U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the

U.S. ARMY JOINT READINESS TRAINING CENTER and FORT POLK

WATER-RESOURCES INVESTIGATIONS
REPORT 01-4064 (SHEET 1 OF 2)
WILLIAMSON CREEK AQUIFER "B" SAND
--HYDROGEOLOGIC FRAMEWORK

INTRODUCTION

The Fort Polk Military Reservation (hereinafter referred to as the Reservation) in Vernon Parish, Louisiana, occupies 107,024 acres of land; 66,998 acres are owned by the U.S. Army, and 40,026 acres are owned by the U.S. Forest Service (Dan Nance, Fort Polk Public Affairs office, written commun., 1998). Some areas of the Reservation, such as an artillery impact area, live-fire areas, and special purpose training areas, are restricted to military personnel. The Williamson Creek and Carnahan Bayou aquifers are major sources of freshwater for the Reservation. In 1996, the Reservation's total water pumpage from the Williamson Creek aquifer for public supply was approximately 2.4 million gallons per day (Edward Ducote, Water and Wastewater Branch, Directorate of Public Works, Fort Polk, written commun., 1998). In 1997, the water withdrawal rate for public supply was approximately 1.88 million gallons per day from 11 wells completed in the Williamson Creek aquifer. Almost all of the water was withdrawn from the "B" sand, which is the predominant sand layer of the Williamson Creek aquifer in the study area. In 1997, nearby Leesville, the seat of Vernon Parish, withdrew all its water for public supply from the deeper Carnahan Bayou aquifer.

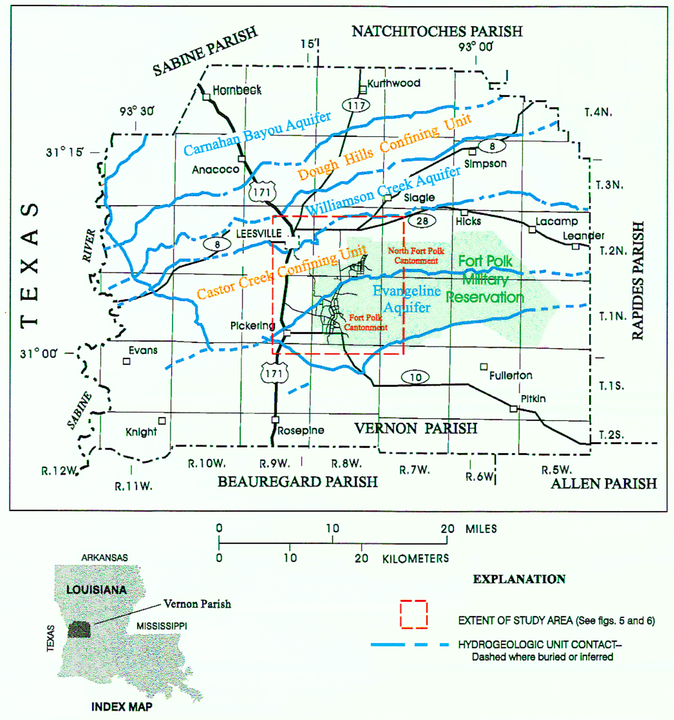

Figure 1. Study area in the Fort Polk area, Vernon Parish, Louisiana, with updip limits (outcrop areas) of hydrogeologic units of Miocene and Pliocene age (modified from McWreath and Smoot, 1989, p. 53).

Knowledge about water flow in the Williamson Creek aquifer and the effects of withdrawals on the "B" sand are needed for assessment of ground-water development potential and protection of the resource. In 1997, the U.S. Geological Survey, in cooperation with the U.S. Army's Joint Readiness Training Center and Fort Polk, collected data and completed this study to describe the hydrogeologic framework and potentiometric surface of the "B" sand within the Williamson Creek aquifer.

Purpose and Scope

This report describes the hydrogeologic framework of the Williamson Creek aquifer and presents data and a map illustrating the potentiometric surface (water level) of the "B" sand within the Williamson Creek aquifer in the Fort Polk area during March 1997. Two hydrogeologic sections through the Fort Polk area are presented. The sections, which were constructed using geophysical log data, highlight the sand layers that are present rather than the compositional materials of the entire Williamson Creek aquifer or adjacent confining units. In addition, the sections illustrate the strike and dip of the aquifer and contain one well that is common to both sections. A composite hydrograph showing water-level data from two wells completed in the "B" sand and a graph showing pumpage from the Williamson Creek aquifer for public supply at the Reservation from 1985 to 1997 are presented. Data used to construct the potentiometric-surface map were used to determine the directions of ground-water flow, hydraulic gradients, and the effects of withdrawal on water levels in the "B" sand. The information presented in this report will contribute to the general understanding of water availability and ground-water flow within the "B" sand of the Williamson Creek aquifer in the Fort Polk area.

Description of Study Area

The study area (Fort Polk area in fig.1) covers about 148 square miles in central Vernon Parish and includes the town of Leesville and the western one-third of the Reservation. The study area is roughly bounded by latitude 31°00′ to 31°10′ and longitude 93°5 40″ to 93°19′. The climate of the area is humid and subtropical with an average annual rainfall of 58.3 inches as measured at the Reservation during the five-year period 1992-96 (Patricia Vollmer, Fort Polk Airfield Weather Station, written commun., 1997). The average annual air temperature for 1996 was 65.3 degrees Fahrenheit, as recorded at the Leesville weather station (National Oceanic and Atmospheric Administration, 1997). Most streams in the study area originate along the northern boundary of the Reservation, which is a topographic high, and radiate outward. The streams generally drain hilly uplands with dense pine forest. Land-surface altitudes range from about 200 feet above sea level in the southern part of the study area to about 425 feet above sea level along the topographic high at the Reservation.

At the western end of the Reservation, and within the study area, are two cantonment areas--Fort Polk and North Fort Polk (a later addition) (Maher and others, 1955, p. 3)--which provide office space, housing, maintenance areas, and other facilities for military and civilian personnel. About 16,812 military personnel and family members resided at the Reservation during 1998, although the total military population temporarily increased during annual and weekend National Guard training (U.S. Army Joint Readiness Training Center and Fort Polk, Uniform Resource Locator accessed January 5, 1999). Leesville had an estimated population of 7,604 in 1997 (University of Louisiana at Monroe, Uniform Resource Locator accessed January 5, 1999).

The 11 water wells used for public supply are located in and near the cantonment areas: eight wells are located at the Fort Polk cantonment; one well is located west of the North Fort Polk cantonment; and two wells are located at the North Fort Polk cantonment. Five other wells at the Reservation are used to withdraw water from the Williamson Creek aquifer for purposes other than public supply: two wells are used for domestic purposes at urban-terrain training sites along Birds Creek Road; one well at each of the cantonment areas is used for supplying water at vehicle-wash facilities; and one well supplies water to the company assembly area located near Mill Creek and Birds Creek Roads.

HYDROGEOLOGIC FRAMEWORK

During the Tertiary Period, much of southern Louisiana subsided under the weight of accumulating sediments, resulting in beds that dip and thicken toward the Gulf of Mexico. Sediments of the Fleming Formation were deposited during the Miocene Epoch, about 5 to 24 million years ago, and the Pliocene Epoch, about 1.8 to 5 million years ago. Sea-level fluctuations affected the depositional environment of sediments being transported south toward the Gulf of Mexico. As the sea level rose, deltaic lands of southern Louisiana became submerged under brackish water. The clay layers that form the Lena, Dough Hills, and Castor Creek Members of the Fleming Formation were laid down in this low-energy environment. The sand layers within the Carnahan Bayou, Williamson Creek, and Blounts Creek Members were deposited by the action of deltaic streams and rivers during periods of relatively lower sea level. Deposits of Miocene age crop out in most of the northern two-thirds of Vernon Parish. In this area, the strata dip gulfward at a rate between

System	Series	Stratigraphic unit		Hydrogeologic unit	
Tertiary	Pliocene	Fleming Formation	Blounts Creek Member	Evangeline aquifer	
	——?——		Castor Creek Member	Castor Creek confining unit	
	Miocene		Williamson Creek Member	Jasper aquifer system	Williamson Creek aquifer
			Dough Hills Member		Dough Hills confining unit
			Carnahan Bayou Member		Carnahan Bayou aquifer
			Lena Member	Lena confining unit	
		Catahoula Formation		Catahoula aquifer	

Figure 2. Stratigraphic and hydrogeologic units in west-central Louisiana (from Smoot and Seanor, 1992).

50 and 70 feet per mile (Rogers and Calandro, 1965, p. 10). The formations occur at progressively greater depths in a gulfward direction while the angle of dip increases with depth; the steeper dips generally are associated with the older formations. Within Vernon Parish, the average dip of the Carnahan Bayou Member is about 90 feet per mile, with the average dips of the overlying Williamson Creek and Blounts Creek Members being slightly less (Rogers and Calandro, 1965, p. 9-10). The stratigraphic and corresponding hydrogeologic units in west-central Louisiana, which includes the study area, are shown in figure 2.

The hydrogeologic units discussed include the Castor Creek confining unit and the upper and middle units of the Jasper aquifer system (fig. 2). Sand layers are present in the Evangeline and Carnahan Bayou aquifers; however, they are not illustrated in this report.

The Castor Creek confining unit overlies the Jasper aquifer system and consists of interfingered lentils of calcareous and non-calcareous clay (light gray and red), silt, and very fine sand (Welch, 1942, p. 48, 57). The confining unit has interspersed sand streaks and scattered sand lenses, but the sands are thin and limited in areal extent (figs. 3 and 4; traces of hydrogeologic sections are shown in fig. 5). The confining unit crops out in the west-central to northeastern part of the study area (fig.1) and is approximately 300 feet thick where sediments of the Evangeline aquifer begin to overlay it in the southern half of the study area.

The Jasper aquifer system consists of three hydrogeologic units: the Williamson Creek aquifer (upper unit), the Dough Hills confining unit (middle unit), and the Carnahan Bayou aquifer (lower unit). Within the Williamson Creek aquifer, the thickness and areal extent of the sand beds vary. The sand beds generally grade laterally or vertically into silt and clay deposits that separate the sand beds (Rogers and Calandro, 1965, p. 8). Welch (1942, p. 56) described the aquifer as consisting of predominantly poorly sorted gray silt that is locally indurated into lenticular-shaped masses of friable siltstone. Mixed in with the silt are particles ranging from clay to coarse sand; at some localities sufficient sand occurs in the rock to classify it as sandstone (Welch, 1942, p. 56). Analysis of 22 geophysical logs from boreholes that completely penetrated the Williamson Creek aquifer at the western end of the Reservation indicated that sand layers constituted 19 to 61 percent of the aquifer, with a median of 33 percent (Prakken and Griffith, 2000, p. 11-12).

The outcrop area of the Williamson Creek aquifer, which is 2 to 6 miles in width, is located near the western boundary of central Vernon Parish and extends east-northeasterly into adjacent Rapides Parish (Smoot and Seanor, 1992). This outcrop area (fig. 1) is the primary area of recharge to the aquifer.

In the Fort Polk cantonment area, the Williamson Creek aquifer is about 500 feet thick at well V-497 (fig. 3), and in the North Fort Polk cantonment area, the aquifer is about 400 feet thick at wells V-504 and V-447 (fig. 4). The dip and thickness of the aquifer increases in a southerly direction. For example, the dip of the aquifer between wells V-515 and V-661, as shown in figure 3, is about 98 feet per mile, and the aquifer thickens at a rate of about 21 feet per mile. In the Fort Polk cantonment area, the top of the Williamson Creek aquifer generally is delineated by the presence of an unnamed sand layer, which is shown in figure 3. In addition, two sand layers within the Williamson Creek aquifer in the Fort Polk cantonment area have been identified and named the "A" (upper) and "B" (lower) sands (Maher, 1945).

The "A" sand is a discontinuous sand layer that generally is present at depths of approximately 600 to 700 feet below land surface (fig. 3) near the center of the Fort Polk cantonment area. The "A" sand ranges in thickness from a few feet to about 70 feet, with thicker sand zones commonly interfingering with thin clay layers. The "A" sand thins toward the north,

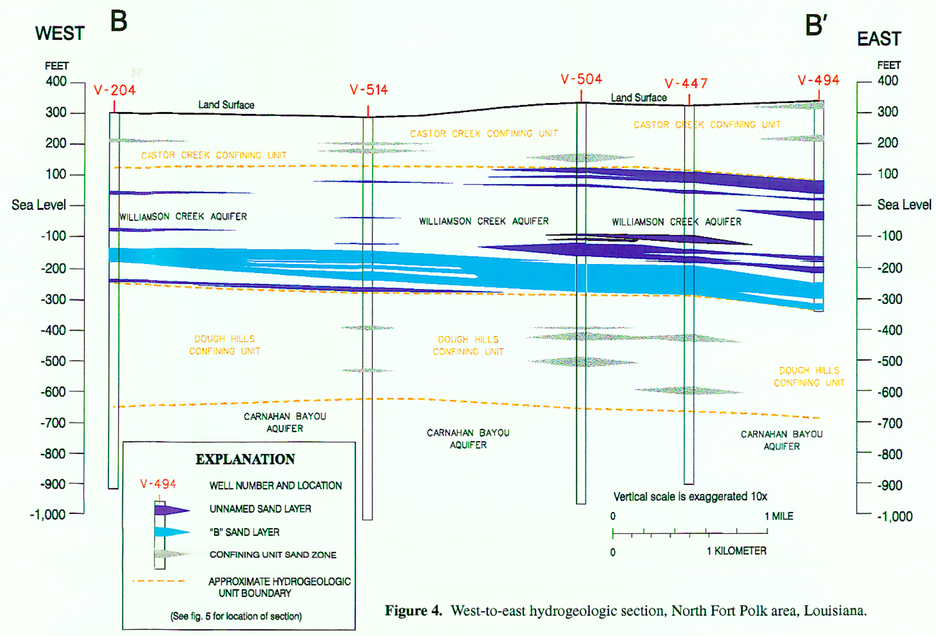

Figure 4. West-to-east hydrogeologic section, North Fort Polk area, Louisiana.

away from the center of the Fort Polk cantonment area. In the North Fort Polk cantonment area, the "A" sand is too thin and fine-grained to be considered as a source of water and is not easily identifiable on electric logs (McWreath and Smoot, 1989, p. 18). In the Fort Polk cantonment area, the "A" sand is poorly sorted and fine-grained (Maher, 1945, p. 1177) and not as permeable as the "B" sand (Klug, 1956, p. 16). In 1997, the Reservation operated only one public-supply well completed in the "A" sand, V-446, which is located in the Fort Polk cantonment area.

The "B" sand is the most continuous sand layer in the study area, and this sand extends through both the North Fort Polk and Fort Polk cantonment areas (figs. 3 and 4). At well V-504 in the North Fort Polk cantonment (fig. 4), the "B" sand is present between 184 and 275 feet below sea level and is 91 feet thick. At well V-518 in the Fort Polk cantonment (fig. 3), the "B" sand is present between 480 and 548 feet below sea level and is 68 feet thick.

Klug (1956, p. 16) reports that the aquifer characteristics for the "B" sand change considerably within short distances and that pumping test results indicate a great variation in hydraulic characteristics within the same sand zone at different localities. The "B" sand contains discontinuous interfingerings of silt and clay. Electric logs frequently indicate thin clay zones that range in thickness from 3 to 15 feet within the "B" sand, which can contribute to the variations in hydraulic characteristics.

The Dough Hills confining unit underlies the Williamson Creek aquifer. The confining unit consists of a lower bentonitic clayey siltstone facies of possible fluviatile origin and an upper facies of calcareous clay and silt lentils (gray and white) interbedded with non-calcareous silt and siltstone (Welch, 1942, p. 48, 54). The confining unit contains scattered sand streaks and lenses of very fine sand. As in the Castor Creek confining unit, these sands are thin and limited in areal extent. The thickness of the Dough Hills confining unit at well V-447 in the North Fort Polk cantonment area is approximately 380 feet (fig. 4), and at well V-497 in the Fort Polk cantonment area the thickness is approximately 415 feet (fig. 3). Sand lenses (zones) within the Dough Hills confining unit are illustrated in figures 3 and 4.

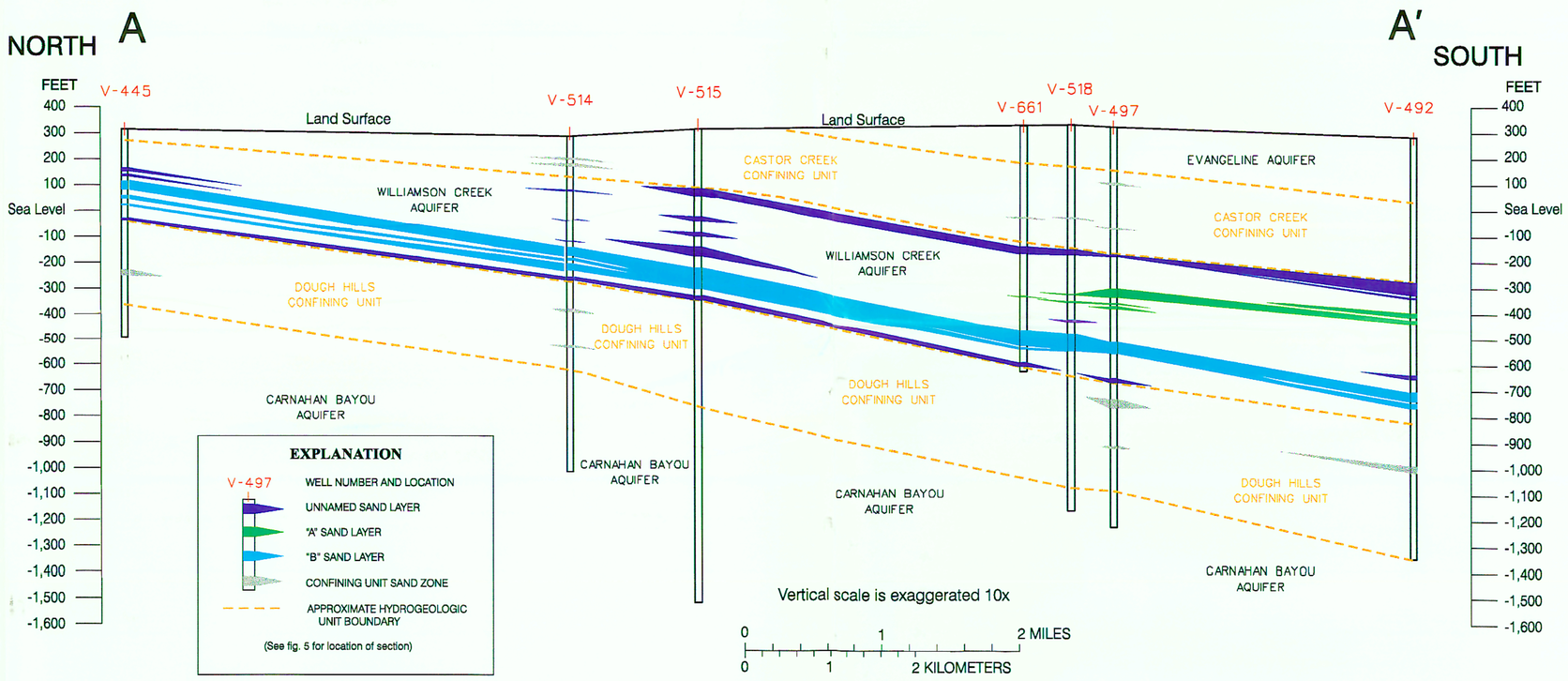

Figure 3. North-to-south hydrogeologic section, Fort Polk area, Louisiana.

Hydrogeologic Framework and Potentiometric Surface of the Williamson Creek Aquifer "B" Sand in the Fort Polk Area, Vernon Parish, Louisiana, March 1997

By Lawrence B. Prakken

2001

For additional information, contact:

District Chief
U.S. Geological Survey
3535 S. Sherwood Forest Blvd., Suite 120
Baton Rouge, Louisiana 70816
E-mail: dc_la@usgs.gov
Telephone: (225) 389-0281
Fax: (225) 389-0706

Copies of this report can be purchased from:

U.S. Geological Survey
Branch of Information Services
Box 25286
Denver, Colorado 80225
E-mail: infoservices@usgs.gov
Telephone (toll free): 1-888-ASK-USGS
Fax: (303) 202-4188

USGS science for a changing world