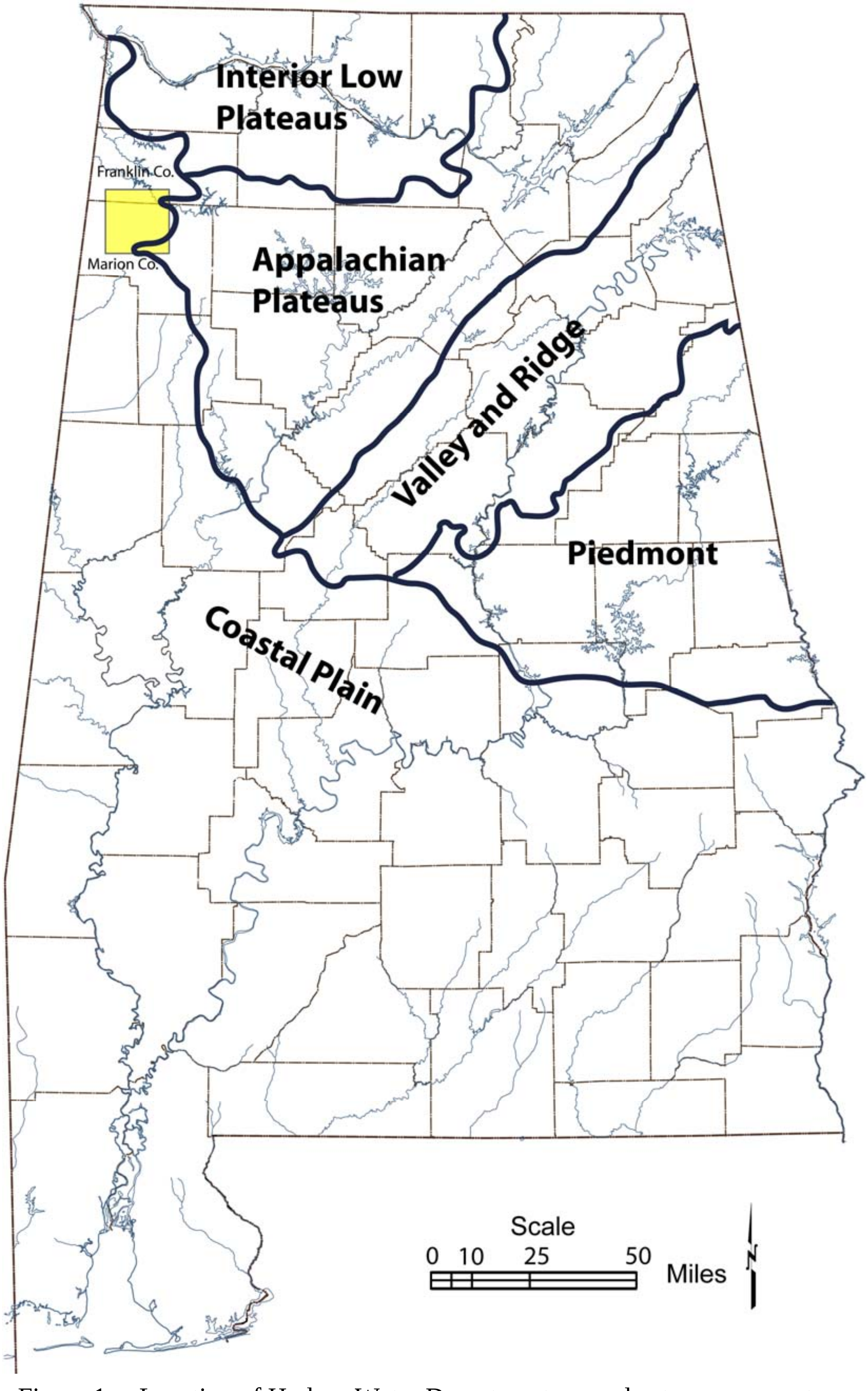

Figure 1.—Location of Hodges Water Department groundwater assessment area, Franklin and Marion Counties, Alabama and physiographic provinces of Alabama.

relied primarily on geological field data collected in 2012-2013, data on file at GSA from water wells and test holes drilled in the assessment area, available subsurface geologic data on file at the Alabama Oil and Gas Board from petroleum test holes and wells drilled in Marion and Franklin Counties, published geologic maps and data, and satellite imagery. Whereas the current water supplies for HWD are sourced in loosely consolidated sand and gravel deposits of Cretaceous age that overlie much older and generally deeper Paleozoic rock units, this assessment considered all potential groundwater sources, with the goal of locating potential aquifers at drill depth less than about 500 feet.

Although groundwater is stored in and flows through all of the geologic formations in the assessment areas, some geologic units, or portions thereof, have greater potential as aquifers than others, especially with regard to groundwater flow rates and water quality necessary for public water supplies. Some sediment and sedimentary rock types found in the assessment area, such as clay and shale, commonly have relatively poor aquifer transmissive properties, making them unlikely targets for development of large capacity wells, whereas other lithologies, such as loosely consolidated sand and gravel deposits, sandstone, and carbonate rocks (limestone and dolomite), commonly are generally more permeable. In hydrogeologic settings in which fracturing and/or dissolution processes have occurred, porosity and permeability may be enhanced. Therefore, in this investigation, effort has been concentrated on geologic units which are more likely to serve as aquifers.

Quality (geochemistry) of groundwater in low permeability rocks, such as shale, is commonly marginal to poor for drinking water, whereas other lithologies are more likely to contain groundwater with acceptable levels of dissolved ions. Unacceptable levels of dissolved iron have been encountered in groundwater from some wells in the area (Peace, 1963; Causey and others, 1972). Peace (1963) also reported some noticeable amounts of hydrogen sulfide and greater hardness in wells completed in the Bangor Limestone northeast of the Hodges groundwater assessment area in Franklin County.

Because of the importance of geologic structure in delineation of potential aquifers and groundwater flow, considerable effort was made to determine structural attitude (strike and dip) and spatial relationships of geologic units. Subsurface geologic interpretations, based on primarily on correlation of geologic units interpreted from geophysical logs, drillers logs, and sample logs, coupled with structural projections updip to outcrops or subcropping geologic units, were used to construct structure and isopach (thickness) maps and make estimations of depths of aquifers for test well planning purposes.

Limited water level data, sparse data regarding aquifer characteristics such as porosity and permeability, and only rudimentary understanding of the hydrogeology in the assessment areas preclude quantitative estimations of groundwater storage and flow. Experience from other areas in similar hydrogeologic settings, however, coupled with available data and analyses mentioned above, allow reasonable estimations of aquifer potential of geologic units in the assessment areas and their suitability for public water supply use.

PHYSIOGRAPHIC, HYDROLOGIC, AND GEOLOGIC SETTING

Physiography is important in delineating hydrogeology and hence aquifer potential of geologic units. The Hodges groundwater assessment area lies in the updip portion of the Gulf Coastal Plain Province (fig. 1), a region characterized generally by low relief hills and valleys, and the area borders the Appalachian Plateaus Province. Higher relief is locally present, however, where erosion through the Coastal Plain sediments has been extensive enough to form entrenched streams in underlying bedrock. Surface water drainage is generally to the south toward the Buttahatchee River in the southern part of the assessment area, to the west to Bull Mountain Creek in portions of the northwestern area, and to the north to Bear Creek in the northern part of the area. Geomorphic features are commonly influenced by stratigraphy and geologic structure, and geomorphology similarly affects surface water and groundwater hydrology. Highland areas commonly serve as aquifer recharge areas. Potential energy, which is imparted to groundwater through gravity and measured as elevation head and/or pressure head, provides the energy for production of work necessary for groundwater flow.

Loosely consolidated sediments of the Cretaceous Coker and Gordo Formations of the Tuscaloosa Group unconformably overlie Paleozoic rocks of Mississippian and Pennsylvanian age across the assessment area (fig's. 2 and 3). The Paleozoic-Cretaceous unconformity forms a surface that slopes generally southwest across the area (plate 1).

STRATIGRAPHIC COLUMN					
ERA	SYSTEM	SERIES	GROUP	GEOLOGIC UNIT	LITHOLOGY
Cenozoic	Quaternary	Holocene		Alluvial Deposits	Gravel, sand, and clay
Mesozoic	Cretaceous	Upper Cretaceous	Tuscaloosa Group	Gordo Formation	Sand, gravel, and clay
				Coker Formation	Sand and clay
Paleozoic	Pennsylvanian			Pottsville Formation (lower part)	Shale, sandstone, siltstone, and coal
				Parkwood Formation	Shale, sandstone, limestone
	Mississippian			Bangor Limestone	Limestone, thin shale beds

Figure 2.—Stratigraphic column, Hodges Water Department groundwater assessment area, Franklin and Marion Counties, Alabama.

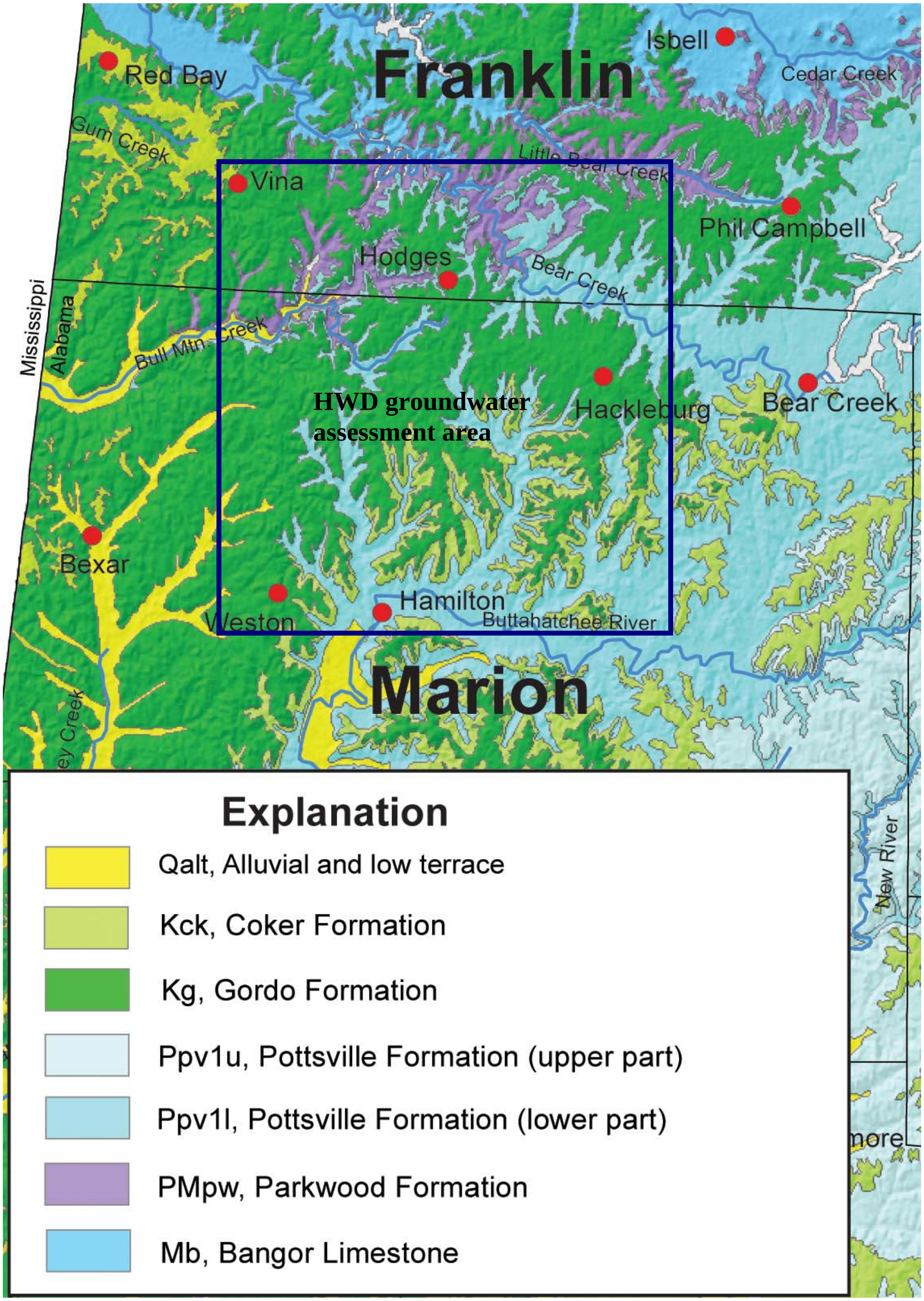

Figure 3.—Geologic map, Hodges Water Department groundwater assessment area, Franklin and Marion Counties, Alabama (modified from Geological Survey of Alabama, 2006).

However, a southwest-trending nose (general location of axis shown as a dashed line on plate 1) occurs across the south-central part of the assessment area where the strike of this surface changes from a nearly east-west direction in the eastern part of the area to a more northerly direction toward the west. The significance of this nose will be discussed later in the report.

The Coker Formation consists of light colored, fine- to medium-grained, micaceous sand and varicolored clay deposits. Coarse-grained sand and gravelly beds are locally present in the Coker, primarily in the lowermost part of the formation. Gravel and coarse-grained sand along with red to pale purple, white, and gray clay are the principal lithologies of the overlying Gordo Formation. In the northern part of the assessment area the Coker Formation is absent, and the Gordo lies immediately above Paleozoic rocks. Water-bearing sand and gravel intervals in the Coker and/or Gordo serve as the current groundwater sources for Hodges' wells and spring.

Paleozoic rocks in the area consist, in ascending order, of the Bangor Limestone, Parkwood Formation, and the Pottsville Formation. An interval of interbedded sandstone, shale, and limestone of the lower Parkwood Formation, termed the Pennington Formation by some geologists and in some previous investigations (Peace, 1963), is informally identified and correlated in this report to aid in distinguishing the Bangor Limestone from limestone beds in the overlying Parkwood Formation. The Pennington Formation of formal stratigraphic usage is now restricted to northeastern Alabama and does not extend into the assessment area (Thomas, 1972). As will be further discussed later in this report, sandstone intervals in the Pottsville Formation and some limestone beds in the upper part of the Bangor are herein considered the most prospective Paleozoic rock intervals in the assessment area. The Parkwood Formation is not considered a significant potential aquifer due to lack of known porous and permeable intervals and its generally shaly lithologic character.

The Bangor Limestone is a 500 feet thick interval of bioclastic and oolitic limestone with a few thin shale beds. Most of the limestone is dense and lacks porosity and permeability, but some intervals in the upper part of the formation are sufficiently porous to be considered potential aquifers. Furthermore, the limestone is subject to dissolution by groundwater, and karst features occur in the Bangor's area of outcrop north of the assessment area.

Sandstone, shale, siltstone and thin coal beds comprise the Pottsville Formation. Grain size in the sandstone intervals ranges from coarse and pebbly to very fine-grained. Good exposures of Pottsville sandstone occur along North Fork Creek where U. S. Highway 43 crosses the creek in sections 33 and 34 of T. 9 S., R. 13 W. between Hamilton and Hackleburg, Alabama. There Pottsville sandstone beds exhibit fractures that extend at least tens of feet in horizontal and vertical directions and are interpreted to be the result of large-scale stresses that affected the entire assessment area. Fractures and bedding plane conduits are significant in groundwater flow and storage in rock units such as the Pottsville sandstones. Measured fracture azimuths from outcrops along with azimuths of possible fractures interpreted from geomorphic features are shown on plates 1, 2 and 3.

In the subsurface two Pottsville intervals comprised primarily of sandstone, herein informally termed "lower Pottsville sandstone 1" and "lower Pottsville sandstone 2", are identified and correlated across portions of the assessment area using geophysical well logs and drillers' logs (plate 4). Lower Pottsville sandstone 1 is the principal sandstone unit containing aquifer intervals utilized in the Hamilton area. Lower Pottsville sandstone 2 is present in the southern part of the assessment area and crops out prominently along Marion County road 29 in the valleys of Stevens and Williams Creeks (sec. 23, T. 10 S., R. 14 W.). There weathering of the sandstone has produced friable sandstone and loose sand that is porous and permeable. By analogy it is hypothesized that effects of weathering of lower Pottsville sandstone 1 and effects of groundwater flow could have produced similar favorable petrophysical characteristics along and near its area of subcrop within the assessment area. Porosity ranging from 15 to 19 percent was measured using density-neutron porosity logging tools in a 75 feet thick interval (log depth 355-430 feet) of the lower part of lower Pottsville sandstone 1 in oil and gas test well P4462 in sec. 19, T. 10 S., R. 13 W. Though no other porosity measurements are known in the area for the lower Pottsville sandstone 1, this measurement is evidence that significant intergranular porosity exists at depths at or exceeding the range of drill depths anticipated for groundwater test wells recommended herein in the assessment area.

Paleozoic rocks generally dip to the south-southwest at rates of 40 to 60 feet per mile, but the rate of dip increases to about 90 feet per mile in the southernmost part of the assessment area (plates 2 and 3). Overlying Cretaceous geologic units dip to the southwest but generally at lower rates compared to the dip of the Paleozoic rocks and strike in a more northwesterly direction as evidenced by the configuration of the base of the Cretaceous stratigraphic section (compare plates 1 and 2). Still evident but generally broader and subtler at the levels of the top of Parkwood Formation (plate 2) and top of Bangor Limestone (plate 3) is the southwest-plunging nose highlighted on the top of Paleozoic rock surface (plate 1).

The geologic history of the region includes a long period of erosion (and/or non-deposition) that resulted in the significant unconformity separating the Paleozoic and Mesozoic strata. Regional uplift of Paleozoic rocks centered in western Tennessee and subsequent erosion removed progressively older sedimentary rocks in that direction (Jennings, 1994). Renewed deposition in the late Mesozoic was followed by regional subsidence to the south and more recent exposure and erosion of the Cretaceous and Paleozoic strata. This long geologic history has resulted in progressively older Paleozoic rocks that subcrop beneath Cretaceous units from south to north in the assessment area (plate 4). As a result, the thickness of the subcropping Pottsville Formation decreases from about 600 feet in the south near Hamilton to about 150 feet in the northwestern part of the assessment area (plate 5). Moreover, the Pottsville sandstone intervals noted above are not present in the northern part of the area, having been completely removed by erosion. Removal of all but the basal portion of the Pottsville Formation is evident north of the town of Hodges. In the valley of Bear Creek at the northernmost part of the HWD distribution area, downward erosion has locally exposed uppermost Bangor Limestone and/or limestone beds of the “Pennington” interval of the lower Parkwood Formation.

HYDROGEOLOGY OF PROSPECTIVE AREAS

Prospective drill sites in the assessment areas are divided into two categories: areas where Pottsville sandstone and Cretaceous sand and gravel are the potential aquifers and areas where Bangor Limestone is the potential aquifer. Bangor Limestone is here considered too deep to be an economically viable prospective interval in Marion County. Because the greater portion of the assessment area in Marion County is comprised of Cretaceous sediments that overlie eroded remnants of the lower Pottsville Formation, additional criteria were used to delineate drill sites in that area. These criteria include potential depth to reach the base of the lower Pottsville sandstone 1 and interpretation of geomorphic expression of possible fractures in the Pottsville Formation. Prospective areas chosen for further considerations by Hodges include five areas in Marion County where drill depths to reach the base of the lower Pottsville sandstone 1 are less than 350 feet (plates 1 and 2). At each of these sites the entire thickness of lower Pottsville sandstone 1 interval is projected to be present, but the sandstone interval is not far downdip from its area of subcrop beneath Coker and/or Gordo sand and gravel beds (plates 2, 4, and 5). This is an important factor in consideration of recharge to the Pottsville sandstone by groundwater flow through overlying Cretaceous sediments. Total thickness of Cretaceous sediments overlying Paleozoic rocks in the prospective areas in Marion County is estimated to range from about 75 feet to 105 feet.

Table 1.—Potential drill sites, Hodges Water Department groundwater assessment area, Franklin and Marion Counties, Alabama. (Notes: K, Cretaceous Coker and/or Gordo Formations; Pottsville Sd., lower Pottsville Formation sandstone; PTD, projected total drill depth; see plates 1-3 for locations).

Site No.	Location (section, township, range)	Ground elevation (feet above mean sea level)	Depth to top of Paleozoic rock (feet below ground level)	Potential aquifer(s)	PTD (feet below ground level)
1	Sec. 19, T. 9 S., R. 13 W.	780	100	K, Pottsville Sd.	250
2	Sec. 36, T. 9 S., R. 14 W.	770	80	K, Pottsville Sd.	340
3	Sec. 30, T. 9 S., R. 13 W.	760	80	K, Pottsville Sd.	290
4	Sec. 32, T. 9 S., R. 13 W.	790	105	K, Pottsville Sd.	330
5	Sec. 36, T. 9 S., R. 14 W.	750	75	K, Pottsville Sd.	315
6	Sec. 17, T. 8 S., R. 13 W.	650	15	Bangor Limestone	380

Bangor Limestone occurs at depths considered economically feasible to drill in Franklin County north of Hodges. Intervals having moderate porosity (approximately 12 to17 percent) within the Bangor Limestone are found at depths ranging from 56 feet to 188 feet below the top of the formation as measured by density and neutron porosity geophysical well logs from petroleum test wells in the assessment area. Relatively porous limestone intervals in the Bangor likely have the greatest potential for aquifer development, though porosity logs are poor detection methods for fractures and/or bedding plane conduits that may occur in the formation. At a possible test well site in the northernmost part of the HWD water system (plate 3), it is estimated that potential upper Bangor porosity zones in the upper 188 feet of the formation could be reached by drilling a test well of about 380 feet total drilled depth.

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