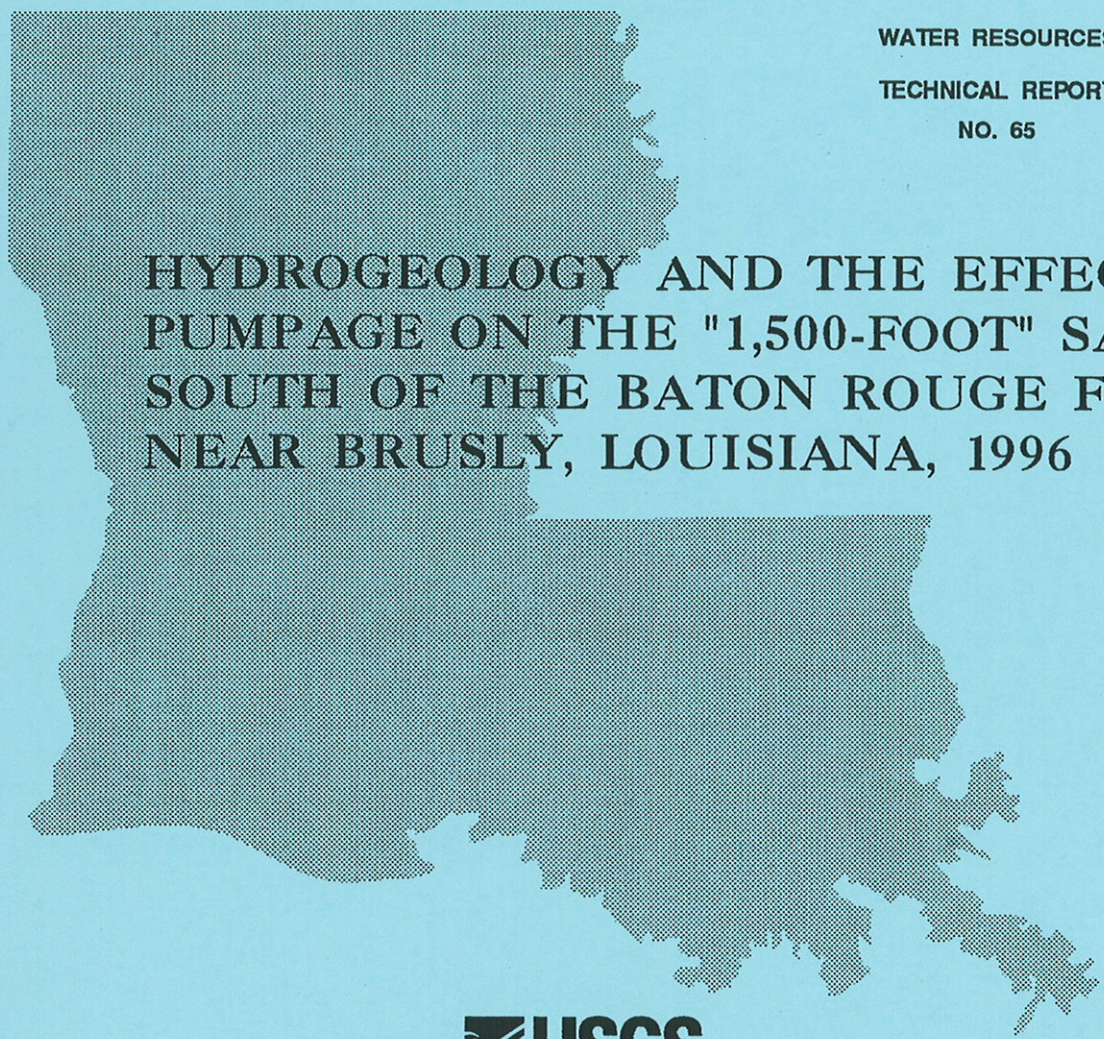
STATE OF LOUISIANA

DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

PUBLIC WORKS AND FLOOD CONTROL DIRECTORATE

WATER RESOURCES SECTION



WATER RESOURCES

TECHNICAL REPORT

NO. 65

HYDROGEOLOGY AND THE EFFECTS OF PUMPAGE ON THE "1,500-FOOT" SAND SOUTH OF THE BATON ROUGE FAULT, NEAR BRUSLY, LOUISIANA, 1996

USGS

science for a changing world

Prepared by

U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

In cooperation with the

LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

and

CAPITAL AREA GROUND WATER CONSERVATION COMMISSION

1998

STATE OF LOUISIANA

DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

PUBLIC WORKS AND FLOOD CONTROL DIRECTORATE

WATER RESOURCES SECTION

and

CAPITAL AREA GROUND WATER CONSERVATION COMMISSION

In cooperation with the

U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

WATER RESOURCES

TECHNICAL REPORT NO. 65

HYDROGEOLOGY AND THE EFFECTS OF PUMPAGE ON THE "1,500-FOOT" SAND SOUTH OF THE BATON ROUGE FAULT, NEAR BRUSLY, LOUISIANA, 1996

By

Dan J. Tomaszewski

U.S. GEOLOGICAL SURVEY

Published by the
LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
Baton Rouge, Louisiana

1998

STATE OF LOUISIANA

M.J. "MIKE" FOSTER, JR., Governor

DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

FRANK M. DENTON, Secretary

PUBLIC WORKS AND FLOOD CONTROL DIRECTORATE

Curtis G. Patterson, Director

WATER RESOURCES SECTION

Zahir "Bo" Bolourchi, Chief

and

CAPITAL AREA GROUND WATER CONSERVATION COMMISSION

Zahir "Bo" Bolourchi, Chairman

Don C. Dial, Director

Cooperative project with the

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Thomas J. Casadevall, Acting Director

For additional information contact:

Zahir "Bo" Bolourchi, P.E.
Chief, Water Resources Section
Louisiana Department of
Transportation and Development
P.O. Box 94245
Baton Rouge, LA 70804-9245
E-mail: bbolourc@dotdmail.dotd.state.la.us
Telephone: (504) 379-1434
FAX: (504) 379-1523

Don C. Dial, Director
Capital Area Ground Water
Conservation Commission
3535 S. Sherwood Forest Blvd., Suite 129
Baton Rouge, LA 70816
Telephone: (504) 293-7370

Edward H. Martin, District Chief
U.S. Geological Survey
3535 S. Sherwood Forest Blvd., Suite 120
Baton Rouge, LA 70816
E-mail: dc_la@usgs.gov
Telephone: (504) 389-0281
FAX: (504) 389-0706

CONTENTS

FIGURES

TABLES

CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
foot per day (ft/d)	0.3048	meter per day
foot per year (ft/yr)	0.3048	meter per year
foot per mile (ft/mi)	0.1894	meter per kilometer
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
gallons per minute (gal/min)	3.785	liter per minute
	0.003785	cubic meter per minute
million gallons per day (Mgal/d)	3,785	cubic meter per day

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) as follows: °F = 1.8 (°C) + 32

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated water-quality units:

micrograms per liter (µg/L)

milligrams per liter (mg/L)

HYDROGEOLOGY AND THE EFFECTS OF PUMPAGE ON THE "1,500-FOOT" SAND SOUTH OF THE BATON ROUGE FAULT, NEAR BRUSLY, LOUISIANA, 1996

By Dan J. Tomaszewski

ABSTRACT

Freshwater (water having chloride concentrations less than 250 milligrams per liter) in the "1,500-foot" sand near Brusly, Louisiana, is used chiefly for public supply; about 2.5 million gallons per day total were pumped in 1996. The Baton Rouge fault is an important hydrogeologic control that transects the northern part of the study area and roughly parallels Interstate Highway 10. The part of the study area that lies south of the fault is referred to in this report as the Brusly area. Ground water north of the fault generally is fresh. Most ground water in the Brusly area contains chloride concentrations exceeding 250 mg/L (milligrams per liter) and is referred to as saltwater in this report. In the Brusly area, about 15 square miles are underlain with freshwater in the "1,500-foot" sand. Freshwater extends south from the fault approximately 2.5 miles; the western extent of the freshwater area south of the fault has not been determined. Freshwater in the "1,500-foot sand" is bordered in an eastward and southward direction by saltwater.

Water-level declines in the Brusly area are mostly due to withdrawals south of the Baton Rouge fault. Prior to pumpage from the Plaquemine station (1968), wells screened in the "1,500-foot" sand in the Brusly area flowed at land surface. Water levels at two wells declined rapidly about 30 to 38 feet during the period 1968-69, after production wells were installed at the nearby Plaquemine pumping station.

Generally, wells in the central area of the freshwater body south of the fault yielded water having concentrations of chloride less than 10 mg/L. Wells that yielded water having moderate (50-150 mg/L) to high (151-250 mg/L) concentrations of chloride are located near the Plaquemine pumping station or near the freshwater-saltwater interface.

INTRODUCTION

The "1,500-foot" sand is an extensive aquifer in most of East and West Baton Rouge Parishes, Louisiana. South of the Baton Rouge fault, only a small area within this aquifer is known to contain freshwater (water having chloride concentrations less than 250 mg/L) in East and West Baton Rouge Parishes (fig. 1). The Brusly area in West Baton Rouge Parish is dependent on this freshwater south of the fault for public supply; about 2.5 Mgal/d total were pumped in 1996 (Don Dial, Capital Area Ground Water Conservation Commission, written commun., 1996).

Freshwater in the "1,500-foot" sand is a very soft sodium carbonate/bicarbonate type. The water generally contains less than 10 platinum cobalt units of color. Concentrations of iron and manganese generally are less than 160 µg/L and 30 µg/L, respectively, in analyses listed in the appendix, table A1. Two additional aquifers, the Mississippi River alluvial aquifer and the "2,000-foot" sand, contain freshwater in the Brusly area. The Mississippi River alluvial aquifer contains freshwater to 500 ft or more below sea level; however, the water is very hard (concentrations as $CaCO_3$ greater than 180 mg/L) and is not used in the study area. The "2,000-foot" sand is not used in the study area because the water has high color.

The depletion of the freshwater supply and the effects of saltwater encroachment in the "1,500-foot" sand near Brusly are of concern to water managers and users. To aid water managers in planning future water supplies, a study was conducted during the period 1993-96 to describe the "1,500-foot" sand south of the fault and estimate the effects that present-day (1996) pumpage may have on the aquifer. Data and results from this study will add to the understanding of the effects of faulting on ground-water flow in southeastern Louisiana.

This study was conducted by the U.S. Geological Survey (USGS), in cooperation with the Louisiana Department of Transportation and Development and the Capital Area Ground Water Conservation Commission. The study area encompasses about 36 mi^2 in East and West Baton Rouge Parishes. The important feature of concern is the limited area of fresh ground water which extends south from the Baton Rouge fault. The part of the study area south of the Baton Rouge fault is referred to as the Brusly area in this report.

This report describes the hydrogeology and effects of pumpage on water levels and chloride concentrations in the "1,500-foot" sand in the Brusly area. The effects of the Baton Rouge fault on the distribution of freshwater are described and water-level and chloride trends in the "1,500-foot" sand are documented.

The areal extent of freshwater in the "1,500-foot" sand has been delineated using electric-log (E-log) and water-quality (chloride-analysis) data. The extent and thickness of the aquifer were determined using E-log data, and selected data are shown in two hydrogeologic sections. Chloride and water-level data collected previous to and during the study were analyzed to delineate chloride and water-level trends. These data are available from USGS water-level and chloride monitoring networks and special studies in the area. Additional data were supplied by drillers and well owners. During this study, wells were sampled for chloride, and water levels were measured by the USGS to evaluate present-day (1996) conditions. Pumpage records were analyzed to determine amounts and sources of withdrawals. Locations of selected wells and control points are shown in figure 1 and are listed in table 1. Descriptive data for selected wells are presented in table 1. Data used for this project (including E-log data) are contained in files at the USGS office in Baton Rouge, Louisiana.

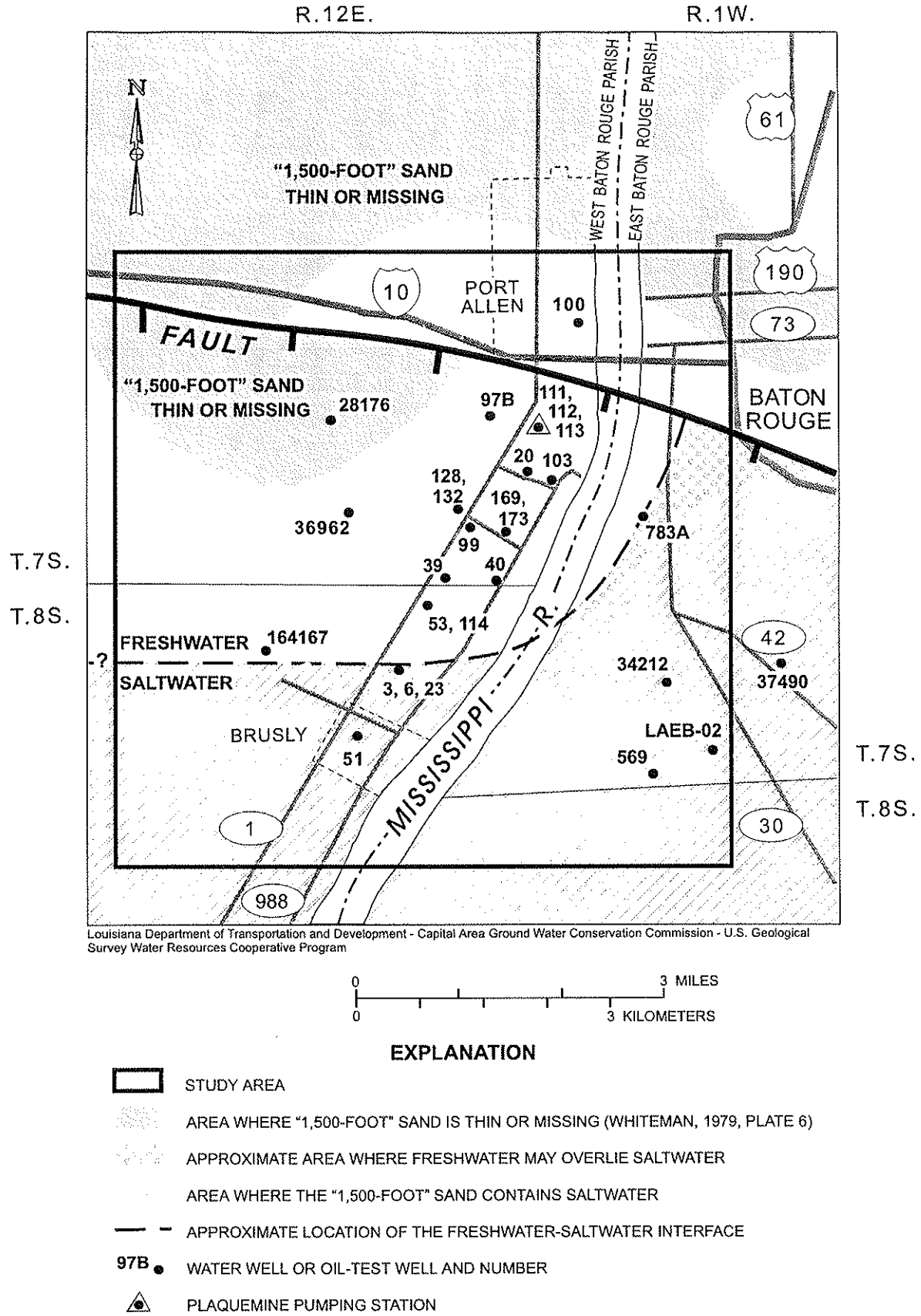


Figure 1. Location of the study area near Brusly, Louisiana.

Table 1. Records of selected water wells near Brusly, Louisiana

[--, no data; U, unused; S, stock; P, public supply]

Well name	Land-net location	Altitude of land surface, in feet above sea level	Year of construc-tion	Diameter of casing, in inches	Depth of well, in feet below land surface	Top of open interval, in feet below land surface	Bottom of open interval, in feet below land surface	Dis-charge, in gallons per minute	Date discharge measured	Water level, in feet below or above (+) land surface	Date water level measured	Primary use of water (1996)	Aquifer
East Baton Rouge Parish													
EB-783A	Sec. 54 T. 7S R. 1W	26	1965	4	2,179	2,174	2,179	--	--	+13.6	06-22-65	U	"1,500-foot" sand
West Baton Rouge Parish													
WBR-3	Sec. 10 T. 8S R. 12E	21	1923	6	2,156	2,076	2,156	350	--	+62.40	10-13-23	U	"1,500-foot" sand
WBR-6	Sec. 10 T. 8S R. 12E	21	1916	4	2,134	2,094	2,134	--	--	+71	01-01-16	U	"1,500-foot" sand
WBR-20	Sec. 71 T. 7S R. 12E	26	1944	4	2,080	--	--	--	--	+46.20	03-01-44	U	"1,500-foot" sand
WBR-23	Sec. 10 T. 8S R. 12E	21	1946	8	2,098	2,065	2,098	214	--	+55.90	07-30-46	U	"1,500-foot" sand
WBR-39	Sec. 5 T. 8S R. 12E	25	1956	6	2,140	2,100	2,120	300	04-27-56	+43.90	04-27-56	U	"1,500-foot" sand
WBR-40	Sec. 3 T. 8S R. 12E	28	1956	3	2,191	2,151	2,191	--	--	--	--	U	"1,500-foot" sand
WBR-53	Sec. 5 T. 8S R. 12W	20	1958	2.50	2,150	2,135	2,150	60	--	+38.00	06-27-58	U	"1,500-foot" sand
WBR-97B	Sec. 70 T. 7S R. 12E	17	1964	4	2,200	2,170	2,200	32	07-22-64	+26.50	07-22-64	U	"1,500-foot" sand
WBR-99	Sec. 75 T. 7S R. 12E	22	1965	6	2,200	2,150	2,200	--	--	+21	10-22-65	U	"1,500-foot" sand
WBR-100B[1]	Sec. 68 T. 7S R. 12E	29	1966	2	2,448	2,444	2,448	25	--	90.44	04-05-66	U	"2,400-foot" sand
WBR-103	Sec. 71 T. 7S R. 12E	30	1966	4	2,137	2,117	2,137	--	--	--	--	S	"1,500-foot" sand
WBR-111	Sec. 70 T. 7S R. 12E	25	1968	16	2,650	2,610	2,630	750	- -68	+43.50	01-15-70	U	"2,000-foot" sand
WBR-112	Sec. 70 T. 7S R. 12E	25	1968	16	2,205	2,105	2,205	750	- -68	23.80	01-15-70	P	"1,500-foot" sand
WBR-113	Sec. 70 T. 7S R. 12E	28	1968	16	2,242	2,148 2,176 2,214	2,168 2,206 2,242	620	--	49.20	05-07-74	P	"1,500-foot" sand
WBR-114	Sec. 5 T. 8S R. 12E	20	1959	10	2,146	2,096	2,146	550	05-09-68	--	--	U	"1,500-foot" sand
WBR-128	Sec. 74 T. 7S R. 12E	20	1974	4	2,195	2,175	2,195	25	--	18.60	03-25-74	U	"1,500-foot" sand
WBR-132	Sec. 74 T. 7S R. 12E	20	1976	12.75	2,082	2,012	2,082	614	09-21-76	30.65	02-10-76	P	"1,500-foot" sand
WBR-169	Sec. 74 T. 7S R. 12E	25	1985	10.75	2,170	2,140	2,170	--	--	60	01-25-85	U	"1,500-foot" sand
WBR-173	Sec. 74 T. 8S R. 12E	25	1985	12	2,194	2,124	2,194	800	--	60.00	04-08-85	P	"1,500-foot" sand

[1] E-log data for WBR-100 was collected at this site.

In this report, saltwater is defined as water containing concentrations of 250 mg/L or more chloride. Concentrations of chloride greater than 250 mg/L exceed the secondary maximum contaminant level (SMCL) for drinking water (U.S. Environmental Protection Agency, 1977, 1992)[1].

Special thanks are extended to Zahir "Bo" Bolourchi, Chief, Louisiana Department of Transportation and Development, Water Resources Section; and to Don Dial, Director, and George Cardwell, Assistant to the Director, Capital Area Ground Water Conservation Commission, for their cooperation in supplying data, including pumpage records. Additionally, the assistance and cooperation of individuals who allowed data collection from privately owned wells is greatly appreciated.

HYDROGEOLOGY

Aquifers in the Brusly area are unconsolidated sand deposits that range in age from Miocene to Holocene (fig. 2). The aquifers (sand units) present in the Brusly area are geographically extensive and have been identified and named (except the Mississippi River alluvial aquifer) according to their depth below land surface in Baton Rouge. In the Brusly area, aquifers generally range in thickness from less than 20 ft to about 600 ft (figs. 3 and 4). Confining units interlayered between the aquifers are composed of clay and silt and generally are at least 100 ft thick but may be as much as 500 ft thick.

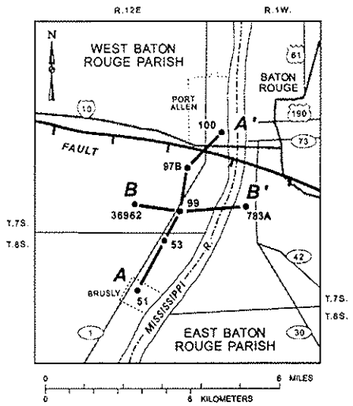
System	Series	Aquifer	Lithologic description	Quality of water in the study area
Quaternary	Holocene and Pleistocene	Mississippi River alluvial aquifer	Fine sand to gravel	Fresh, very hard
		"400-foot" sand, and "600-foot" sand	Fine sand to pea gravel	Salty
Tertiary	Pliocene	"800-foot" sand	Fine to medium sand	Salty
		"1,000-foot" sand	Fine to coarse sand	Salty
		"1,200-foot" sand	Fine to medium sand	Salty
		"1,500-foot" sand		Fresh
		"1,700-foot" sand		Salty
	Miocene	"2,000-foot" sand	Medium sand	Fresh, high color
		"2,400-foot" sand	Fine to medium sand	Salty
		"2,800-foot" sand	Fine to coarse sand	Salty

Louisiana Department of Transportation and Development-U.S. Geological Survey Water Resources Cooperative Program

Figure 2. Hydrogeologic description of aquifers in the Baton Rouge area, Louisiana (modified from Huntzinger and others, 1985).

[1] Secondary maximum contaminant level (SMCL) pertains to contaminants that affect the aesthetic quality of drinking water. At high concentrations or values, health implications as wells as aesthetic degradation also may exist. SMCL's are not Federally enforceable, but are intended as guidelines for the states.

Louisiana Department of Transportation and Development - Capital Area Ground Water Conservation Commission -
U.S. Geological Survey Water Resources Cooperative Program



EXPLANATION

- FRESHWATER IN SAND
- SALTWATER IN SAND
- CLAY
- D/U - FAULT
- U - UPTHROWN
- D - DOWNTHROWN

SP LN
(mV) (Ohm•m)
120 20 200

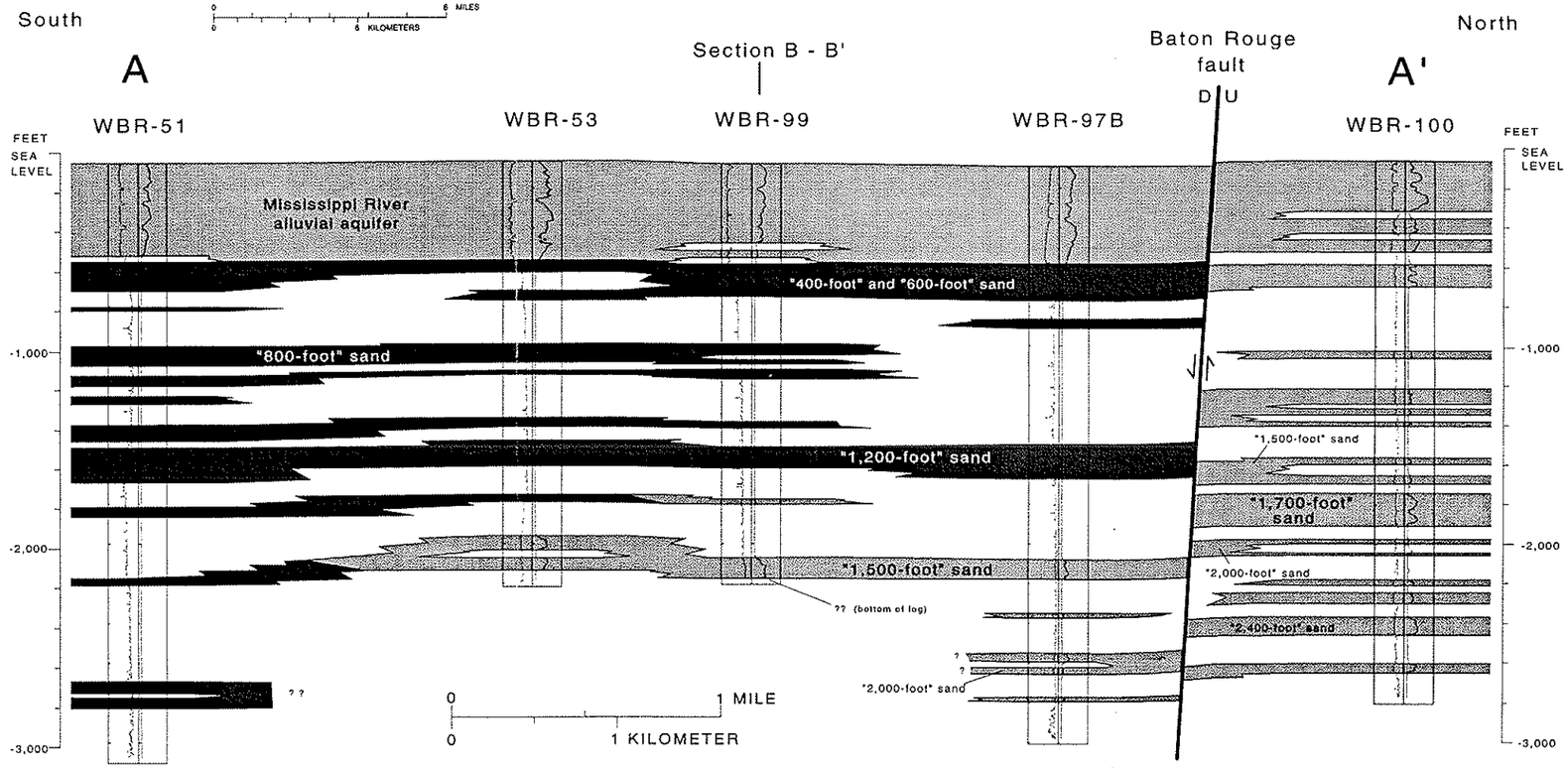
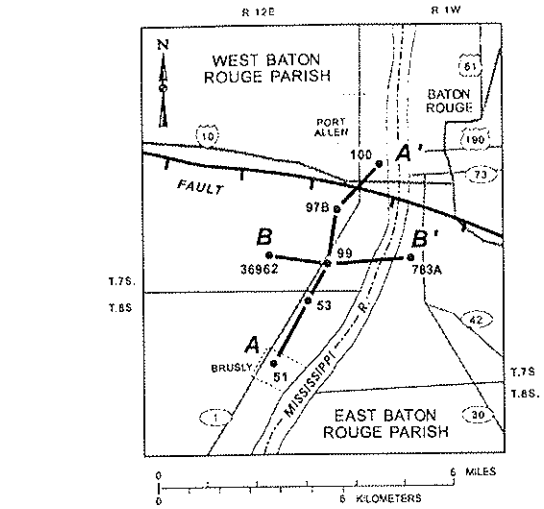
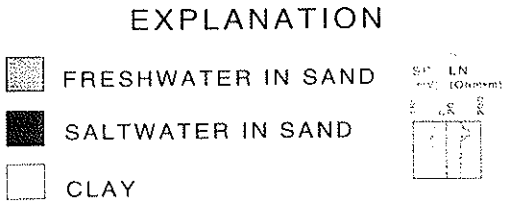


Figure 3. North-south hydrogeologic section.





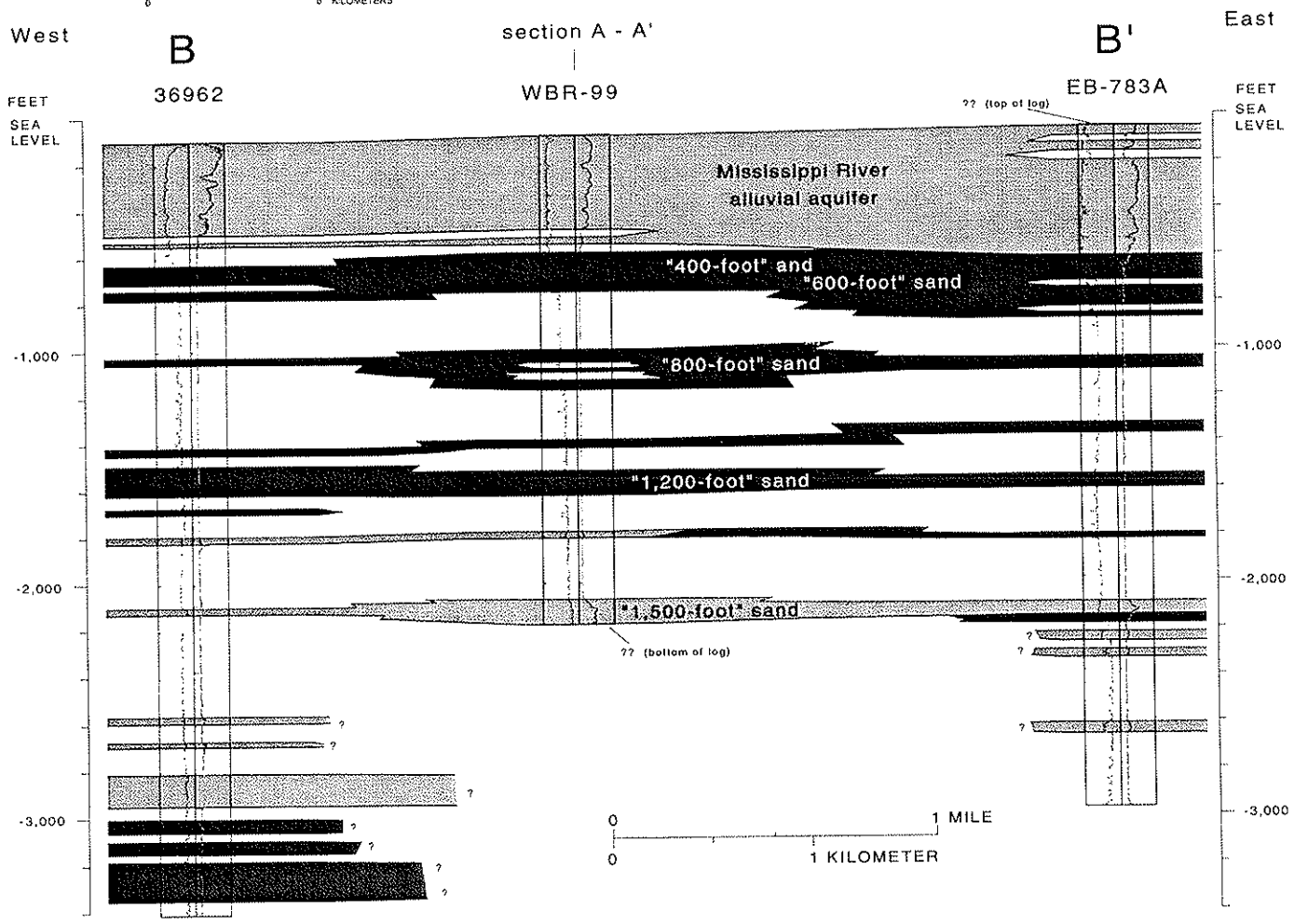


Figure 4. East-west hydrogeologic section.

The "1,500-foot" sand generally ranges in thickness from 20 ft or less to about 150 ft in the Brusly area. Generally, the sand is about 100 ft thick (figs. 3 and 4). In western and southern parts of the Brusly area the sand thins to about 20 ft or less (figs. 3 and 4). The aquifer is thin or absent (less than 10 ft of sand at oil test 28176) near the fault in the northwestern part of the study area (fig. 1). At the Plaquemine pumping station (fig. 1) the sand ranges from about 120 to 150 ft in thickness (determined by E-log interpretation at wells WBR-111 and WBR-113). The aquifer is between 2,000 and 2,200 ft below sea level throughout the Brusly area. Little or no slope of the base of the sand was noted in the study area.

Sand particles range in size from fine to medium in the "1,500-foot" sand as determined by investigations in the Baton Rouge area (Morgan, 1961, p. 39; Meyer and Turcan, 1955, p. 39). Hydraulic conductivity values determined by aquifer tests in the Baton Rouge area range from 125 to 155 ft/d (Morgan, 1961, p. 39) in the "1,500-foot" sand.

The Baton Rouge fault is an important hydrogeologic control, as most ground water north of the fault is fresh and most ground water south of the fault has chloride concentrations exceeding 250 mg/L. The fault transects the northern part of the study area and roughly parallels Interstate Highway 10. Test drilling across the fault in East Baton Rouge Parish has indicated that displacement ranges from a few feet at land surface to as much as 350 ft at the top of the "2,000-foot" sand (Durham and Peeples, 1956, p. 65; Whiteman, 1979, p. 4). Effects of faulting include displacement of sediments (sands and clays), and disruption of ground-water flow.

The effects of displacement across the fault on stratigraphy and water quality in the study area are shown in figure 3. The E-log of well WBR-97B, located south of the fault, indicates saltwater is present in aquifers of intermediate depth between the Mississippi River alluvial aquifer and the "1,500-foot" sand; north of the fault the aquifers of intermediate depth contain freshwater. Freshwater is contained in most of the Mississippi River alluvial aquifer, although saltwater may be present in the base of the aquifer. Freshwater is contained in the "1,500-foot" and "2,000-foot" sands at well WBR-97B. Interpretation of E-log data collected at WBR-100 (located north of the fault) and WBR-97B (fig. 3) indicates that displacement has occurred across the fault. At the base of the Mississippi River alluvial aquifer, displacement across the fault is only about 30 ft; below the aquifer, however, displacement gradually increases with depth. Aquifer displacement of particular importance to this study includes the "1,500-foot" sand, which is displaced downward south of the fault and may be interconnected with the "2,000-foot" sand north of the fault (fig. 3).

Previous investigations have shown that the Baton Rouge fault acts as a leaky barrier to flow of water across the fault (Rollo, 1969; Tomaszewski, 1996; Whiteman, 1979). Subdued declines in water levels south of the fault in comparison to those north of the fault, and flow of saltwater into freshwater areas north of the fault indicate that some leakage across the fault occurs in the Baton Rouge area (Whiteman, 1979, p. 31). However, large differences in water levels in sands laterally adjacent at the fault indicate the restrictive effect that the fault has on ground-water flow in the study area. Water levels may vary more than 100 ft across the fault where the "1,500-foot" sand is displaced adjacent to the "2,000-foot" sand (Tomaszewski, 1996, figs. 9 and 12). No data are available in the study area to determine the quantity of flow across the fault; however, little or no recharge probably moves southward across the fault into the "1,500-foot" sand in the Brusly area. Water from the "1,500-foot" sand in the Brusly area may leak northward across the fault in response to a gradient induced by pumpage from the "2,000-foot" sand in the Baton Rouge area.

DISTRIBUTION OF FRESHWATER IN THE "1,500-FOOT" SAND

In the Brusly area, about 15 mi^2 are underlain with freshwater (fig. 1) in the "1,500-foot" sand. Freshwater extends about 2.5 mi south of the Baton Rouge fault (figs. 1 and 3). Records indicate that the "1,500-foot" sand is only about 20 ft thick at well WBR-51 and contains saltwater. Freshwater is present east of the Mississippi River at well EB-783A (fig. 4); however, saltwater (about 40 ft) occupies the base of the aquifer at this site. Interpretation of E-log data at well EB-780A (not shown in fig. 1) indicates that, south of the fault, freshwater does not extend more than 3 mi east of well EB-783A. Well EB-780A is located near the fault in East Baton Rouge Parish, about 1 mi east of the study area. The "1,500-foot" sand contains freshwater as far west as oil test 164167, where the aquifer is about 110 ft thick. The extent of freshwater west of the study area has not been determined.

Freshwater in the Brusly area may have resulted from preferential flushing of saltwater with freshwater from north of the fault. This flushing process may have taken millions of years. In approximately the last 100 years, as the aquifers have been developed, pumpage in both the Baton Rouge and Brusly areas has altered the natural flushing of saltwater south of the Baton Rouge fault. At present, it is unlikely that the aquifer south of the fault receives freshwater flow from across the fault, unless this occurs west of the study area.

EFFECTS OF PUMPAGE

Pumpage for public supply is the chief use of water from the "1,500-foot" sand in the Brusly area. In 1996, pumpage in the Brusly area totaled about 2.5 Mgal/d from the "1,500-foot" sand. Most of this pumpage, about 1.5 Mgal/d, is from wells WBR-112 and WBR-113 at the Plaquemine pumping station. These two wells supply water for the City of Plaquemine, located south of the study area. Pumpage from wells WBR-132 and WBR-173 is about 0.5 Mgal/d per well. Pumpage data for the period 1975-95 indicate withdrawals from the "1,500-foot" sand south of the fault ranged approximately from 2 to 2.5 Mgal/d. No known pumpage occurs from the "1,500-foot" sand south of the fault adjacent to the study area.

Previous investigations in East and West Baton Rouge Parishes (Whiteman, 1979; Tomaszewski, 1996) have shown that pumpage from the Brusly area has affected water levels south of the Baton Rouge fault eastward into East Baton Rouge Parish. A potentiometric map constructed in April 1976 (Whiteman, 1979, pl. 7) shows that water levels within a few miles south of the fault decreased from about 10 ft above sea level in central East Baton Rouge Parish to 20 ft below sea level near (within 0.4 mi) the Plaquemine pumping station. Whiteman (1979) also indicated that a somewhat distorted cone of depression was centered about the Plaquemine pumping station. Water-level data collected in spring 1990 (Tomaszewski, 1996, fig. 9) showed that water levels within a few miles south of the fault were near sea level in central East Baton Rouge Parish and decreased westward to about 30 ft below sea level near the Mississippi River. Both studies (Whiteman, 1979; Tomaszewski, 1996) indicated that a hydraulic gradient existed from East Baton Rouge Parish into the Brusly study area. Because well locations and pumpage in the study area have remained relatively unchanged, a cone of depression centered about the Plaquemine pumping station and a gradient into the Brusly area probably still exist.

As water is withdrawn from the area, recharge to the "1,500-foot" sand in the Brusly area probably occurs as horizontal flow from the surrounding freshwater and saltwater areas. Water-level gradients in the Brusly area are low (probably 5-10 ft/mi), and indicate that general movement of water from the freshwater-saltwater interfaces may be slow. Although vertical leakage of saltwater from overlying sediments is a possibility, it is likely to be minimal. In much of the area where heavy pumpage occurs (Plaquemine pump-

ing station), the "1,500-foot" sand is underlain by freshwater or is separated from overlying saltwater-bearing aquifers by a clay bed more than 200 ft thick. Throughout the study area, saltwater-bearing sands generally are separated from the "1,500-foot" sand by 100 ft or more clay. No data are available on the quality of water contained in the clays.

Water-Level Trends

Data collected at selected sites since the 1940's indicate declining water-level trends. Water-level declines in the Brusly area can be attributed mostly to withdrawals south of the Baton Rouge fault. Water levels immediately east of the Mississippi River are declining in response to withdrawals from the Brusly area and, to a lesser degree, in response to withdrawals north of the fault. Prior to pumpage from the Plaquemine station (1968), wells screened in the "1,500-foot" sand in the Brusly area flowed at land surface. The earliest water-level data, collected as part of a routine data-collection network and reported on well inventory forms, indicate that water levels exceeded 40 ft above land surface at wells WBR-20 and WBR-23 (table 1 and fig. 5). At sites measured in 1994, water levels in the "1,500-foot" sand ranged from about 55 to 77 ft below land surface (appendix, table A2).

Data collected at wells WBR-20 and WBR-23 indicate water levels in the Brusly area were declining in the 1950's and early 1960's. These declines were probably in response to withdrawals both in the study area and in the nearby, heavily developed Baton Rouge area. During the period 1944-62, the water level declined about 1.5 ft/yr at well WBR-20, located about 0.5 mi south of the Plaquemine pumping station. Data are not available at WBR-20 after 1962.

Water-level trends at well WBR-23 (fig. 5), located about 3 mi south of the Plaquemine pumping station, are similar to those trends at well WBR-20. During the period 1946 through mid-year 1968, the water level declined about 2 ft/yr. The water level declined about 30 ft from mid-1968 to mid-1969. Although pumpage records are not available, sharp water-level declines during this period (1968-69) probably indicate the effect of withdrawing an additional estimated 1 to 1.5 Mgal/d at the Plaquemine pumping station. Water-level data are not available at WBR-23 after 1970.

Additional water-level data for well WBR-97B, located about 0.5 mi west of the Plaquemine pumping station, were available for the period 1964-84 (fig. 6). This well was constructed in 1964 and screened in the "1,500-foot" sand at an interval between 2,170 and 2,200 ft below land surface. At the time of completion (1964), the water level was 26.5 ft above land surface. During the period 1964-67, the water level declined about 2.5 ft/yr. The water level declined about 38 ft during the period 1968-69, after production wells at the Plaquemine pumping station were installed and began withdrawing an additional estimated 1 to 1.5 Mgal/d. The water level declined about 3 ft/yr at well WBR-97B during the period 1970-84. In 1985, well WBR-97B probably began leaking above the screened interval as indicated by an unusually high water level, failure of the well to recover after being pumped for sampling, and the production of muddy water.

Well EB-783A is located in East Baton Rouge Parish about 1.5 mi southeast of the Plaquemine pumping station. Water-level data collected at this site since 1965 indicate that the water level was declining about 3 ft/yr prior to the development of the Plaquemine pumping station in 1968 (fig. 6). A total decline of about 30 ft occurred during the 2-year period 1968-69. No change was noted between 1970 and 1972; however, the water level declined about 4.5 ft/yr during the period 1973-79. Since 1979, the water level has declined slightly, about 0.5 ft/yr.

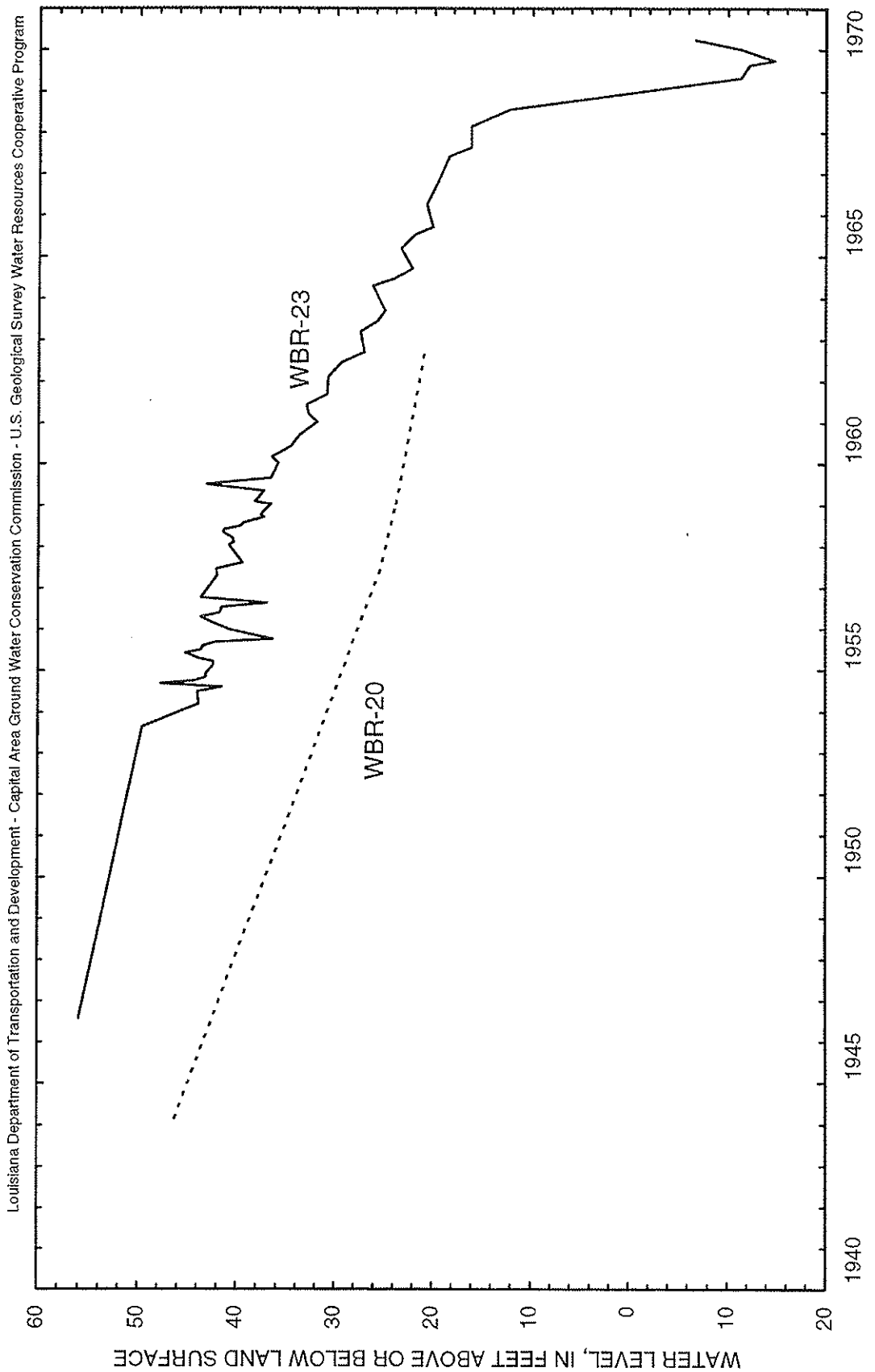


Figure 5. Water levels in wells WBR-20 and WBR-23 in West Baton Rouge Parish, Louisiana.

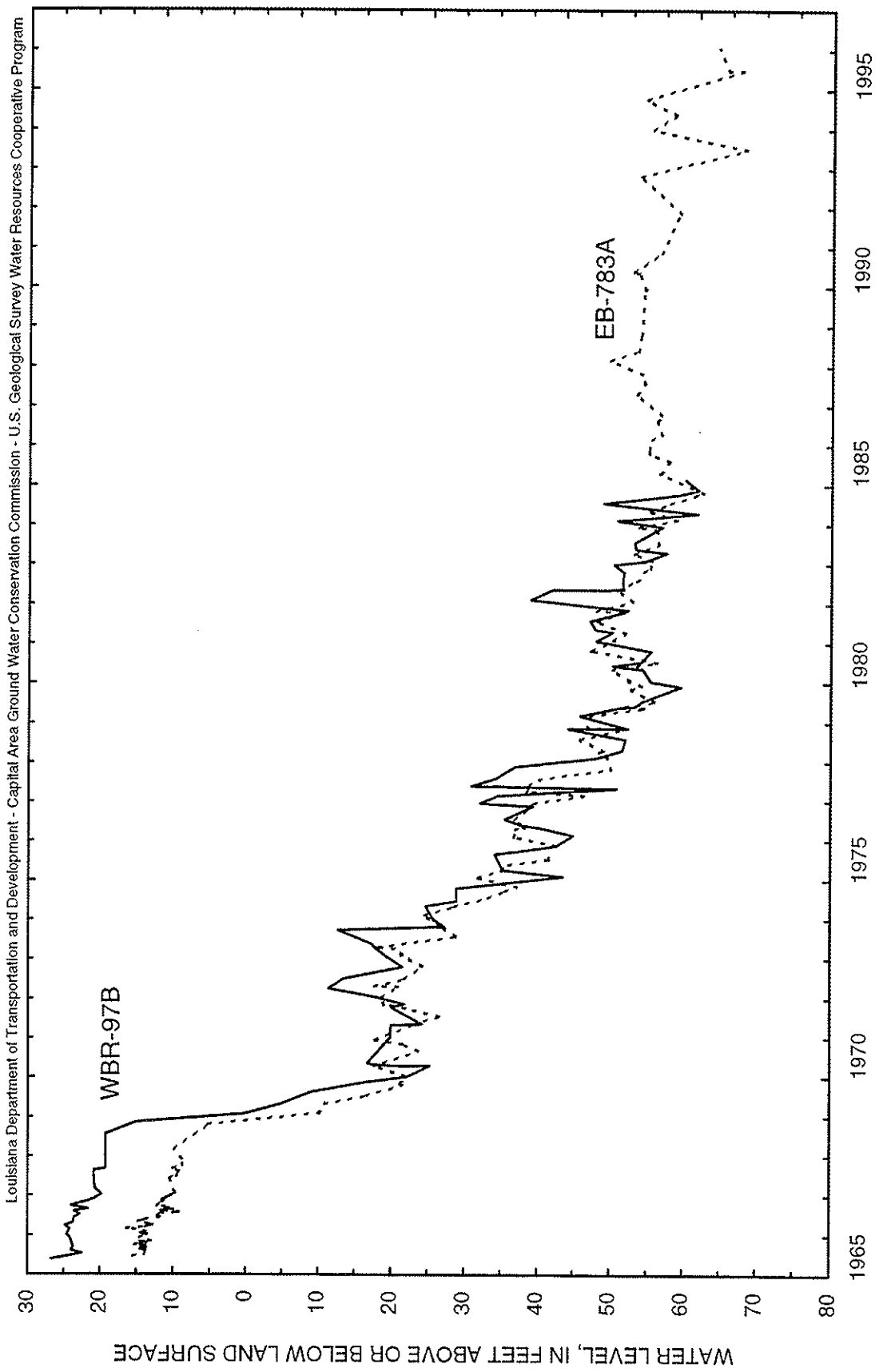


Figure 6. Water levels in wells WBR-97B and EB-783A in West and East Baton Rouge Parishes, Louisiana.

Chloride Trends

During the period 1993-96, chloride concentrations in water from wells screened in the "1,500-foot" sand in the Brusly area ranged from 3.0 to 200 mg/L (table 2). Wells WBR-132 and WBR-173 yielded water containing chloride concentrations less than 10 mg/L; chloride concentrations in water from these wells have not increased during the period of record (table 2). These wells are located in the central area of the freshwater body extending south of the fault. Wells that yielded water having moderate (50-150 mg/L) to high (151-250 mg/L) concentrations of chloride are located at or near the Plaquemine pumping station or near the saltwater interface. Analysis of chloride data collected from wells WBR-112, WBR-113, WBR-97B, and EB-783A indicates that concentrations have increased at these sites during the period of record (figs. 7 and 8).

Chloride concentrations in water from wells WBR-112 and WBR-113 were very low (less than 10 mg/L), when the wells were constructed in 1968. Wells WBR-112 and WBR-113 are located near the fault at the Plaquemine pumping station. Interpretation of E-log data from wells WBR-113 and WBR-111 (also located at this site) indicates water in the aquifer generally was fresh through the entire sand thickness when the wells were constructed. Wells WBR-112 and WBR-113 both began yielding water with increasing chloride concentrations soon after construction (fig. 7). Chloride concentrations in water from well WBR-112 reached 50 mg/L in 1972 and increased to about 80 mg/L in 1996. Chloride concentrations in water from well WBR-113 increased from 140 mg/L in 1969 to 200 mg/L in 1996. At the present trend (during the period 1985-96), the chloride concentration in water from well WBR-113 is increasing about 6 mg/L per year.

Increasing chloride concentrations in water from well EB-783A (fig. 7) may indicate saltwater is encroaching in a westerly direction toward the freshwater in the Brusly area. Chloride concentrations initially decreased from about 120 mg/L in 1965 to about 40 mg/L in 1972; however, since 1972 a steady increase is apparent. By 1996, the chloride concentration had reached 190 mg/L in water from this well. Although EB-783A yields freshwater, interpretation of E-log data indicates saltwater was present in the aquifer below the screened interval when the well was completed.

An increase in the chloride concentration in water from well WBR-97B began in 1968, when wells were installed in the "1,500-foot" sand at the Plaquemine pumping station. Chloride concentrations continued to increase in the 1970's and remained elevated for the period of record shown (fig. 8). A suspected leak in the casing of well WBR-97B may have allowed water from overlying aquifers to enter the well after 1985, and data collected after 1985 are unreliable. To substantiate the presence of saltwater in the "1,500-foot" sand at well WBR-97B, well remediation and additional sampling would be needed.

SUMMARY AND CONCLUSIONS

Aquifers in the Brusly area, Louisiana, consist of unconsolidated sand deposits that range in age from Miocene to Holocene. The aquifers (sand units) present in the study area are geographically extensive and generally have been identified and named according to their depth below land surface in nearby Baton Rouge. In the Brusly area, these aquifers range in thickness from less than 20 feet to about 600 feet. The Baton Rouge fault transects the northern part of the study area and roughly parallels Interstate Highway 10. The fault is an important hydrogeologic control, as most ground water north of the fault is fresh (chloride concentrations are less than 250 milligrams per liter) and most ground water south of the fault contains chloride concentrations exceeding 250 mg/L (milligrams per liter) and is referred to as saltwater in this report. The part of the study area that lies south of the fault is referred to in this report as the Brusly area.

Table 2. Selected chloride data for wells screened in the "1,500-foot" sand near Brusly, Louisiana

[--, no data]

Date	Specific conductance, in microsiemens per centimeter at 25 degrees Celsius	Chloride, in milligrams per liter	Date	Specific conductance, in microsiemens per centimeter at 25 degrees Celsius	Chloride, in milligrams per liter
East Baton Rouge Parish					
Well EB-783A					
12-28-93	1,180	140	01-19-96	866	160
06-29-95	846	150	12-12-96	960	190
West Baton Rouge Parish					
Well WBR-40					
11-04-94	541	68			
Well WBR-112					
10-26-73	517	49	12-12-94	616	75
03-18-93	612	73	02-09-95	626	79
06-04-93	--	74	06-08-95	619	81
08-16-93	617	76	08-18-95	613	79
12-03-93	618	80	10-13-95	616	79
03-01-94	631	81	02-05-96	625	78
05-11-94	618	79	08-19-96	614	79
09-22-94	614	79	10-30-96	623	80
Well WBR-113					
01-12-68	339	3.5	02-09-95	1,090	190
03-18-93	1,050	170	06-08-95	1,080	200
06-04-93	--	180	08-18-95	1,080	180
08-16-93	1,050	170	10-13-95	1,080	190
12-03-93	1,070	190	02-05-96	1,090	190
03-01-94	1,100	190	05-07-96	1,060	180
05-11-94	1,070	190	08-19-96	1,100	200
09-22-94	1,070	190	10-30-96	1,120	200
12-12-94	1,080	180			
Well WBR-132					
08-27-76	310	2.1	02-16-89	--	2.4
05-20-77	311	2.2	07-11-90	--	3.8
11-30-79	310	1.8	06-19-92	319	5.9
10-14-80	315	1.8	06-30-93	312	3.4
11-09-81	--	2.4	02-09-96	328	6.4
Well WBR-173					
02-17-89	--	3.0	06-29-93	318	3.0
07-10-90	--	2.2	05-11-94	321	3.2
06-19-92	324	4.8	02-09-96	328	4.0

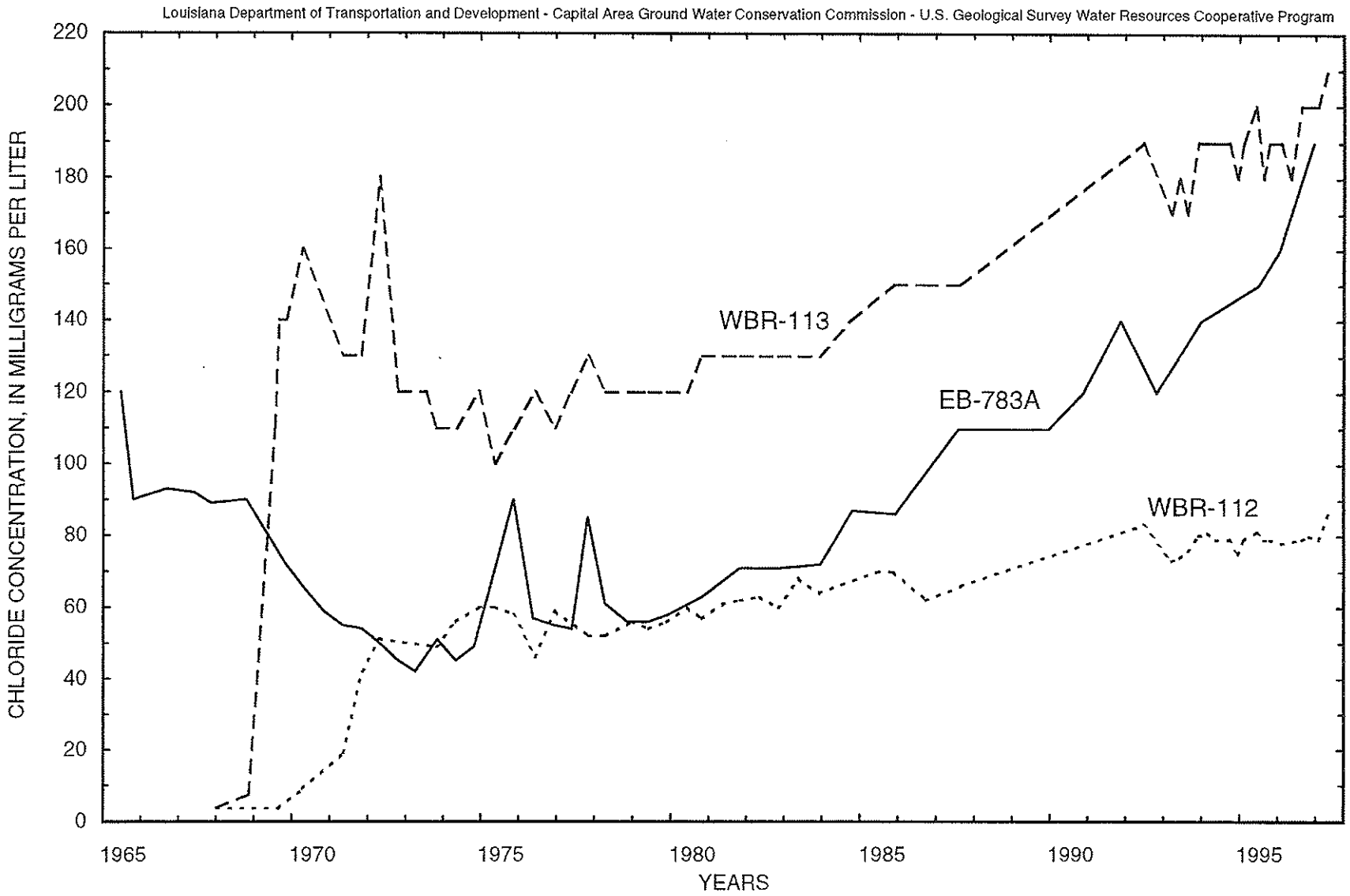


Figure 7. Chloride concentration in water from selected wells in West and East Baton Rouge Parishes, Louisiana.

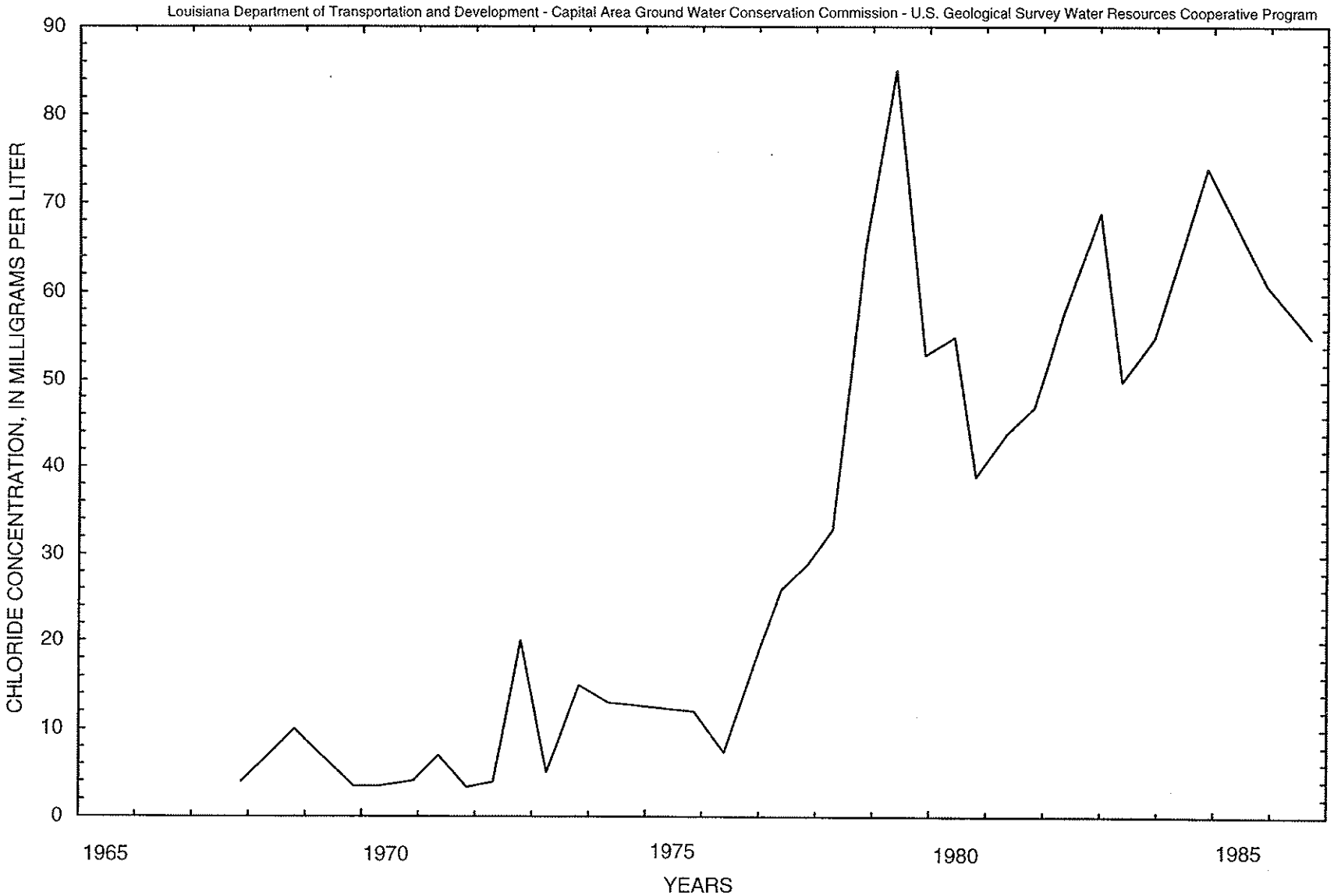


Figure 8. Chloride concentration in water from well WBR-97B in West Baton Rouge Parish, Louisiana.

Three freshwater aquifers are present south of the Baton Rouge fault in the Brusly area: the Mississippi River alluvial aquifer, the "2,000-foot" sand, and the "1,500-foot" sand. The Mississippi River alluvial aquifer contains freshwater, but the water to 500 feet or more below sea level is very hard, and is not used in the study area. The "2,000-foot" sand contains water with high color and also is not used in the study area. The "1,500-foot" sand ranges in thickness from less than 20 feet to about 150 feet in the Brusly area. Generally, the sand is about 100 feet thick. The aquifer is located between 2,000 and 2,200 feet below sea level throughout the Brusly area. In the Brusly area, about 15 square miles are underlain with freshwater in the "1,500-foot" sand. Freshwater in the "1,500-foot" sand is bordered in an eastward and southward direction by saltwater. Freshwater extends south from the fault about 2.5 miles. East of the Mississippi River, saltwater is present at the base of the aquifer at well EB-783A. The western extent of freshwater south of the fault is beyond the study area, and was not determined.

Public supply is the chief use of freshwater from the "1,500-foot" sand in the Brusly area. In 1996, pumpage in the Brusly area totaled about 2.5 million gallons per day. Most of the pumpage south of the fault, about 1.5 million gallons per day, is from wells WBR-112 and WBR-113 at the Plaquemine pumping station.

Water-level declines in the Brusly area can be attributed mostly to withdrawals south of the Baton Rouge fault. Prior to pumpage from the Plaquemine pumping station (1968), wells screened in the "1,500-foot" sand in the Brusly area flowed at land surface. Earliest water-level data indicate that water levels exceeded 40 feet above land surface at wells WBR-20 and WBR-23, located south of the Plaquemine pumping station. The water level at well WBR-20 declined about 1.5 feet per year between 1944 and 1962. Declines at wells WBR-20 and WBR-23 probably were due to low-volume pumpage in the Brusly area and in the heavily developed Baton Rouge area. After production wells were installed nearby at the Plaquemine pumping station, the water levels at wells WBR-97B and EB-783A declined about 38 feet and 30 feet, respectively, during the period 1968-69. Pumping at the Plaquemine pumping station probably causes horizontal flow from surrounding areas (freshwater and saltwater). Water from the "1,500-foot" sand in the Brusly area may leak northward across the fault in response to a gradient induced by pumpage from the "2,000-foot" sand in the Baton Rouge area.

During the period 1993-96, chloride concentrations in water from wells screened in the "1,500-foot" sand ranged from 3.0 to 200 mg/L in the Brusly area. Wells WBR-132 and WBR-173 yielded water containing chloride concentrations less than 10 mg/L. These wells are located in the central area of the freshwater body south of the Baton Rouge fault. Wells that yielded water having moderate (50-150 mg/L) to high (151-250 mg/L) concentrations of chloride are located at or near the Plaquemine pumping station or near the freshwater-saltwater interface. Chloride concentrations in water from wells WBR-112 and WBR-113, located near the fault at the Plaquemine pumping station, were very low (less than 10 mg/L) when the wells were constructed in 1968. Also, electric-log data for wells WBR-111 and WBR-113 indicate water in the aquifer generally was fresh throughout the sand thickness when the wells were constructed. In 1996, wells WBR-112 and WBR-113 yielded water with chloride concentrations of 80 and 200 mg/L, respectively.

SELECTED REFERENCES

Durham, C.O., Jr., and Peeples, E.M., III, 1956, Pleistocene fault zone in southeastern Louisiana [abs.]: Gulf Coast Association of Geological Societies Transaction, v. 6, p. 65-66.

Huntzinger, T.L., Whiteman, C.D., Jr., and Knochenmus, D.D., 1985, Simulation of ground-water movement in the "1,500- and 1,700-foot" aquifer of the Baton Rouge area, Louisiana: Louisiana Department of Transportation and Development, Office of Public Works Water Resources Technical Report no. 34, 52 p.

Meyer, R.R., and Turcan, A.N., Jr., 1955, Geology and ground-water resources of the Baton Rouge area, Louisiana: U.S. Geological Survey Water-Supply Paper 1296, 138 p.

Morgan, C.O., 1961, Ground-water conditions in the Baton Rouge area, 1954-59, with special reference to increased pumpage: Department of Conservation, Louisiana Geological Survey, and Louisiana Department of Public Works Water Resources Bulletin no. 2, 78 p.

Rollo, J.R., 1969, Saltwater encroachment in aquifers of the Baton Rouge area, Louisiana: Department of Conservation, Louisiana Geological Survey, and Louisiana Department of Public Works Water Resources Bulletin no. 13, 45 p.

Tomaszewski, D.J., 1996, Distribution and movement of saltwater in aquifers in the Baton Rouge area, Louisiana, 1990-92: Louisiana Department of Transportation and Development Water Resources Technical Report no. 59, 44 p.

Whiteman, C.D., Jr., 1979, Saltwater encroachment in the "600-foot" and "1,500-foot" sands of the Baton Rouge area, Louisiana, 1966-78, including a discussion of saltwater in other sands: Louisiana Department of Transportation and Development, Office of Public Works Water Resources Technical Report no. 19, 49 p.

----- 1980, Measuring local subsidence with extensometers in the Baton Rouge area, Louisiana, 1975-79: Louisiana Department of Transportation and Development, Office of Public Works Water Resources Technical Report no. 20, 18 p.

U.S. Environmental Protection Agency, 1977, National secondary drinking water regulations: Federal Register, March 31, 1977, v. 42, no. 62, pl. 143, p. 17143-17147.

----- 1992, Drinking water regulations and health advisories: Washington, D.C., U.S. Environmental Protection Agency, Office of Water, 11 p.

APPENDIX

Table A1. Physical and chemical data for selected wells screened in the "1,500-foot" sand near Brusly, Louisiana

[--, no data]

Well name	Date	Specific conductance, in microsiemens per centimeter at 25 degrees Celsius	pH, in standard units	Water temperature, in degrees Celsius	Color, in platinum cobalt units	Milligrams per liter				
						Hardness, total, as $CaCO_3$	Hardness, noncar-bonate, as $CaCO_3$	Calcium, dissolved, as Ca	Magnesium, dissolved, as Mg	Sodium, dissolved, as Na
				East Baton Rouge Parish						
EB-783A	06-22-65	807	8.1	--	10	7	0	1.9	0.50	170
	06-01-67	661	8.2	--	10	1	0	.20	.0	150
				West Baton Rouge Parish						
WBR-20	01-13-60	313	9.1	--	5	4	0	1.4	.10	76
WBR-23	12-30-54	2,850	7.6	--	10	110	0	33	7.8	560
WBR-39	04-26-56	307	7.9	31.0	5	3	0	.50	.50	71
	09-29-61	--	8.7	--	5	2	--	.50	.20	--
WBR-97B	07-22-64	351	8.8	--	40	2	0	.20	.40	87
	09-14-64	366	8.9	--	--	1	0	.20	.05	90
WBR-112	01-12-68	347	9.0	30.5	0	0	0	.0	.0	85
WBR-113	01-12-68	339	9.0	31.5	0	0	0	.0	.0	84
WBR-114	06-28-60	--	8.9	--	10	12	0	1.8	1.8	--
	05-09-68	306	9.2	--	5	2	0	.60	.10	74
WBR-128	03-25-74	309	8.8	29.5	0	1	0	.30	.10	73

Table A1. Physical and chemical data for selected wells screened in the "1,500-foot" sand near Brusly, Louisiana—Continued

Well name	Date	Milligrams per liter								Micrograms per liter	
		Potassium, dissolved, as K	Alkalinity, as $CaCO_3$	Sulfate, dissolved, as SO_4	Chloride, dissolved as Cl	Fluoride, dissolved, as F	Silica, dissolved, as SiO_2	Dissolved solids, residue at 180 degrees Celsius	Nitrogen, nitrate, total, as NO_3	Iron, dissolved, as Fe	Manganese, dissolved, as Mn
East Baton Rouge Parish											
EB-783A	06-22-65	1.6	--	7.2	120	0.50	26	461	--	160	30
	06-01-67	.30	--	7.6	92	.60	26	388	--	--	--
West Baton Rouge Parish											
WBR-20	01-13-60	.50	151	16	2.5	.40	19	212	--	--	--
WBR-23	12-30-54	2.2	217	5.1	780	.40	28	1,550	--	--	--
WBR-39	04-26-56	.30	144	9.6	3.0	.30	28	209	--	--	--
	09-29-61	--	--	--	6.6	.40	--	215	--	--	--
WBR-97B	07-22-64	.80	172	9.2	4.0	.50	60	293	--	--	--
	09-14-64	--	172	--	--	--	15	--	--	--	--
WBR-112	01-12-68	.30	164	10	3.6	.40	49	251	--	60	--
WBR-113	01-12-68	.30	161	11	3.5	.30	45	247	--	20	--
WBR-114	06-28-60	--	146	--	6.0	.20	--	195	--	--	--
	05-09-68	.30	148	10	4.8	.30	25	210	--	50	--
WBR-128	03-25-74	.40	156	8.4	2.0	.10	25	198	0.11	20	<10

Table A2. Selected water-level data for wells screened in the "1,500-foot" sand near Brusly, Louisiana

Well name	Site identification	Date	Water level, in feet below	
			Land surface	Sea level
		East Baton Rouge Parish		
EB-783A	302502091113601	05-11-90	53.52	27.52
		05-16-90	52.96	26.96
		11-16-90	56.59	30.59
		11-12-91	59.10	33.10
		10-22-92	53.76	27.76
		06-30-93	68.27	42.27
		12-28-93	55.45	29.45
		05-10-94	58.42	32.42
		10-01-94	54.50	28.50
		06-27-95	67.66	41.66
		06-29-95	65.22	39.66
		West Baton Rouge Parish		
WBR-40	302431091130301	11-04-94	60.69	32.69
WBR-113	302547091123201	03-01-94	69.60	41.60
		05-11-94	69.86	41.86
		07-14-94	71.75	43.75
		12-06-94	76.55	48.55
		12-12-94	76.39	48.39
		02-09-95	74.62	46.62
		06-08-95	77.59	49.59
		08-18-95	81.55	53.55
		10-13-95	82.90	54.90
		02-05-96	83.94	55.94
WBR-132	302505091132001	06-29-93	57.99	37.99
WBR-173	302456091130202	05-10-94	56.72	31.72