HYDROGEOLOGIC DATA FOR GRACES QUARTERS, ABERDEEN PROVING GROUND, MARYLAND

By Lisa K. Ham, Frederick J. Tenbus, Lewis N. Sears, and Scott W. Phillips

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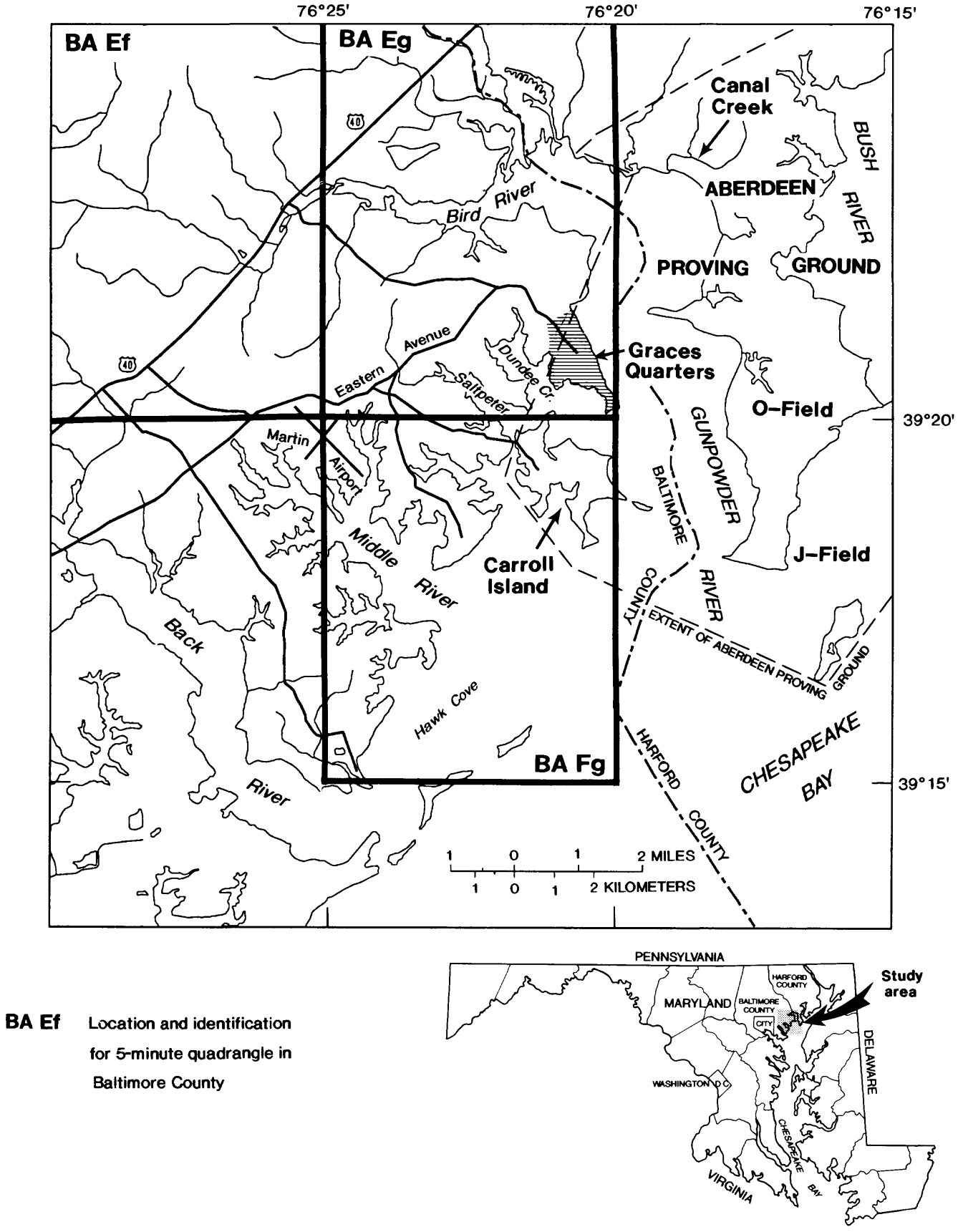
ABSTRACT

Hydrogeologic data were collected from Graces Quarters, Aberdeen Proving Ground, Maryland, as part of a hydrogeologic assessment begun in 1986 to determine the potential environmental effects of military testing and disposal. The U.S. Army conducted chemical-agent and munitions tests in this area from the late 1940's to 1972. This report includes a description of the well network, lithologic, and hydrologic data collected on or near Graces Quarters from April 1987 through April 1989. Observation-well network data include information used for well placement, location and construction data for 32 wells on Graces Quarters, and an inventory of 44 offsite wells. Lithologic data consist of lithologic and geophysical logs and analyses of the physical properties of core sediments. Hydrologic data collected from October 1987 through April 1989 include tables of synoptic measurements and continuous records of ground-water levels, as well as pumpage, aquifer-test, tidal, and precipitation data.

INTRODUCTION

The Edgewood Area of Aberdeen Proving Ground (APG), Maryland, has been used to develop, manufacture, and test military-related chemicals and munitions since World War I. Graces Quarters (fig. 1), as part of the Edgewood Area of APG, was identified by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) as an area that has some degree of environmental contamination. In 1986, the U.S. Environmental Protection Agency (USEPA) issued a Resource Conservation and Recovery Act (RCRA) permit (MD3-21-002-1355) to address solid waste management units (SWMU's) on Graces Quarters. One of the requirements of the permit was to do a hydrogeologic assessment (HGA) to determine the nature and extent of chemical releases from disposal areas (SWMU's) and other sources. In 1986, the U.S. Geological Survey (USGS), in cooperation with the U.S. Army, began the HGA of Graces Quarters.



BA Ef Location and identification for 5-minute quadrangle in Baltimore County

Figure 1.--Location of study area.

The study is being performed in two phases. The objectives of phase I are to--

1) Identify the locations and dimensions of SWMU's and chemical-agent test sites,
2) define the hydrogeologic system, and
3) verify whether SWMU's in the study area have released or are still releasing chemicals into the environment and whether there is residual contamination from chemical-agent testing activities in the study area.

Whether or not phase II of the hydrogeologic assessment will be implemented is contingent on the results from phase I. The objectives of phase II of the hydrogeologic assessment are to--

1) Further characterize the extent of contamination,
2) identify possible remedial-action alternatives, and
3) evaluate the hydrogeologic effects of various remedial-action scenarios.

This report includes information collected for objective two (phase I), which consists of hydrogeologic data compiled from April 1987 through April 1989.

Purpose and Scope

This report presents hydrogeologic data collected from April 1987 through April 1989 for Graces Quarters. The data include (1) the description of the observation-well networks, (2) lithologic data, and (3) hydrologic data.

Twenty-six new observation wells were drilled and used in conjunction with five existing wells (one well, Q04, was never found) to establish a water-level and water-quality network. Lithologic data were collected from 5 test holes and 26 observation wells that were installed in 1988. These data include geophysical logs, lithologic descriptions of split-spoon and continuous core samples, and grain-size analyses from selected lithologic core samples. Data also are presented for slug tests that were performed to obtain an estimate of horizontal hydraulic conductivity at various locations in the Graces Quarters aquifers. Hydrologic data collected included monthly synoptic water levels measured in the wells with chalked steel tapes and continuous water-level data collected from analog to digital recorders (ADR's) that were installed on 11 wells. Data also were collected from a tide gage that was installed near Graces Quarters to help study ground-water and surface-water interactions, and a rain gage that was installed to help estimate aquifer recharge.

Description of Study Area

Graces Quarters is a peninsula located in Baltimore County, 1 mi southeast of Chase, Maryland (fig. 1). The study area is the southern extent of the peninsula bounded by the Gunpowder River to the east, Saltpeter Creek to the south, Dundee Creek to the west, and the Hammerman area of Gunpowder State Park to the north. Land-surface elevations (fig. 2) range from sea level on the southern and western fringes to 45 ft above sea level in the northeastern areas. The 500-acre peninsula is occupied by wildlife and covered with forest, open fields, and marsh.

The Graces Quarters area is underlain by unconsolidated sediments of the Atlantic Coastal Plain. The Coastal Plain sediments are composed primarily of interbedded sand, silt, and clay. The geologic formations that crop out on Graces Quarters are the Patapsco and Arundel Formations (Bennett and Meyer, 1952, pl. 2).

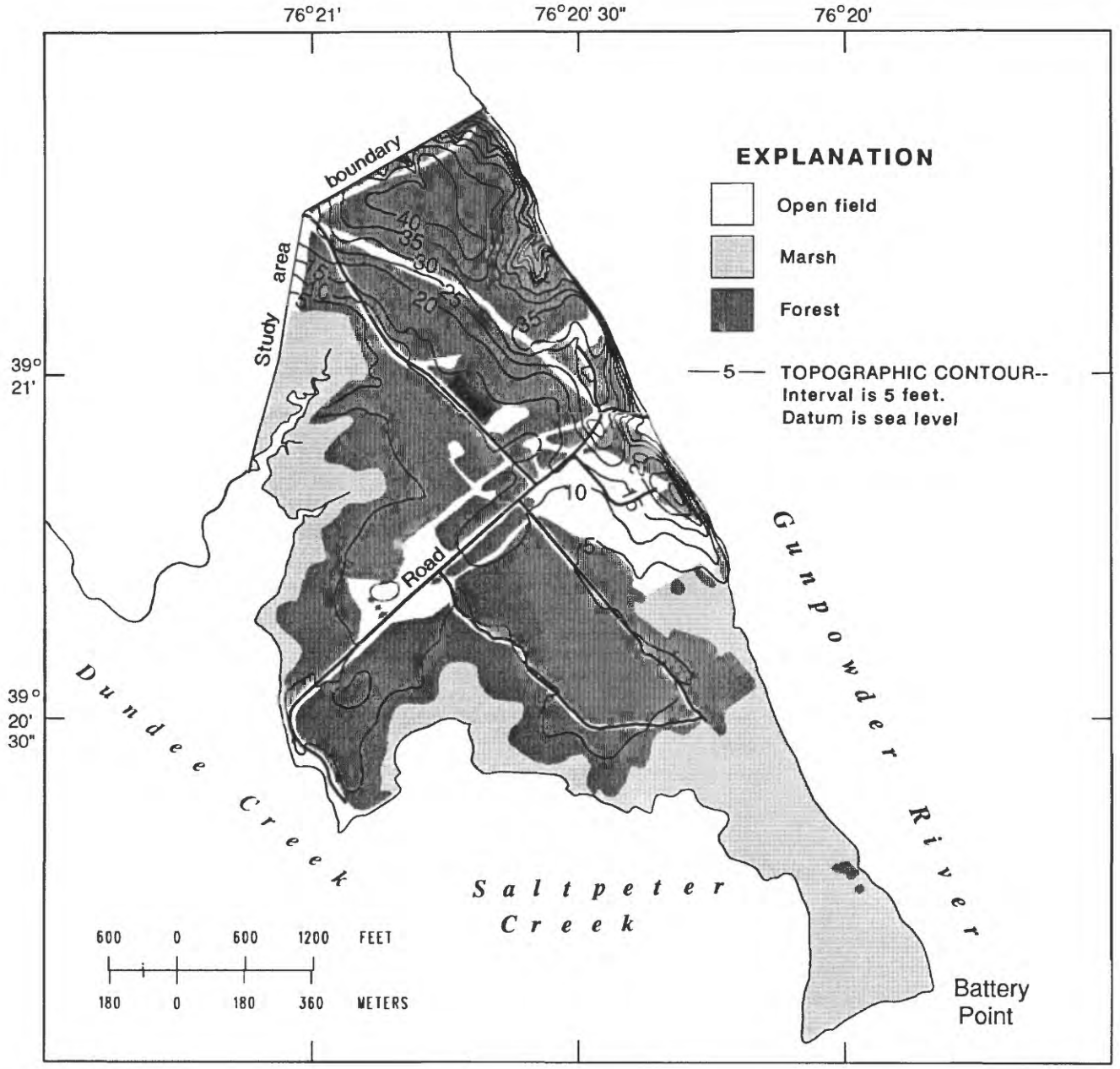


Figure 2.--Terrain and topography of Graces Quarters.

Graces Quarters was acquired by the U.S. Army in 1918 and leased as farmland until 1944. From the late 1940's through 1971, several sites in the area were used for testing various chemical agents (fig. 3). Nemeth (1989) reported that nerve agents (GB, VX, GD, EA 3990), a herbicide (Telvar [1]), and an irritant (CS-1) were tested on Graces Quarters. Quantities released from July 1964 to December 1971 are given in table 1. Although no documentation of the chemical releases prior to 1964 is available, it is known that chemicals such as distilled mustard (HD) were tested (Nemeth, 1989, p. 150). Decontamination was performed using calcium hypochlorite solution, supertropical bleach (STB), and a solvent based solution (DANC). Small dump areas were used for the disposal of test material. The disposal sites are considered SWMU's.

Table 1.--*Quantities of chemicals released at Graces Quarters from July 1964 through December 1971*

[Modified from Nemeth (1989, p. 150)]

Material released	Type	Chemical name	Pounds released
VX	anticholinesterase	B-diisopropylaminoethyl-mercapto-O-ethyl methylphosphonothioate	199.5
Telvar	herbicide		50.0
GB*	anticholinesterase	isopropylmethyl phosphono fluoridate	9.2
GD	anticholinesterase	pinacolylmethyl phosphono fluoridate	1.2
EA 3990	anticholinesterase	No chemical name available	.5
CS-1	irritant	o-chlorobenzalmalononitrile (blended with 5-percent silica aerogel)	.3
Total pounds			260.7

* Includes 6.6 pounds destroyed in a caustic bath.

Previous Investigations

An environmental survey of the Edgewood Area (Nemeth and others, 1983) was conducted by USATHAMA in the late 1970's. The study involved a records search, collection of hydrogeologic data, and collection of samples for chemical analyses of soil, sediment, ground water, and surface water. The records search identified four potential contaminant sources on Graces Quarters. Six wells were drilled near these sites to collect hydrogeologic data. The wells were drilled to a depth of about 25 ft. Samples were collected from each well to determine the lithology and physical properties of the sediments. Water levels in each of the wells were measured once during this study.

Chemical sampling and analysis included the collection of one soil sample, three bottom-sediment samples, three surface-water samples, and five ground-water samples. The samples were analyzed for general chemical quality and for volatile and semivolatile organic compounds. Various halocarbons were present in the ground-water and soil samples at concentrations of 1 to 3,000 µg/L (micrograms per liter). USATHAMA (U.S. Army Toxic and Hazardous Materials Agency, written commun., July 20, 1983) concluded that ground-water contamination on Graces Quarters was not expected but recommended that all wells be sampled quarterly for 1 year. This sampling was not performed.

[1] The use of trade, product, industry, or firm names in this report is for identification or location purposes only, and does not constitute endorsement of products by the U.S. Geological Survey, nor impute responsibility for any present or potential effects on the natural resources.

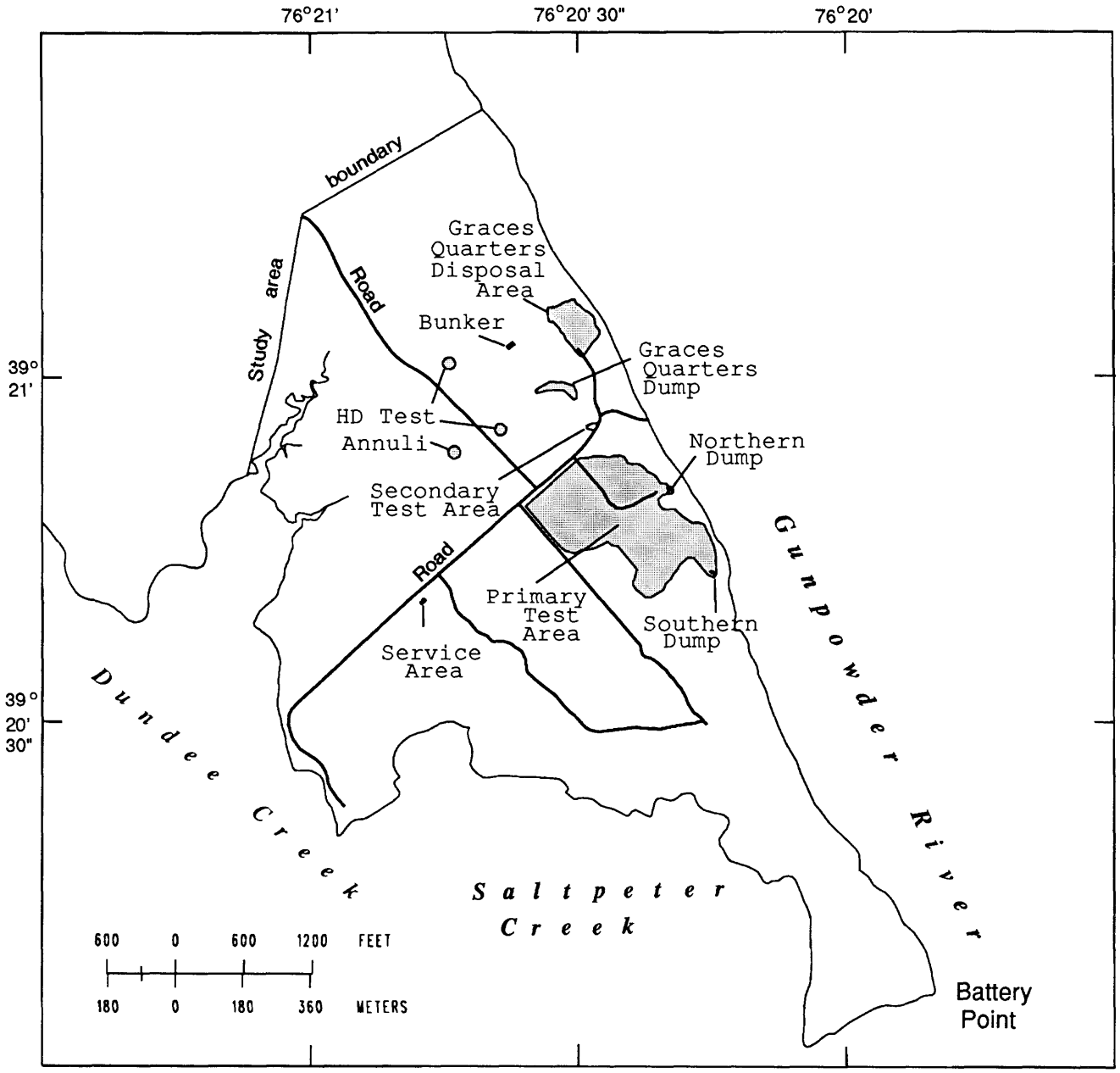


Figure 3.--Approximate location of potential sources of contamination.

As part of the RCRA permit, a RCRA Facility Assessment (RFA) for the Edgewood Area (Nemeth, 1989) was done by the U.S. Army Environmental Hygiene Agency. The purpose of the RFA was to identify SWMU's, collect existing information on contaminant releases, and identify areas that needed further investigation. The RFA study discusses previous testing, environmental study work, photographic interpretations, and descriptions of sites on Graces Quarters. Eight sites, which include the previously identified sites, were identified and classified by Nemeth (1989, p. 492-497) and are listed in table 2.

Table 2.--*Classification of sites at Graces Quarters*

[SWMU = solid waste management unit]

Site name	Classification
Graces Quarters disposal area	SWMU
Graces Quarters dump	SWMU
Test site, northern dump	SWMU
Test site, southern dump	SWMU
Primary test area	test area
Secondary test area	test area
HD test annuli [1]	test area
Service area	support facility

[1] HD is an abbreviation for distilled mustard.

Acknowledgments

The authors wish to thank the following people for their assistance with the Graces Quarters study. Cynthia Couch of the U.S. Army Environmental Management Division acted as a liaison between the U.S. Army, the U.S. Environmental Protection Agency, and the U.S. Geological Survey. Gary Nemeth of AEHA supplied invaluable assistance in project planning and provided information concerning historical use of the study area. Eric Kauffman and Ira May of USATHAMA provided assistance in project planning. Paul Buckmaster of the U.S. Army Chemical Research, Development, and Engineering Center provided a critique of the project safety and health plan. The U.S. Army Corps of Engineers (COE) and technical Escort Unit completed remote-drilling operations on Graces Quarters in a safe and efficient manner. James Stefano was project geologist for the COE, John Bush was drilling foreman, and Edward Woods, William Woods, and John Sanders were the principal drillers.

DESCRIPTION OF OBSERVATION-WELL NETWORK

An observation-well network was established to determine ground-water quality and the direction of ground-water flow at Graces Quarters. The network consisted of 5 observation wells from a previous study (Nemeth and others, 1983) and 26 observation wells that were installed from January through April of 1988. The five existing USATHAMA wells were constructed of 2-in. inside-diameter (I.D.) polyvinyl chloride (PVC) casing with 15- to 20-ft screens. The wells installed for the HGA were constructed of 4-in. I.D. PVC casing with 5-, 10-, or 15-ft long screens. Because of the low water table and fine-grained sediments in some locations, an extra 5 to 10 ft of pipe was included below the screen to act as a water collector (sump). Typical construction of both kinds of wells installed on Graces Quarters is shown in figure 4 (at end of report).

Network Design

Various types of data were used to determine the placement of wells for the study area. Existing literature and historical data were used to locate possible sources of contamination. Field inspections were conducted to estimate the direction of ground-water flow; electromagnetic-induction surveys were conducted (fig. 5 and table 3, at end of report) to locate possible contaminant plumes. Additionally, five test holes were drilled to determine the geologic framework of Graces Quarters, especially the depth and thickness of the uppermost aquifer.

Location and Numbering System of Wells

In order to identify the wells, the USGS used a local numbering system, consistent with that used in Nemeth and others (1983). The wells were numbered in sequential order. The prefix 'Q' indicates that the well is located on Graces Quarters; the suffix 'A' or 'B' indicates that the well was part of a cluster and the chronological order in which the wells in the cluster were installed.

In addition to the local numbering system, a regional USGS number was assigned to each well and test hole in order to store them in the USGS Ground-Water Site Inventory system. These numbers are based on the location of the well by county, the Maryland grid coordinate system, and the chronological order of that particular well in the grid system (for example, BA Eg 113 means Baltimore County, Eg is the grid, and well 113 is the 113th well inventoried inside the Eg grid).

Observation Wells

In 1977, USATHAMA drilled and collected data from six observation wells on Graces Quarters. However, when the USGS began its research for the area, one well, Q04, could not be located. Although the construction data for well Q04 has been included in this report, the well is not part of the water-level network. In 1987 and 1988, the COE drilled 5 test holes and 26 wells on the peninsula. Locations of observation wells are shown in figure 6, test-hole locations are shown in figure 7, and the well-construction and development data from all wells are presented in table 4 (at end of report).

During drilling operations at the study area, safety precautions were used because of the possibility of unexploded munitions. The U.S. Army Technical Escort Unit was on site during the remote-control drilling phase to assist in the safety of the operation. Remote-control drilling was required for the first 15 ft of each hole. After the first 15 ft, standard auger drilling was performed for the remainder of the hole. Lithologic samples and geophysical logs were collected during the drilling to determine the optimum depth and interval of the well screen.

Latitudes and longitudes were determined from topographic maps; altitude of land surface and measuring point was leveled in by the USGS. The completion date shown in table 4 is the date the well was developed. This information, along with other well construction information, was recorded by the COE and provided to the USGS.

Offsite Wells

All wells within a 3-mi radius of Graces Quarters were inventoried to determine possible influences of pumpage on ground-water levels in and near the study area. This inventory consisted of compiling well information from previous studies and updating the previous work with information from wells drilled after the studies were completed. An additional 44 wells were inventoried and located for the current study.

Well locations and data from previous reports can be found in Laughlin (1966) and Chapelle (1985). Laughlin (1966, p. 302-335) inventoried 207 wells in the Maryland well quadrangles (BA Eg and BA Fg) that are closest to Graces Quarters. In 1982, Chapelle (1985, p. 81-83) inventoried 14 new wells in the same quadrangles.

The 44 well-completion reports compiled for this study were obtained from the Maryland Geological Survey files; all wells were plotted on location maps based on the Maryland grid coordinate system (figs. 8, 9, and 10, located at end of report). The majority of these wells are used for domestic supply by residents in the Chase and Middle River areas; the remainder are used for industrial and farming purposes. These wells are listed and discussed in the Pumpage Data section of this report. Well-construction and development data are located in table 5 (at end of report).

LITHOLOGY

This section contains lithologic and geophysical logs for each well. These logs were compiled from samples collected during drilling operations.

Lithologic Logs

Field descriptions were recorded for each of the lithologic samples recovered during drilling operations. Samples were characterized by sediment type (gravel, sand, silt, clay, or various combinations), by color, and by the presence of layering, organic material, mica, or other distinguishing characteristics. Sands and gravels were further categorized by grain size, roundness, sorting, and mineralogy (if it could be determined in the field). Sand-size categories used in this study were: fine [lower (fL) and upper (fU)], medium [lower (mL) and upper (mU)], coarse [lower (cL) and upper (cU)], and the extremes on both ends of the scale [very fine (vf) and very coarse (vc)]. Grain-size dimensions are as follows:

cobble = 64.000 - 256.000 mm	mU = 0.350 - 0.500 mm
pebble = 2.000 - 64.000 mm	mL = 0.250 - 0.350 mm
vcU = 1.410 - 2.000 mm	fU = 0.177 - 0.250 mm
vcL = 1.000 - 1.410 mm	fL = 0.125 - 0.177 mm
cU = 0.710 - 1.000 mm	vfU = 0.088 - 0.125 mm
cL = 0.500 - 0.710 mm	vfL = 0.062 - 0.088 mm

Lithologic descriptions of samples collected during the drilling of the observation wells and test holes are given in table 6 (at end of report). Depth is to the top of the bed; thickness is the distance from the top of the bed to the bottom, or the thickness of the sample taken during split-spoon sampling (usually 0.5 to 1.5 ft). Lithologic descriptions for wells Q01-Q06 can be found in Nemeth and others (1983, p. 3-29 to 3-30).

Geophysical Logs

Geophysical logs were run at each of the test hole and observation well locations by the COE (fig. 11, at end of report). Electric logs can only be obtained from uncased boreholes that contain drilling fluid; therefore, electric logs were collected from test holes only. Gamma logs were collected from both observation wells and test holes. The logging operation consisted of lowering a probe to the bottom of the hole and recording the responses as it was raised. The resulting graph is a plot of either resistance, spontaneous potential, or gamma radiation as a function of depth.

The electric logs used in this study were single-point resistance and spontaneous-potential logs, run in conjunction with each other. The probe for these electric logs consists of a single electrode lowered down the borehole, with another electrode at the surface in the mud pit. One channel of the logger measures resistivity between the two electrodes, while the other channel measures the strength of the potentials that occur at the contacts of down-hole formations.

Gamma logs measure the natural radiation emitted by materials (primarily clay) encountered in the borehole. As the probe is raised, it records the radioactivity of the surrounding formations. A gamma log may be obtained through augers, casing, and (or) any fluids encountered in the hole.

Physical Properties of Core Sediments

Twelve sediment samples from 11 sites were analyzed for grain-size distribution. The samples were taken from well and test-hole cores, and were chosen to characterize the different lithologies found in the study area. Sample site locations are shown in figure 12 (at end of report). The analysis consisted of passing the sample through progressively finer sieves and recording the percent (by weight) of sample passing through each one (table 7, at end of report). Nine different-sized sieves were used.

HYDROLOGY

Ground-water levels in the study area respond to tidal influences, pumpage, and seasonal variations of precipitation and evapotranspiration. To study the response of the ground-water system to these variables, continuous and monthly water-level data were collected using ADR's and synoptic surveys conducted by USGS.

Ground-Water Levels

Synoptic water-level surveys (table 8, at end of report) were conducted on the five USATHAMA wells beginning in October 1987. From March 1988 (when all new observation wells were completed) through March 1989, 31 wells (well Q04 was never found) on Graces Quarters were included in the synoptic surveys. A fixed measuring point (usually the top of the well casing) was established for each well. The elevation of the measuring point was surveyed from a first-order bench mark by the USGS. If an ADR was installed on the well, a new measuring point was established. The measuring points on table 8 are the ones that were used after the ADR's were installed.

The procedure for the synoptic surveys was as follows: (1) Wells on the peninsula were divided so that three groups of personnel could do simultaneous measurements; (2) water levels were measured with a steel tape to an accuracy of 0.01 ft; water levels and time of measurement were recorded; and (3) the measurements were subtracted from the altitude of the measuring point to present the water-level data in relation to sea level.

Hydrographs for Selected Wells

Eleven ADR's were installed on selected wells to monitor the water level at 15-minute intervals. These data helped in determining seasonal and short-term variations of ground-water levels. Data from the ADR's were collected each month. The data are presented on hydrographs, which are graphs showing water levels (relative to sea level) over time (figs. 13-23, at end of report). The water level is shown by a solid line; missing data are indicated by a dotted line.

Pumpage Data

Seven production wells are located within a 3-mi radius of Graces Quarters (table 9 and figs. 9 and 10; all at end of report). Table 9 includes two columns for water usage, stated in gallons per day. One column reflects pumpage values reported by well owners. The accuracy of these quantities depends on the accuracy of the metering technique employed. The far right column shows annual average withdrawal estimates, as reflected on Water Appropriation Permits issued by the Maryland Water Resources Administration.

Aquifer-Test Data

Slug-injection tests, by the volume-displacement method, were conducted on 15 selected wells to determine horizontal hydraulic conductivity and storativity. The slug used in this study was a Teflon-coated cylinder (5.4 ft long and 2.3-in. in diameter). A pressure transducer and a digital data logger were used to monitor the water-level recovery. The slug was placed below the water surface in the well causing a temporary rise in the water level which diminished with time to the equilibrium water level. Rapid removal of the slug caused a lowering of the water level in the well; the recovery was recorded by the data logger as the water level returned to equilibrium. Instantaneous water levels (table 10, at end of report) were recorded at intervals that varied from 0.2 seconds at the beginning of the test to 100 seconds at the end of the test. Tests were run for approximately 16 minutes, except in instances where the equilibrium water level was attained in less time.

Tidal Data

A tide gage was installed in Saltpeter Creek on the northern shore of Carroll Island (fig. 1) to collect data for surface-water and ground-water interactions. Tide-gage data from January 1988 through April 1989 are presented in figure 24 (at end of report). Tidal fluctuations were recorded at 15-minute intervals. Because of the large number of data points, mean daily values are shown. Missing data are indicated by a dotted line.

Precipitation Data

A precipitation gage was installed on Carroll Island to collect data for rainfall and recharge relations in the aquifers. The gage was installed in a heated trailer to prevent freezing during the winter months. Data were recorded at 5-minute intervals. Precipitation data (daily totals) from November 1987 through April 1989 are shown in figure 25 (at end of report). Missing data are shown by a dotted line.

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Tables 3 - 10

Table 3.--*Electromagnetic-induction data, April through October 1987*

[Coils were oriented in both vertical and horizontal planes at each station. Vertical orientation values appear first, separated from the horizontal orientation values by a slash (vertical/horizontal). All values are expressed in milliSiemens per meter. Missing data are expressed as dashes (--); < is less than; > is greater than; - is negative. Note: For location of electromagnetic-induction lines see figure 5]

BASELINE DATA:
Bearing of baseline is 310 degrees.
Data points are at 100-foot intervals.
April 1987

Data point	Vertical/horizontal
1	17/ 22
2	16/ 6
3	14/ 14
4	13/ 13
5	13/ 12
6	10/ 12
7	12/ 19
8	21/ 22
9	22/ 25
10	22/ 30
11	18/ -25
12	17/>300
13	80/>300

NORTHEAST OF BASELINE
Bearing is 40 degrees.
April 1987

	Distance from baseline					
Line	Baseline	100 feet	200 feet	300 feet	400 feet	500 feet
1	21/ 34	16/ 10	19/ 15	--	--	--
2	30/ 12	20/ 18	20/ 22	--	--	--
3	25/ 12	18/ 14	26/ 22	--	--	--
4	22/ 17	20/ 18	20/ 19	22/ 27	18/ 24	--
5	32/ 14	13/ 18	18/ 15	23/ 19	19/ 22	--
6	17/ 18	15/ 16	16/ 17	18/ 20	17/ 18	--
7	16/ 16	14/ 15	16/ 16	16/ 19	17/ 22	18/ 24
8	21/ 19	24/ 24	24/ 26	18/ 24	27/ 8	18/ 25
9	22/ 28	17/ --	22/ 21	20/ 24	18/ 22	17/ 22
10	27/ 20	23/ 27	21/ 27	19/ 24	18/ 20	21/ 22
11	18/ 16	19/ 24	15/ 25	18/ 23	20/ 20	21/ 32
12	17/-87	19/ 57	14/ 19	44/ 23	24/ 20	32/ 36

SOUTHWEST OF BASELINE
Bearing is 220 degrees.
April 1987

	Distance from baseline							
Line	100 feet	200 feet	300 feet	400 feet	500 feet	600 feet	700 feet	800 feet
13	15/ 14	11/ 9	7/ 8	6/ 8	7 / 10	4/ 8	6/ 6	5/ <1
14	8/ 5	5/ 7	6/ 8	8/ 8	5 / 8	3/ 4	2/ 4	2/-24
15	11/ 9	11/ 11	9/ 11	9/ 7	6 / 6	5/ 5	--	5/ 6
16	9/ 14	10/ 13	7/ 7	6/ 20	>300 />300	25/140	90/240	35/235
17	21/ -4	15/ 5	8/ 38	6/-30	9 / 48	10/110	7/130	4/-60

Table 3.--*Electromagnetic-induction data, April through October 1987*--Continued

BACK AREAS
Bearing is 130 degrees.
Data points are at 50-foot intervals.
Coils are oriented horizontally.
October 1987

Line 18		Line 19		Line 20	
Data Point	Reading	Data Point	Reading	Data Point	Reading
1	13.0	1	11.0	1	5.0
2	11.0	2	35.0	2	14.0
3	9.0	3	6.0	3	7.0
4	10.5	4	7.0	4	36.0
5	13.0	5	6.0	5	13.0
6	38.0	6	7.0	6	9.0
7	53.0	7	6.0	7	-15.0
8	26.0	8	--	8	2.0
9	-75.0	9	12.0	9	1.5
10	300.0	10	10.0	10	3.0
11	12.0	11	7.0	11	3.2
12	-6.0	12	6.0	12	2.3
13	--	13	8.0	13	3.2
14	20.0	14	12.0	14	-3.0
15	10.0	15	12.0	15	-2.0
16	6.0	16	11.0	16	10.0
17	6.0	17	12.0	17	24.0
18	6.0	18	15.0	18	5.0
19	6.0	19	12.0	19	6.0
20	7.0	20	18.0	20	5.0
21	7.0	21	12.0	21	6.2
22	8.0	22	12.0	22	6.0
23	7.0	23	11.0	23	6.0
24	8.0	24	9.0	24	7.2
25	7.0	25	8.0		
26	7.0	26	7.0		
27	7.0	27	7.0		
28	9.0	28	6.0		
29	10.0	29	6.0		
30	17.0	30	7.0		
		31	7.0		
		32	7.0		
		33	5.0		
		34	6.0		
		35	11.0		

Table 4.--*Description of observation wells and test holes*

[Driller: U.S. Army Corps of Engineers; method of construction: Bored; use of water: None. Latitude and longitude: Degrees (°), minutes ('), and seconds ("). Depths are measured from land surface datum, altitude is land surface in reference to sea level. Type of pump is either hand (H) or submersible (S). Missing data are represented by dashes (--). NR denotes "not recorded". ft = feet; in. = inches; gal/min = gallons per minute. For location of observation wells, see figure 6; for location of test holes, see figure 7]

Well no.	Latitude (o,',")	Longitude (o,',")	Altitude (ft)	Date of completion	Depth of well (ft)	Depth of hole (ft)	Diameter of screen/casing (in.)	Aquifer
Q01	392106	762035	30.14	1977	22.3	--	2.0	surficial
Q02	392105	762029	37.19	1977	28.0	--	2.0	surficial
Q03	392100	762028	35.26	1977	30.0	--	2.0	surficial
Q04	--	--	--	1977	26.0	--	2.0	surficial
Q05	392054	762039	11.68	1977	22.0	--	2.0	surficial
Q06	392103	762053	7.00	1977	23.5	--	2.0	surficial
Q07	392107	762034	25.93	04-13-88	29.0	35.0	4.0	surficial
Q08	392104	762032	37.47	04-12-88	20.0	26.5	4.0	surficial
Q09A	392103	762029	35.88	04-12-88	25.0	25.0	4.0	surficial
Q09B	392103	762029	36.23	04-20-88	150.0	181.0	4.0	confined
Q09T	392103	762029	--	01-21-88	--	181.0	--	--
Q10	392101	762033	27.48	04-12-88	31.0	49.5	4.0	surficial
Q11	392059	762035	20.76	04-15-88	33.0	35.0	4.0	surficial
Q12	392058	762031	20.24	04-19-88	30.0	80.0	4.0	surficial
Q13	392102	762028	37.36	04-19-88	43.0	60.0	4.0	surficial
Q14	392051	762029	11.08	04-21-88	30.0	40.0	4.0	surficial
Q15	392045	762017	11.61	04-22-88	22.0	25.0	4.0	surficial
Q16A	392047	762024	12.09	NR	87.3	98.0	4.0	confined
Q16B	392047	762024	11.99	04-25-88	30.0	30.0	4.0	surficial
Q16T	392047	762024	--	02-05-88	--	176.0	--	--
Q17	392056	762038	14.08	04-15-88	14.0	19.5	4.0	surficial
Q18A	392054	762045	8.36	04-19-88	20.0	25.0	4.0	surficial
Q18B	392054	762045	8.11	04-19-88	75.0	86.0	4.0	confined
Q18T	392054	762045	--	12-10-87	--	142.0	--	--
Q19A	392113	762048	40.84	04-20-88	169.0	175.0	4.0	confined
Q19T	392113	762048	--	12-07-87	--	175.0	--	--
Q20A	392041	762050	10.17	02-03-88	90.0	120.0	4.0	confined
Q20B	392041	762050	10.59	04-19-88	24.0	25.0	4.0	surficial
Q20T	392041	762050	--	01-30-88	--	180.0	--	--
Q21	392056	762030	22.82	04-19-88	18.0	32.0	4.0	surficial
Q22	392102	762038	33.77	04-13-88	20.0	21.5	4.0	surficial
Q23	392050	762021	29.09	04-21-88	20.0	25.0	4.0	surficial
Q24	392051	762020	28.03	04-21-88	21.0	25.0	4.0	surficial
Q25	392050	762019	33.05	04-21-88	27.0	35.0	4.0	surficial
Q26	392043	762016	3.33	04-22-88	17.0	20.0	4.0	surficial
Q27	392043	762014	6.77	04-22-88	13.0	20.0	4.0	surficial
Q28	392042	762015	5.22	04-13-88	20.0	44.0	4.0	surficial

Table 4.--*Description of observation wells and test holes*--Continued

Interval of									
Screen (ft)	Sand pack (ft)	Bentonite seals (ft)	Grout (ft)	Pumping rate (gal/min)	Hours pumped	Type of pump	Remarks	USGS well no.	Well no.
7.3- 22.3	--	--	--	--	--	--		BA Eg 155	Q01
8.0- 28.0	--	--	--	--	--	--		BA Eg 200	Q02
10.0- 30.0	--	--	--	--	--	--		BA Eg 201	Q03
5.9- 25.9	--	--	--	--	--	--	Not located	--	Q04
7.0- 22.0	--	--	--	--	--	--		BA Eg 157	Q05
8.5- 23.5	--	--	--	--	--	--		BA Eg 204	Q06
14.0- 24.0	11.6- 35.0	9.3- 11.6	3.0- 9.3	--	--	H	5-ft sump	BA Eg 205	Q07
5.0- 15.0	3.8- 26.5	0.0- 3.8	--	--	--	H	Shelby/5-ft sump	BA Eg 206	Q08
5.0- 20.0	4.0- 25.0	0.0- 4.0	--	--	--	H	5-ft sump	BA Eg 207	Q09A
140.0-150.0	120.0-151.0	117.0-120.0	4.0-117.0	4.5	4.0	S		BA Eg 208	Q09B
--	--	--	--	--	--	--	Test hole	BA EG 159	Q09T
21.0- 31.0	18.2- 31.6	16.4- 18.2	3.0- 16.4	0.8	4.0	H	Shelby	BA Eg 209	Q10
18.0- 28.0	15.1- 35.0	13.4- 15.1	3.0- 13.4	--	2.0	H	5-ft sump	BA Eg 210	Q11
20.0- 30.0	16.8- 80.0	15.3- 16.8	3.0- 15.3	1.0	4.0	H		BA Eg 211	Q12
33.0- 43.0	29.6- 60.0	28.2- 29.6	3.0- 28.2	--	2.0	H		BA Eg 161	Q13
20.0- 30.0	15.0- 40.0	12.0- 15.0	3.0- 12.0	1.0	2.0	H		BA Eg 213	Q14
17.0- 22.0	16.0- 25.0	14.0- 16.0	3.0- 14.0	--	1.0	H		BA Eg 214	Q15
77.3- 87.3	73.8- 98.0	72.4- 73.8	3.0- 72.4	--	--	--		BA Eg 162	Q16A
5.0- 20.0	3.0- 30.0	0.0- 3.0	30.0-175.0	6.0	4.0	S	10-ft sump	BA Eg 163	Q16B
--	--	--	--	--	--	--	Test hole	BA Eg 164	Q16T
9.0- 14.0	7.0- 19.5	5.0- 7.0	2.5- 5.0	--	1.0	H		BA Eg 217	Q17
10.0- 20.0	9.0- 25.0	7.0- 9.0	3.0- 7.0	--	1.5	H		BA Eg 165	Q18A
65.0- 75.0	61.4- 80.5	59.0- 61.4	3.0- 59.0	5.0	3.0	S		BA Eg 166	Q18B
--	--	--	--	--	--	--	Test hole	BA Eg 167	Q18T
159.0-169.0	155.3-175.0	153.8-155.3	5.0-153.8	4.0	3.0	S		BA Eg 168	Q19A
--	--	--	--	--	--	--	Test hole	BA Eg 169	Q19T
80.0- 90.0	76.8-101.2	75.2- 76.8	3.0- 75.2	6.5	3.0	H		BA Eg 172	Q20A
4.0- 14.0	2.2- 25.0	0.0- 2.2	--	--	--	--	10-ft sump	BA Eg 171	Q20B
--	--	--	--	--	--	--	Test hole	BA Eg 170	Q20T
8.0- 18.0	5.3- 32.0	4.1- 5.3	2.0- 4.1	--	1.0	H	Shelby	BA Eg 223	Q21
5.0- 15.0	3.0- 21.5	0.0- 3.0	--	0.1	3.0	H	Shelby/5-ft sump	BA Eg 224	Q22
10.0- 20.0	8.1- 25.0	6.9- 8.1	3.0- 6.9	NR	<0.1	H		BA Eg 225	Q23
11.0- 21.0	8.7- 25.0	7.2- 8.7	3.0- 7.2	NR	<0.1	H		BA Eg 226	Q24
17.0- 27.0	14.6- 35.0	13.3- 14.6	3.0- 13.3	NR	<0.1	H		BA Eg 227	Q25
12.0- 17.0	10.0- 20.0	8.0- 10.0	3.0- 8.0	0.1	2.0	H		BA Eg 228	Q26
8.0- 13.0	6.0- 20.0	4.0- 6.0	2.0- 4.0	0.1	2.0	H		BA Eg 229	Q27
15.0- 20.0	14.0- 20.0	12.0- 14.0	3.0- 12.0	<0.1	3.0	H		BA Eg 230	Q28

Table 5.--*Description of offsite wells*

[Method of drilling: Rotary; pumping equipment = air. ft = feet; in. = inches; gal/min = gallons per minute; (gal/min)/ft = gallons per minute per foot. Aquifer: Kp = Patapsco Formation; Kpx = Patuxent Formation. Use of water: D = domestic; I = industrial; A = agricultural (farming). N/A = not available. Altitude is land surface in reference to sea level. Screen interval and depth of well are relative to land-surface datum. Casing-screen diameter: When casing diameter does not equal screen diameter, first value is diameter of casing; second value is diameter of screen. For location of offsite wells, see figures 8, 9, and 10]

USGS well number	State permit number	Owner	Driller	Date completed	Altitude (ft)	Depth of well (ft)	Casing-screen diameter (in.)	Length of casing (ft)	Screen interval
BA Ef 172	BA-81-4665	John Dumer	W. Frank	04/14/86	35	90	4-2	80	80- 90
BA Ef 173	BA-81-2047	James Haga	W. Frank	09/26/83	40	115	4-2	105	105-115
BA Ef 174	BA-73-5119	Milton Gardner	J. Branham	11/21/77	45	87	4-2	80	80- 87
BA Ef 175	BA-81-2662	Jay McCleave	R. Frank	05/11/84	65	208	4-2	198	198-208
BA Ef 176	BA-73-8064	Matthew Cook	W. Frank	03/24/81	45	55	4-2	45	45- 55
BA Eg 177	BA-81-2212	James Baker	W. Frank	11/25/83	45	97	4-2	87	87- 97
BA Eg 178	BA-81-0352	Dept. of the Army	W. Frank	11/19/81	15	199	4	189	189-199
BA Eg 179	BA-81-2012	Veronica Barbour	W. Frank	09/09/83	10	115	4-2	105	105-115
BA Eg 180	BA-73-1592	Thomas O'Day	W. Leonard	09/30/74	10	110	4-2	103	103-110
BA Eg 181	BA-81-0134	Daniel Bevans	W. Frank	08/17/81	15	120	4-2	113	113-120
BA Eg 182	BA-73-7964	Mike Meagher	W. Frank	02/25/81	15	115	4-2	105	105-115
BA Eg 183	BA-73-2294	William Budreski	W. Frank	07/16/75	20	75	4-2	70	70- 75
BA Eg 184	BA-81-1459	Mike Murphy	W. Frank	04/01/83	20	120	4-2	110	110-120
BA Eg 186	BA-81-0550	Leroy Johnson	W. Frank	02/15/82	15	130	4-2	120	120-130
BA Eg 187	BA-81-2026	Rita McMullen	W. Frank	09/14/83	65	140	4-2	130	130-140
BA Eg 188	BA-81-2838	T & A Excavating	W. Frank	07/05/84	80	100	4-2	90	90-100
BA Eg 189	BA-81-2114	Clifton Mizelle	W. Frank	10/21/83	20	60	4-2	50	50- 60
BA Eg 190	BA-81-5683	Leroy Burrs	W. Frank	09/25/86	20	62	4-2	55	55- 62
BA Eg 191	BA-81-5557	Dorothy Tischler	W. Frank	09/04/86	25	72	4-2	62	62- 72
BA Eg 192	BA-81-5556	Dorothy Tischler	W. Frank	09/05/86	15	60	4-2	50	50- 60
BA Eg 193	BA-81-5978	Elsie Steinmann	W. Frank	01/06/87	10	55	4-2	48	48- 55
BA Eg 194	BA-81-8637	Steven Kline	W. Frank	09/26/86	15	60	4-2	52	52- 60
BA Eg 195	BA-73-7406	Frank Wallis	W. Leonard	05/07/80	10	90	4-2	83	83- 90
BA Eg 196	BA-81-7195	Charlotte Diffendall	W. Frank	09/14/87	5	120	4-2	113	113-120
BA Eg 197	BA-81-7318	Veronica Barbour	W. Frank	10/29/87	10	110	4-2	103	103-110
BA Eg 198	BA-81-7396	Moore Precast Concrete	W. Frank	11/24/87	40	220	4-2	213	213-220
BA Fg 148	BA-81-5142	Edgar Lassahn	W. Frank	06/09/86	5	38	4-2	31	31- 38
BA Fg 149	BA-81-2079	James Wilhelm	W. Frank	09/27/83	5	65	4-2	55	55- 65
BA Fg 150	BA-81-6641	Elizabeth Martin	W. Frank	04/27/87	5	67	4-2	60	60- 67
BA Fg 151	BA-81-5445	Thomas Lamar	W. Frank	08/14/86	5	140	4-2	130	130-140
BA Fg 153	BA-87-G014	Baltimore G & E	Branham	12/16/87	5	110	6-4	70	70-105
BA Fg 154	BA-73-0108	Richard Fantom	W. Leonard	08/22/72	10	104	4-2	99	99-104
BA Fg 155	BA-73-7310	Charles Miller	W. Frank	03/04/80	10	100	4-2	103	103-100
BA Fg 156	BA-81-5684	Elizabeth Edwards	W. Frank	10/22/86	10	110	4-2	100	100-110
BA Fg 157	BA-81-0596	Frank Carlotta	W. Frank	03/29/82	10	87	4-2	77	77- 87
BA Fg 158	BA-73-5786	Ruth Conrad's Villa	W. Frank	05/25/78	5	50	4-2	45	45- 50
BA Fg 159	BA-73-7197	Jerry Hanincheck	W. Frank	12/12/79	10	135	4-2	125	125-135
BA Fg 160	BA-73-6521	Willner Raymond	W. Frank	03/06/79	10	100	4-3	93	93-100
BA Fg 162	BA-73-6219	Kathleen Butler	W. Frank	10/18/78	5	145	4-2	140	140-145
BA Fg 164	BA-81-6866	Charles Ritter	W. Frank	08/12/87	10	250	4-2	237	237-250
BA Fg 166	BA-81-3216	Virginia Smith	W. Frank	11/07/84	5	40	4-2	33	33- 40
BA Fg 167	BA-81-1547	Romuald Nickles	W. Frank	05/03/83	5	60	4-2	50	50- 60
BA Fg 169	BA-81-2098	Carol Spultz	W. Frank	10/12/83	5	65	4-2	55	55- 65
BA Fg 170	BA-73-7276	Denver Cross	W. Frank	02/14/80	5	67	4-2	60	60- 67

Table 5.--*Description of offsite wells*--Continued

Aquifer	Water level (feet below land surface) Static	Pumping	Date	Yield (gal/min)	Length of test (hours)	Specific capacity [(gal/min)/ft]	Use of water	Remarks	USGS well
Kp	12	21	04/14/86	60	3	6.67	D		BA Ef 172
Kp	22	32	09/26/83	30	3	3	D	Replacement well	BA Ef 173
Kp	38	58	11/21/77	60	2	3	D	Replacement well	BA Ef 174
Kpx	85	93	05/11/84	30	3	3.75	D		BA Ef 175
Kp	11	21	03/21/84	30	2	3	D	Replacement well	BA Ef 176
Kp	41	51	11/25/83	15	3	1.50	D	Replacement well	BA Eg 177
Kpx	1	55	11/19/81	N/A	4	N/A	I		BA Eg 178
Kp	2	12	09/09/83	60	3	6	D	Replacement well	BA Eg 179
Kp	1	30	09/30/74	25	1	0.86	D	Replacement well	BA Eg 180
Kp	6	16	08/17/81	30	2	3	D	Replacement well	BA Eg 181
Kp	3	13	02/25/81	30	2	3	D	Replacement well	BA Eg 182
Kp	10	20	07/16/75	30	2	3	D	Replacement well	BA Eg 183
Kpx	23	33	04/01/83	50	3	5	D	Replacement well	BA Eg 184
Kp	14	29	02/15/82	40	3	2.67	D		BA Eg 186
Kpx	63	73	09/14/83	25	3	2.5	D	Replacement well	BA Eg 187
Kp	20	31	07/05/84	20	3	1.82	I		BA Eg 188
Kp	16	26	10/21/83	20	3	2	D	Replacement well	BA Eg 189
Kp	23	32	09/26/86	20	3	2.22	D	Replacement well	BA Eg 190
Kp	24	33	09/04/86	15	3	1.67	D	Replacement well	BA Eg 191
Kp	15	24	09/05/86	20	3	2.22	D	Replacement well	BA Eg 192
Kp	10	19	01/06/87	30	3	3.33	D	Replacement well	BA Eg 193
Kp	16	25	09/26/86	25	3	2.78	D	Replacement well	BA Eg 194
Kp	16	25	05/07/80	35	2	3.89	D	Replacement well	BA Eg 195
Kp	6	15	09/14/87	50	3	5.56	D	Replacement well	BA Eg 196
Kp	7	18	10/29/87	60	3	5.45	D	Replacement well	BA Eg 197
Kpx	28	37	11/24/87	50	3	5.56	I		BA Eg 198
Kp	3	12	06/09/86	25	3	2.78	D	Replacement well	BA Fg 148
Kp	3	13	09/27/83	30	3	3	D	Replacement well	BA Fg 149
Kp	9	19	04/27/87	30	3	3	D	Replacement well	BA Fg 150
Kp	21	30	08/14/86	20	3	2.22	D	Replacement well	BA Fg 151
Kp	11	28	12/29/87	150	24	8.82	I		BA Fg 153
Kp	5	100	08/22/72	15	2	0.16	D		BA Fg 154
Kp	3	13	03/04/80	30	2	3	D	Replacement well	BA Fg 155
Kp	9	18	10/22/86	20	3	2.22	D	Replacement well	BA Fg 156
Kp	10	20	03/29/82	15	3	1.5	D	Replacement well	BA Fg 157
Kp	3	15	05/25/78	21	2	1.75	I	Replacement well	BA Fg 158
Kp	8	18	12/12/79	40	2	4	D	Replacement well	BA Fg 159
Kp	13	23	03/06/79	25	2	2.5	D	Replacement well	BA Fg 160
Kp	8	18	10/18/78	25	2	2.5	D	Replacement well	BA Fg 162
Kpx	23	32	08/12/87	80	3	8.89	A		BA Fg 164
Kp	12	21	11/07/84	21	3	2.33	D	Replacement well	BA Fg 166
Kp	3	13	05/03/83	60	3	6	D	Replacement well	BA Fg 167
Kp	3	13	10/12/83	50	3	5	D	Replacement well	BA Fg 169
Kp	3	13	02/14/80	30	2	3	D	Replacement well	BA Fg 170

Table 6.--*Lithologic logs of observation wells*

[ft = feet; in. = inches; depth is from land surface datum; for location of observation wells, see figure 6]

Grain sizes are as follows:

cobbles	= 64.0 - 256.000 millimeters	mU	= 0.350 - 0.500 millimeters
pebbles	= 2.0 - 64.000 millimeters	mL	= 0.250 - 0.350 millimeters
vcU	= 1.410 - 2.000 millimeters	fU	= 0.177 - 0.250 millimeters
vcL	= 1.000 - 1.140 millimeters	fL	= 0.125 - 0.177 millimeters
cU	= 0.710 - 1.000 millimeters	vfU	= 0.088 - 0.125 millimeters
cL	= 0.500 - 0.710 millimeters	vfL	= 0.062 - 0.088 millimeters

Description	Depth (ft)	Thickness (ft)
Well Q07		
Soil zone. Matrix is silt, dark brown; micaceous, roots present.	0	0.5
Silt, orange-brown; micaceous, roots throughout, some staining from older roots. Gradational lower contact.	.5	1.5
Clay, silty, gray with orange mottling; hard, trace of mica.	2.0	2.9
Interbedded sand and clay, gray and beige (clay), and beige with some orange mottling (sand). Sand is well sorted, fU-mU, and rounded to well rounded. Orange staining present at most of the sand-clay contacts.	4.9	4.1
Clay, multi-colored, orange-brown and gray grading to brick red with gray and purple.	9.0	5.0
Sand, clay, and gravel mixture, brown, red, and gray; sand sizes fU-mL, rounded. Rounded pebbles up to 1.5 in. were found.	14.0	3.5
Clay, red with some gray.	17.5	1.5
Silt, varies from sandy to clayey, color grades from light-gray to light-gray with red and yellow mottling to light-gray with brown mottling; micaceous.	19.0	5.0
Silt, clayey grading to sandy, light-gray with brown grades to light-gray to light-gray with orange-yellow mottling; sandy silt at bottom contains fL-fU subrounded grains, micaceous throughout.	24.0	5.0
Silt, sand and clay mixture, light-gray with some orange mottling; sand grains are fL-fU, subrounded; a 1 in. rounded pebble was found. Gradational lower contact.	29.0	1.2
Silt, sandy grading to silty clay, light-gray; micaceous.	30.2	3.8
No sample taken from 34.0 to 35.0 ft.		

Description	Depth (ft)	Thickness (ft)
Well Q08		
Soil zone. Matrix is silt, dark brown; roots present.	0	0.9
Silt, light-orange with some tan and brown; hard, friable, micaceous, roots throughout.	.9	3.6
Clay, silty, whitish-gray and greenish-gray with orange mottling throughout, orange staining from 4.5 to 5.5 ft; hard, friable, micaceous.	4.5	5.0
Silt and silty sand, tan with orange mottling, some white sand from 11.0 to 11.5 ft; micaceous, sand is poorly sorted, subrounded, fL-mU.	9.5	5.0
Sand, clayey and sand, gray and dark-orange; fL-mU, rounded, partially cemented with iron. Abrupt lower contact.	14.5	.6
Clay, red with gray; very hard and dry.	15.1	9.4
No sample taken from 24.5 to 26.5 ft.		
Well Q09A		
Soil zone. Matrix is silt, brown; roots present.	0	0.7
Silt, light-brown with some orange mottling; abundant black organic material that looks like charcoal; some roots present.	.7	1.6
Clay, light brownish-gray, some purple organic material in the center of the core down to about 4.0 ft; very hard and dry.	2.3	2.2
Clay, light brownish-gray with trace of orange mottling; roots present, very hard and dry.	4.5	3.0
Silt, sandy, tan grading to light-orange, sand is very poorly sorted, vfL-vcU, and subrounded. Gradational lower contact.	7.5	2.0

Table 6.–*Lithologic logs of observation wells*–Continued

[ft = feet; in. = inches; depth is from land surface datum; for location of observation wells, see figure 6]

Description	Depth (ft)	Thickness (ft)
Well Q09A--Continued		
Sand, silty, orange with some tan; poorly sorted vfL-vcU.	9.5	1.3
Silt and clay mixture, light-gray with orange mottling; some mica, dry, hard.	10.8	3.7
Sample was not recorded from 14.5 to 25.0 ft.		
Well Q09B, test hole Q09T		
Soil zone. Matrix is silt, brown; abundant roots.	0	0.6
Silt, light-brown grading to brownish-white, trace of orange mottling; some roots, very hard and dry. Gradational lower contact.	.6	5.2
Silt, sandy and silty sand, brownish-white grading to light-orange; very poorly sorted, vfU-vcL. Gradational lower contact.	5.8	2.2
Silt, gray with orange mottling; very hard and dry.	8.0	1.5
Silt and clay mixture, gray with orange mottling; micaceous.	9.5	5.0
Silt, clayey, white; grades to silt at about 16.3 ft. Orange mottling is present at some depths, mica present throughout.	14.5	8.0
Silt, sandy, white with orange mottling grading to orange; sand sizes vfU-fL; silt is micaceous. Gradational lower contact.	22.5	1.5
Silt, grades from orange sandy silt through white with orange mottled silt to white clayey silt; micaceous throughout.	24.0	5.0
Clay, various colors; micaceous, hard and dry. Color is brick-red with gray mottling from 29 to about 38 ft; chocolate-brown from 38 to 55 ft, and red, gray and brown from 55 to 69 ft.	29.0	40.0
Began split-spoon sampling at 80.0 ft		
Clay, red and gray.	80.0	1.5
Clay, brick red; trace of mica.	90.0	1.5
Well Q09B, test hole Q09T--Continued		
Clay, brick red; some mica.	100.0	1.5
Clay, red and light gray; micaceous.	110.0	1.5
Clay, light gray and red; micaceous.	120.0	1.5
Clay, silty, beige with brown; micaceous.	130.0	1.5
Clay and sand, light-gray with red; sand is well-sorted, mL-cL.	140.0	1.5
Sand, light-gray; well-sorted, mL-cL, rounded.	150.0	.8
Sand, gravelly with some clay, medium-gray; very poorly sorted, grains are all sizes up to 0.5 in., subrounded to rounded.	160.0	.8
Clay, brown, gray, and dark-gray. Abrupt contact with sand (170.3 ft), tan; well-sorted, mL-mU, subrounded, micaceous, some black and orange particles present in small amounts.	170.0	.5
Clay, silty, medium to dark-gray; lignitic, micaceous	180.0	1.0
Well Q10		
Soil zone. Matrix is silt, sandy, dark brown; roots present.	0	0.9
Silt, sandy, orange-brown grading to orange and tan. One 0.5-in. pebble (subrounded, quartz) was found. Sand sizes mostly mL-mU. Gradational lower contact.	.9	1.7
Silt, gray and greenish-gray with orange mottling; hard, friable.	2.6	1.9
Silt, grayish-white with orange mottling; hard, old roots remain intact to at least 9.5 ft.	4.5	10.0
Clay, silty grading to clay, brown on top grading to light-gray with brown mottling.	14.5	4.3
Silt, sandy, light-gray with orange mottling; grades to silty sand, grains are fL-fU, subrounded to rounded, micaceous. From 29.2 ft to 29.4 ft the material is orange colored. Abrupt lower contact.	18.8	10.6

Table 6.–*Lithologic logs of observation wells*–Continued

[ft = feet; in. = inches; depth is from land surface datum; for location of observation wells, see figure 6]

Description	Depth (ft)	Thickness (ft)
Well Q10--Continued		
Silt, sandy, or silty sand, light-gray; semi-lithified.	29.4	2.1
Clay, silty mixed with semi-lithified material (may be iron cementation), color varies from beige to orange to light-gray.	31.5	3.0
Interbedded sandy silt and silty clay, beige with orange mottling, light-gray, and orange; most of the material is sandy silt (beige with orange mottling), and there is some iron-cemented material at the contacts between beds. Gradational lower contact.	34.5	6.6
Clay, silty, light-gray. Gradational lower contact.	41.1	1.8
Clay, silty, purple; very hard, micaceous.	42.9	6.6
Well Q11		
Soil zone. Matrix is silt, sandy, dark brown; micaceous, roots present.	0	0.5
Silt, sandy, orange-brown and brown; micaceous, some iron staining from old roots, moist at top, hard and friable from 3.5 to 4.0 ft.	.5	3.5
Silt, sand and pebbles, grayish-white and light-orange; some mica. Some pebbles are quartz, about 1.5 in. in diameter, others look like consolidated sediment (size is 2 in. by 1 in. by 0.5 in.). All sand sizes are present, grains are subrounded.	4.0	2.5
Clay, white with traces of red mottling and some orange mottling at the top; very hard and dry, some mica.	6.5	2.5
Clay, beige with light-brown mottling; very hard, friable.	9.0	5.0
Clay-sand mixture, brown with some gray; some lignite present.	14.0	5.0
Well Q11-Continued		
Clay, silty, purplish-brown and light-gray; micaceous. Gradational lower contact.	19.0	2.4
Silt, sandy, light-gray with orange mottling; sand sizes fL-mL, subrounded, micaceous. Gradational lower contact.	21.4	1.5
Clay, reddish-brown with some gray; micaceous.	22.9	1.1
Interbedded clay, sand, and silt, beige with orange mottling; micaceous; sand is fU-mU, well-rounded. Gradational lower contact.	24.0	3.1
Silt, sandy grading to silty sand, beige with orange mottling; sand grains fU-mU, well-rounded.	27.1	1.9
Sand, clayey, beige; fL-mL, subrounded.	29.0	.9
Clay, gray; micaceous; one sandy silt bed from 32.8 ft to 33.4 ft.	29.9	4.1
No sample taken from 34.0 to 35.0 ft.		
Well Q12		
Soil zone. Matrix is silt, sandy, dark brown; micaceous, abundant roots.	0	0.8
Silt, sandy, brown; sand sizes fU-mU, subrounded.	.8	2.6
Clay, silt, sand and pebble mixture, gray and orange mottled; several large (1 in. diam.) subrounded quartz pebbles are present.	3.4	.6
Sand, orange; well-rounded, extremely well-sorted, mU, some rounded quartz pebbles (~0.2 in.) present; clay lens (beige) was present from 7.0 ft to 7.4 ft.	4.0	5.0
Clay, multi-colored; gray and purple grades to beige and pinkish, some fine orange mottling; lignite and mica present.	9.0	5.0

Table 6.--*Lithologic logs of observation wells*--Continued

[ft = feet; in. = inches; depth is from land surface datum; for location of observation wells, see figure 6]

Description	Depth (ft)	Thickness (ft)
Well Q12--Continued		
Clay, gray with brown mottling; some mica. Gradational lower contact.	14.0	2.7
Clay, silty, light-gray with orange mottling; micaceous. Gradational lower contact.	16.7	1.8
Silt, sandy, light-gray with orange mottling; sand sizes fL-fU, subrounded, micaceous. Gradational lower contact.	18.5	1.3
Sand, silty, light-gray with orange mottling; fL-fU, rounded, micaceous. Gradational lower contact.	19.8	.6
Silt, sandy, micaceous.	20.4	3.6
Interbedded silty sand, sandy silt, and clayey silt, light-gray with orange mottling; micaceous, trace of lignite; sand fL-fU.	24.0	5.0
Sand, silty grading to sandy silt, light-gray with orange mottling; fL-fU.	29.0	2.0
Clay, dark-gray.	31.0	3.0
Silt, sandy grading to clayey silt, gray; micaceous.	34.0	2.2
Sand, silty, light-gray or beige with orange mottling; fU-mL, well rounded.	36.2	7.8
Interbedded sand and clay, sand is beige to light-gray; fL-mU, rounded; clay is mostly dark-gray and micaceous, with some lignite, and is very hard at one point. Some orange mottling and layering in the sand and clay.	44.0	5.0
Sand, silty, beige with orange stripes and some purplish striping; sand is fL-fU, rounded.	49.0	5.0
Sand, beige, white, and orange; beige layer is mL-cL, subrounded to well-rounded; white layer is fL-fU and subrounded; orange layer has some reddish and beige sand mixed in, mL-cL, subrounded.	54.0	5.0
No sample	59.0	19.0
Clay, light-gray; hard, some lithified material found.	78.0	2.0
Well Q13		
Soil zone. Matrix is silt, sandy, dark brown; very micaceous, roots, 1-in. quartz pebble found.	0	1.0
Silt, sandy, orange-brown grading to tan and light-orange mottled; micaceous throughout; moist on top, becomes hard and friable at about 2.8 ft. Gradational lower contact.	1.0	6.1
Clay, silty, brownish-gray with orange mottling; micaceous, hard, friable.	7.1	2.4
Sand, silt and clay, light-gray, some orange at the bottom; micaceous, hard, friable; sand is all sizes smaller than mU, and subrounded. Small quartz pebbles (less than 0.3 in.) present at bottom.	9.5	5.0
Silt, sandy, gray and beige with light-orange mottling; sand grains fL-fU, subrounded, some grains as large as cL found, trace of mica.	14.5	5.0
Clay, silty, grayish-white with dark-orange, light-orange, red, and some light-yellow mottling; very hard, dry, and friable.	19.5	5.0
Silt, sandy and silt, light grayish-white with orange, light-orange and light-yellow mottling; hard, friable. Gradational lower contact.	24.5	3.0
Sand, silty, beige; vfL-mL, subangular, dry.	27.5	2.0
Sand, some silt in the matrix, beige with a trace of orange mottling; fL-mL, subangular.	29.5	6.1
Sand, silty or sandy silt, dark-orange, some gray included; sand sizes fL-cL, subrounded, micaceous.	35.6	3.9
Sand, silty, orange grading from dark to light.	39.5	2.7
Sand, beige; fL-mL, subrounded, gets orange again at the bottom of the core.	42.2	2.3
Sand, silty, orange-brown; fL-fU, rounded, micaceous, small clay lens at about 45 ft depth.	44.5	5.0

Table 6.–*Lithologic logs of observation wells*--Continued

[ft = feet; in. = inches; depth is from land surface datum; for location of observation wells, see figure 6]

Description	Depth (ft)	Thickness (ft)
Well Q13--Continued		
Sand, orange-brown; fL-fU, rounded, micaceous, some clay in matrix.	49.5	5.0
Sand, brown; fU-mL, rounded.	54.5	3.3
Clay, silt, and sand mixture, brown; sand is brown, fU-mL, rounded.	57.8	2.2
Well Q14		
Soil zone. Matrix is silt, sandy, brown; micaceous, roots present.	0	0.9
Silt, orange-brown; micaceous, trace of lignite.	.9	1.3
Sand, silty and gravel, orange-brown; lignitic; sand is poorly sorted, fU-cL, rounded; gravel is present throughout, mostly rounded quartz pebbles of less than 1-in. diameter.	2.2	2.3
Sand, pebbles (partial recovery, 3.2 ft), light orange-tan grading to tan; some lignitic clay balls at the top of the core; sand is poorly sorted, fU-vcU, some 0.5-in. pebbles; grains and pebbles are subrounded-rounded. Tan sand at the bottom is better sorted, fU-mU, subrounded, some black particles are present in the sand.	4.5	5.0
Sand (partial recovery, 3.5 ft), tan and beige; mU-cL, rounded and well-sorted at the top, grades slightly coarser (mU-cU) before becoming well-rounded and siltier at the bottom (mU-cL).	9.5	5.0
Sand, tan grading to white; mU-cL, rounded, well-sorted, some orange and black grains.	14.5	5.0
Sand, runny; no sample recovered.	19.5	15.0
Silt, clayey, dark-gray; micaceous. (sample from bottom of bit)	34.5	5.5
Well Q15		
Soil zone. Matrix is silt, brown, micaceous, with abundant roots, a few sand grains.	0	1.0
Silt, tan; micaceous, roots still present.	1.0	.8
Silt, sandy and silty sand, light-gray with orange mottling grading to beige or light-grayish-white. Sand is poorly sorted, mU or finer, subrounded, grades finer with depth. Micaceous, some subrounded quartz pebbles (less than 0.5 in. in diameter) are present.	1.8	2.7
Sand, silty grading to sandy silt, tan grading to light-orange. Grains are very poorly sorted, ranging from silt to cL-cU, subrounded. Material is micaceous; sorting and cohesion get slightly better with depth.	4.5	5.0
Silt, medium-gray; very micaceous, some lignite.	9.5	1.5
Organic material in a clay matrix, black to dark-brown; micaceous; organic material seems to be remnants of woody stems and other plant material.	11.0	4.3
Sand, gray; coarse (mU-vcU), subrounded, chunks of lignite throughout.	15.3	7.2
Clay, red, gray, and yellow.	22.5	2.5
Well Q16A		
Soil zone. Matrix is sandy silt, dark-brown; trace of mica, abundant roots.	0	1.0
Silt, sandy, orange-brown.	1.0	1.6
Sand, silty, orange-brown to light-orange.	2.6	1.9

Table 6.--*Lithologic logs of observation wells*--Continued

[ft = feet; in. = inches; depth is from land surface datum; for location of observation wells, see figure 6]

Description	Depth (ft)	Thickness (ft)
Well 16A--Continued		
Sand, silty, light-orange. Sand is well-sorted, mL-mU, rounded to well-rounded, grades coarser (fU-cL), less rounded, siltier, and more poorly sorted with depth.	4.5	2.0
Silt, clayey, light-gray with a trace of orange mottling.	6.5	3.0
Clay and silt, light-gray with orange mottling; some lignite on the bottom.	9.5	4.0
Sand, silty, light grayish-tan; fL-fU, subrounded.	13.5	1.0
Silt, sandy, light-gray, light-orange mottling; sand size, fL, trace of mica.	14.5	2.0
Clay, sandy, tan and light-orange, sand size, fU.	16.5	3.0
Clay, silty, light-gray, brownish-red mottling.	19.5	5.0
Clay, silty, light-gray, brownish-red, bright-red, orange mottling.	24.5	10.0
Silt, clayey, light-gray, brownish-red mottling, grades to silt, light-gray.	34.5	5.0
Silt, light-gray, purple mottling, grades in color to purple then brownish-red.	39.5	5.0
Silt, medium-to dark-gray; several small sandy lenses, some areas clayey.	44.5	5.0
Silt, clayey, dark-gray grades to silt, medium gray with a few sandy lenses; some mica.	49.5	5.0
Sand, clayey, medium-gray; micaceous, fU-mL, grades to silty sand, mL-mU, tan, color change at 58 ft. Gradational lower contact.	54.5	5.0
Sand, silty, gray; fU-mL, micaceous.	59.5	2.5
Sand, tan with purple, orange, and red mottling, coarse, mL-mU.	62.0	13.0
Sand, runny, no samples.	75.0	23.0

Description	Depth (ft)	Thickness (ft)
Well Q16B, test hole Q16T		
Soil zone. Matrix is sandy silt, dark-brown; trace of mica, abundant roots.	0	1.0
Silt, sandy, orange-brown; some roots present, several pebbles found at a depth of 3 ft. Pebbles are subrounded, quartz, most are less than 1 in. diameter, one pebble was 2 by 1.5 by 1 in. Gradational lower contact.	1.0	2.3
Sand, silty, orange-brown grading to light-orange. Sand is well-sorted, mL-mU, rounded to well-rounded. Sand grades coarser (fU-cL), less rounded, siltier and more poorly sorted with depth.	3.3	1.2
Sand, tan; silty in places, subrounded, moderately well sorted, fU-mU. Abrupt lower contact.	4.5	4.0
Silt, light-gray with fine orange mottling; hard, dry.	8.5	1.0
Silt, clayey or silty clay, pinkish-gray with orange mottling and some brown organic material; very dry, hard, and friable; grades to gray silt at the bottom.	9.5	4.0
Sand, clayey, and gravel, gray, brown, and orange. Sand is fL-fU, gravels are about 0.5 in. and subrounded.	13.5	1.0
Sample was not recorded from 14.5 to 30.0 ft.		
No test hole samples were taken.		
Well Q17		
Soil zone. Matrix is sandy silt, dark-brown; micaceous, abundant roots.	0	0.5
Silt, sandy, reddish-brown; micaceous. roots present. Gradational lower contact.	.5	2.5

Table 6.--*Lithologic logs of observation wells*--Continued

[ft = feet; in. = inches; depth is from land surface datum; for location of observation wells, see figure 6]

Description	Depth (ft)	Thickness (ft)
Well Q17--Continued		
Sand, silty, reddish-brown grading to tan; poorly sorted, vfL-mU, subrounded, micaceous. Gradational lower contact.	3.0	0.8
Silt, sandy, light-tan; micaceous, largest grains are fU, subrounded. Abrupt lower contact.	3.8	1.2
Sand, white; well-sorted, fU-mL, rounded, micaceous. Abrupt lower contact.	5.0	2.5
Sand, orange; well-sorted, fU-mU, rounded, some mica, probably same material as above. Gradational lower contact.	7.5	1.0
Silt, sandy, light-tan; sand grains fL, micaceous.	8.5	1.0
Sand, whitish-tan, grades to tan with orange mottling; well-sorted, fU-mL, rounded, micaceous, grades slightly siltier with depth. Trace of black and orange grains throughout. Gradational lower contact.	9.5	4.5
Silt, sandy or silty sand, tan with orange mottling; well-sorted, fL-fU, some mica and a trace of lignite.	14.0	.5
Sand, silty, same as above, darker gray with orange mottling; grades to silt.	14.5	5.0
Well Q18A		
Soil zone. Matrix is sandy silt, dark-brown; abundant roots.	0	0.5
Silt, sandy, orange-brown, grades to gray with orange mottling; some mica, lignite present. Gradational lower contact.	.5	3.1
Sand, orange and tan mottled; well-sorted, fL-mU with some slightly larger grains, subrounded to rounded.	3.6	.9
Well Q18A--Continued		
Interbedded clay, sand, and silt, gray with orange mottling, micaceous. Sands are mostly rounded and fairly fine (fL-mU).	4.5	2.7
Sand, tan; coarse, poorly sorted, mL-vcL, subrounded-rounded, black and orange grains present. Small lenses of silt were present but not common, and a trace of lignite and some small pebbles (less than 1 in.) were found.	7.2	7.3
No sample taken from 14.5 to 25.0 ft.		
Well Q18B, test hole Q18T		
Soil zone. Silt, sandy, brown; abundant roots, some coarse white gravel fill material.	0	0.7
Silt, sandy, orange-brown; trace of mica.	.7	2.6
Sand, orange.	3.3	1.2
Interbedded clay, silt, and sand.	4.5	2.3
Sand, tan.	6.8	7.7
Split-spoon sampling began at 20.0 ft.		
Sand, clayey, brown with some red and tan; mL-mU, a few vcU, subrounded, some black minerals found.	20.0	1.5
Silt, clayey, dark-gray; micaceous.	30.0	1.5
Clay, silty, dark-gray; micaceous, abundant organic material.	40.0	1.5
Sand, clayey, tan to brown; fU-mL, subangular, some organic matter and mica present.	50.0	1.5

Table 6.--*Lithologic logs of observation wells*--Continued

[ft = feet; in. = inches; depth is from land surface datum; for location of observation wells, see figure 6]

Description	Depth (ft)	Thickness (ft)
Well Q18B--Continued		
Sand, tan to yellow; mL-mU, subangular to subrounded, some organic matter.	60.0	1.5
Sand, tan to orange; fU-cL, subangular to subrounded.	70.0	1.5
Sand, clay, beige, orange-yellow, and dark-brown; sand is poorly sorted, fU-mU, rounded.	80.0	1.5
No sample recovered. Blow counts indicate sand.	90.0	--
Clay, silty, dark-gray; micaceous, trace of lignite.	100.0	1.5
Sand, beige, well sorted, mU-cL, rounded, some silt in the matrix.	110.0	1.5
Sand, silty, tan; poorly sorted, fL-mU, subrounded-rounded, micaceous, trace of black grains.	120.0	1.5
Clay, brick-red, gray, and yellow; hard.	130.0	1.5
No sample collected from 131.5 to 142.0 ft.		
Well Q19A, test hole Q19T		
Soil zone. Matrix is silt, dark-to light-brown; some mica, abundant roots.	0	1.0
Silt, orange with rust colored mottling; some mica, some roots, one sand stringer.	1.0	2.5
Silt, light-gray with orange mottling; micaceous, trace of organic matter, some roots.	3.5	2.7
Silt, clayey, light-gray grading to dark-gray, white mottling; micaceous on top, heavy orange mottling on the bottom, old roots present.	6.2	5.5
Clay, medium-gray with orange mottling; some mica, some organic matter and iron-oxide cement.	11.7	1.8
Well Q19A, test hole Q19T--Continued		
Clay, gray with orange mottling; sand stringers present, iron oxide cement with the sand stringers, some mica.	13.5	1.0
Sand, dark-gray; well-sorted, fL-fU (some mL), some mica, organic matter, and silt present.	14.5	.5
Began split-spoon sampling at 20.0 ft.		
Clay, red with gray mottling.	20.0	1.5
Clay, red with gray mottling.	30.0	1.5
Clay, red with gray mottling.	40.0	1.5
Clay, red with gray mottling at the top; silty with gray, yellow, and red at the bottom.	50.0	1.5
Clay, gray, red, and yellow; changes to sand, gray, hard, poorly sorted, fU-cL, subrounded to rounded.	60.0	1.3
Sand, gray; fU-mU, subrounded to rounded; changes to clay, red and gray at bottom of the sample.	70.0	.8
Clay, dark grayish-brown; some mica, very hard.	80.0	1.5
Clay; red, yellow, and brown mottled; very hard.	90.0	1.5
Clay, brick-red; micaceous.	100.0	1.5
Clay, red, gray, and yellow; very hard, some mica.	110.0	1.5
Sand, grayish-white; well-sorted, fU-mL, some mica, rounded, tightly packed.	120.0	1.5
Clay, red; hard.	130.0	1.5
Sand, white; moderately well-sorted, mL-cL, rounded to subrounded, trace of black material; some red clay in the sample.	140.0	.4

Table 6.–*Lithologic logs of observation wells*--Continued

[ft = feet; in. = inches; depth is from land surface datum; for location of observation wells, see figure 6]

Description	Depth (ft)	Thickness (ft)
Well Q19A, test Q19T--Continued		
Clay, grayish-white; some sandy material and bands of iron stain, hard.	150.0	1.5
Sand, reddish (may be from drillers mud); well-sorted, mL-mU, rounded, hard and dense.	160.0	.3
Clay, gray with some orange and red mottling; hard.	170.0	1.5
No sample collected from 171.5 to 175 ft.		
Well Q20A, test hole Q20T		
Soil zone.	0	0.8
Silt, sandy.	.8	2.8
Sand, tan.	3.6	.9
Sand, white.	4.5	3.5
Silt, sandy.	8.0	1.5
Clay, silty, multi-colored.	9.5	5.5
Auger samples were collected from 15 ft to 120 ft. However, these samples were collected from the same hole that had previously been drilled with a 4-in. mud-rotary bit. This means that the samples were contaminated with drilling mud and are not representative. Therefore they are not included here.		
No sample collected from 120.0 to 180.0 ft.		
Well Q20B		
Soil zone. Matrix is silty sand, brown; well-sorted, mL-mU, subrounded, abundant roots, other organic material present.	0	0.8
Well Q20B--Continued		
Sand, silty, same as the soil zone. Gradational lower contact	0.8	1.8
Silt, sandy, orange-brown; sand particles similar to above, material more cohesive than above.	2.6	1.2
Sand, tan; well-sorted, fU-mL, small amount of silt in the matrix, subrounded.	3.8	.7
Sand, white; very poorly sorted, fL-vcU, rounded, some organic material present (looks like seaweed). Abrupt lower contact.	4.5	3.5
Silt, sandy, white with orange mottling; sand grains poorly sorted, fU-cL, subrounded.	8.0	1.5
Clay, silty, orange, black, red, and white on top, white with red and orange mottling below.	9.5	5.0
Clay, sandy, orange with red streaks; moist, thick in consistency.	14.5	2.0
Silt, clayey, gray with orange mottling; grades to silt.	16.5	8.5
Well Q21		
Soil zone. Matrix is sandy silt, dark-brown; abundant roots, micaceous.	0	1.0
Silt, sandy, orange; old roots present.	1.0	2.3
Silt, light-gray with orange mottling; micaceous, some sand grains present. Grades to brownish-gray with orange mottling after 4.5 ft.	3.3	3.1
Sand, silty grading to sand; poorly sorted, vfL-mU, better sorted with depth (mostly fL-mL at bottom). Grains are subrounded to rounded. Color grades from tan with orange (6.4-7.2 ft) to tan (7.2-8.5 ft) to orange (8.5-10.5 ft).	6.4	4.1

Table 6.--*Lithologic logs of observation wells*--Continued

[ft = feet; in. = inches; depth is from land surface datum; for location of observation wells, see figure 6]

Description	Depth (ft)	Thickness (ft)
Well Q21--Continued		
Interbedded clay, sand, and silt. From 10.5 to 11.0 ft--gray and orange clay and silt; 11.0 to 11.8 ft--orange sand, same as above; 11.8 to 13.0 ft--clay, gray grading to orange-gray. Micaceous, trace of lignite throughout.	10.5	2.5
Clay, sandy, fairly dark-gray; very micaceous, some lignite.	13.0	1.5
Silt, sandy, dark-gray; micaceous, trace of organic material. Sand sizes fL-mL, subrounded to rounded. Abrupt lower contact.	14.5	3.2
Sand, light-gray; well-sorted, mL-mU, well-rounded, some mica, some lignite. Abrupt lower contact.	17.7	2.5
Clay, light-gray and chocolate-brown; trace of iron stain at the top of the bed.	20.2	9.3
No sample taken 29.5 to 32.0 ft.		
Well Q22		
Soil zone. Matrix is clayey silt, brown; abundant roots, micaceous.	0	0.5
Silt, clayey on top grading coarser, mostly orange-brown, some gray mottling at the top. Decayed wood present at 3.8 ft., organic matter and lignite present throughout, trace of mica.	.5	4.0
Silt, brown grading to orange; some lignite and mica present, similar to above. Abrupt lower contact.	4.5	2.5
Clay, silty, gray with brown and orange mottling; abundant old roots, some iron cementing near bottom.	7.0	2.5
Well Q22--Continued		
Silt, clayey, gray with orange mottling; abundant iron cementation, a 1 in. pebble was found, micaceous. Abrupt lower contact.	9.5	2.4
Clay, gray with orange and red mottling, grading to gray and red; very hard and dry.	11.9	7.6
Sample was not recorded from 19.5 to 21.5 ft.		
Well Q23		
Soil zone. Matrix is silt, dark-brown; abundant organic matter and roots, some mica.	0	0.8
Silt, clayey, light-brown with some dark-brown mottling; some mica and organic material.	.8	3.2
Silt, light-gray with white and orange mottling; trace of organic material throughout, root zone and some pebbles (up to 1 in.) present at base.	4.0	3.3
Sand, tan to orange; moderate-sorting, fL-mU, subangular, quartz.	7.3	.7
Silt, light-gray with white and orange mottling; roots present throughout.	8.0	2.0
Sand, silty, light-gray to tan; vfU-fU, subrounded, a few pebbles (up to 0.5 in., rounded), trace of mica.	10.0	2.5
Sand, orange; mL-vcU, subangular to subrounded, some mica.	12.5	.6
Sand, white to tan; fL-mL, subrounded, some mica.	13.1	1.4

Table 6.–*Lithologic logs of observation wells*--Continued

[ft = feet; in. = inches; depth is from land surface datum; for location of observation wells, see figure 6]

Description	Depth (ft)	Thickness (ft)
Well Q23--Continued		
Silt, sandy, light-brown with some orange; sand grains fL-mU, rounded, micaceous, some lignite. Gradational lower contact.	14.5	1.5
Sand, silty, light-gray grading to light-brown; fL-cU, subrounded, micaceous, some lignite at the bottom.	16.0	3.5
Sand, orange and dark-gray; fU-mU, rounded, micaceous, some rounded pebbles (1-in.) were present. Abrupt lower contact.	19.5	1.0
Clay; red, gray, white, black, and yellow; micaceous.	20.5	4.5
Well Q24		
Soil zone. Matrix is silt, dark-brown; some mica, abundant organic matter.	0	0.8
Silt, brown with some orange and gray mottling; some mica and organic material, some roots.	.8	4.2
Silt, gray with some orange and white mottling; some mica and organic material present along with a few roots. Some interbedded sand lenses (fU-mL, subrounded) from 6.5-7.5 ft.	5.0	6.0
Sand, white to yellow; mL-cU, subrounded, trace of mica and organic material.	11.0	3.0
Silt, sandy, light-brown with orange mottling; sand sizes vfL-fU, very micaceous. Gradational lower contact.	14.0	1.6
Sand, beige grading to orange; fairly silty; beige sand is fL-mU, subangular; orange sand is mL-mU, rounded.	15.6	3.4
Sand, dark-gray; poorly sorted, vfL-mU, rounded, micaceous. Abrupt lower contact.	19.0	1.5
Clay, red and gray mottled.	20.5	3.5
No sample taken 24.0 to 25.0 ft.		
Well Q25		
Soil zone. Matrix is silt, dark-brown; mica and organic material present, abundant roots.	0	0.7
Silt, light-brown; some mica and organic material.	.7	6.5
Silt, light-gray with orange mottling; some mica, organic material and roots present.	7.2	5.3
Silt, sandy, light-orange with orange mottling; grain sizes mL-cL, some mica.	12.5	1.5
Silt, brown and orange-brown; micaceous. Abrupt lower contact.	14.0	1.5
Silt, clayey grading to sandy silt, light-gray and tan with some orange mottling; micaceous, trace of lignite; sand grains fL-mL, subangular to subrounded. Gradational lower contact.	15.5	1.5
Sand, beige and tan; very poorly sorted, vfL-cL, subrounded.	17.0	2.0
Sand, silty, brown with reddish mottling; fL-cU, subrounded, micaceous, lignitic.	19.0	2.0
Sand, beige grading to orange and then gray; poorly sorted, fL-cU, subrounded, micaceous.	21.0	2.5
Sand, dark-gray; micaceous, fL-cU, subrounded, some subrounded pebbles (size range to 1 in.). Abrupt lower contact.	23.5	3.0
Clay, red with gray; micaceous.	26.5	7.5
No sample taken 34.0 to 35.0 ft.		

Table 6.--*Lithologic logs of observation wells*--Continued

[ft = feet; in. = inches; depth is from land surface datum; for location of observation wells, see figure 6]

Description	Depth (ft)	Thickness (ft)
Well Q26		
Soil zone. Matrix is silt, dark-brown.	0	0.5
Silt, clayey, brown with rust-colored mottling; abundant roots and organic matter, some mica.	0.5	1.5
Silt, clayey, light-gray with orange mottling; some mica and organic material present.	2.0	2.0
Silt, clayey, same as above, grading to clayey sand at the base of the unit. Sand is fU-mU, micaceous; some organic material, one cobble approximately 2.5 in., subrounded.	4.0	3.2
Clay, light-gray; some mica, a few sand lenses (fU-mL, subrounded) after 9 ft depth.	7.2	6.8
Sand, silty, gray; grades to sand, mL-mU, subrounded.	14.0	3.0
Clay, gray.	17.0	2.0
No sample taken 19.0 to 20.0 ft.		
Well Q27		
Soil zone.	0	0.5
Silt, light-gray with orange mottling (decreases with depth); some sand lenses, mica, organic material and rootlets present throughout.	.5	6.0
Clay, dark-gray; some mica, abundant organic material. Abrupt lower contact.	6.5	3.5
Sand with silt lenses, orange to tan; mL-cU, some mica and organic material.	10.0	4.0
Clay, silty, light-gray with red mottling.	14.0	5.0
No sample taken 19.0 to 20.0 ft.		
Well Q28		
Soil zone.	0	0.5
Silt, sandy, orange grading to light-gray with orange mottling; some mica, organic material, roots near top.	.5	3.5
Silt, light-gray with some orange mottling near top; some mica and organic material present.	4.0	5.0
Interbedded sand and silt, light-gray; beds are 2 to 6 in. thick, sand is mL-cU, subrounded; silt has some mica and organic material.	9.0	5.0
Sand, running (1.5-ft recovery), tan to light-gray, fU-mL, grades to silty sand.	14.0	5.0
Silt, sandy, beige; sand grains up to mL, rounded to well-rounded, micaceous.	19.0	3.0
Silt, sandy, beige, similar to above with some yellow added; some organic material, micaceous.	22.0	2.0
Sand, beige; very wet, well-sorted, fU-mU, well-rounded.	24.0	5.0
Silt, sandy, gray-beige with some orange; some lignite and mica; sand is fL-fU, well-rounded.	29.0	3.0
Silt, sandy and silty sand, grayish-tan; sand grains are very poorly sorted, vfL-vcU, subangular to subrounded; micaceous, trace of lignite.	32.0	2.0
Silt, sandy (1.5-ft recovery), light-gray; sand grains vfL-fU, rounded; micaceous.	34.0	5.0
Clay, silty (2-ft recovery), light-brown with some yellowish-brown; hard, micaceous.	39.0	5.0

Table 7.--*Physical properties of core sediments*

[Data contained in this table represents the percentage passing the sieve; sampling depth is feet below land surface; for location of sites sampled, see figure 12]

Site no.	Sample depth (feet)	Grain-size distribution (inch)								
		0.500	0.375	0.187	0.079	0.033	0.017	0.010	0.006	0.003
Q08	9.5- 14.5	--	--	100	99.8	98.9	95.7	87.1	58.1	35.7
Q09	160.0-160.8	100	93.3	83.1	69.5	51.7	38.4	32.7	28.6	24.8
Q14	14.5- 19.5	--	--	--	100	99.9	91.5	44.0	14.0	8.8
Q15	15.3- 19.5	--	--	100	99.6	95.7	70.3	34.8	19.3	13.4
Q16	70.0- 75.0	--	--	100	99.9	99.0	96.3	29.8	13.0	10.9
Q17	9.5- 14.0	--	--	--	--	100	97.0	52.7	17.9	9.3
Q18	9.5- 14.0	--	100	99.9	99.7	98.2	70.0	28.2	21.1	19.0
Q18	70.0- 71.5	--	100	99.7	99.5	99.2	82.9	42.9	17.6	9.4
Q19	120.0-121.5	--	--	100	99.9	99.7	99.4	86.5	42.3	30.8
Q26	15.0- 18.0	--	100	99.0	96.5	93.4	81.2	52.0	31.4	22.3
Q27	10.0- 14.0	--	--	100	99.9	99.5	94.5	81.2	63.3	47.8
Q28	25.0- 30.0	--	--	--	100	99.0	96.6	79.0	41.3	22.3

Table 8.--*Ground-water levels at Graces Quarters, October 1987 through March 1989*

[Measuring point elevation is in feet above sea level, water levels in feet above or below (-) sea level; missing data are represented by dashes (--); screen interval from land surface; lat: latitude; long: longitude; latitude and longitude: degrees (°), minutes (′), seconds (″); for location of observation wells, see figure 6; for hydrographs of selected wells, see figures 13-23]

Well Q01
Lat: 39° 21′ 06″ long: 76° 20′ 35″
Measuring point elevation: 33.94
Highest water level: 27.62 feet on MAY 18, 1988
Lowest water level: 21.41 feet on OCT 19, 1988

Location: Disposal area
Measuring point: floor of shelter
Screen interval: 7.3 - 22.3 feet
Records available: OCT 1987-MAR 1989

Date	Water level	Date	Water level	Date	Water level
OCT 2, 1987	21.78	APR 20	25.91	NOV 21	21.96
NOV 19	21.82	MAY 18	27.62	DEC 15	21.90
DEC 18	22.30	JUN 24	23.18		
		JUL 18	22.29	JAN 31, 1989	23.64
JAN 15, 1988	22.44	AUG 19	--	FEB 27	25.49
FEB 18	25.41	SEP 21	21.75	MAR 28	27.03
MAR 17	24.89	OCT 19	21.41		

Well Q02
Lat: 39° 21′ 05″ long: 76° 20′ 29″
Measuring point elevation: 39.34
Highest water level: 26.15 feet on MAY 18, 1988
Lowest water level: 17.19 feet on NOV 21, 1988

Location: Disposal area
Measuring point: top of well casing
Screen interval: 8.0 - 28.0 feet
Records available: NOV 1987-MAR 1989

Date	Water level	Date	Water level	Date	Water level
NOV 19, 1987	17.29	MAY 18	26.15	NOV 21	17.19
DEC 18	--	JUN 24	19.79	DEC 15	17.43
		JUL 18	19.04		
JAN 15, 1988	17.47	AUG 19	--	JAN 31, 1989	20.66
FEB 18	24.82	SEP 21	18.18	FEB 27	22.90
MAR 17	22.29	OCT 19	17.36	MAR 28	24.65
APR 20	24.95				

Well Q03
Lat: 39° 21′ 00″ long: 76° 20′ 28″
Measuring point elevation: 39.07
Highest water level: 12.00 feet on MAR 28, 1989
Lowest water level: dry--NOV 1987; DEC 1988

Location: Disposal area
Measuring point: top of well casing
Screen interval: 10.0 - 30.0 feet
Records available: NOV 1987-MAR 1989

Date	Water level	Date	Water level	Date	Water level
NOV 19, 1987	dry	MAY 18	11.21	NOV 21	8.17
DEC 18	7.22	JUN 24	11.52	DEC 15	dry
		JUL 18	10.49		
JAN 15, 1988	--	AUG 19	--	JAN 31, 1989	8.52
FEB 18	--	SEP 21	8.74	FEB 27	10.53
MAR 17	10.45	OCT 19	8.38	MAR 28	12.00
APR 20	10.56				

Well Q05
Lat: 39° 20′ 54″ long: 76° 20′ 39″
Measuring point elevation: 15.07
Highest water level: 9.99 feet on MAY 18, 1988
Lowest water level: 1.95 feet on NOV 19, 1987

Location: HD test annuli
Measuring point: floor of shelter
Screen interval: 7.0 - 22.0 feet
Records available: OCT 1987-MAR 1989

Date	Water level	Date	Water level	Date	Water level
OCT 2, 1987	2.20	APR 20	6.88	NOV 21	2.22
NOV 19	1.95	MAY 18	9.99	DEC 15	3.13
DEC 18	2.29	JUN 24	5.21		
		JUL 18	3.87	JAN 31, 1989	4.54
JAN 15	2.70	AUG 19	--	FEB 27	6.70
FEB 18	5.44	SEP 21	2.61	MAR 28	8.78
MAR 17	6.40	OCT 19	2.10		

Table 8.--*Ground-water levels at Graces Quarters, October 1987 through March 1989*--Continued

[Measuring point elevation is in feet above sea level, water levels in feet above or below (-) sea level; missing data are represented by dashes (--); screen interval from land surface; lat: latitude; long: longitude; latitude and longitude: degrees (°), minutes (′), seconds (″); for location of observation wells, see figure 6; for hydrographs of selected wells, see figures 13-23]

Well Q06
Lat: 39° 21′ 03″ long: 76° 20′ 53″ **Location: Background well**
Measuring point elevation: 10.24 Measuring point: top of well casing
Highest water level: 4.37 feet on MAY 18, 1988 Screen interval: 8.5 - 23.5 feet
Lowest water level: 2.24 feet on OCT 2, 1987 Records available: OCT 1987-MAR 1989

Date	Water level	Date	Water level	Date	Water level
OCT 2, 1987	2.24	APR 20	3.84	NOV 21	3.46
NOV 19	2.56	MAY 18	4.37	DEC 15	3.42
DEC 18	2.82	JUN 24	2.95		
		JUL 18	2.37	JAN 31, 1989	3.50
JAN 15, 1988	3.37	AUG 19	--	FEB 27	3.86
FEB 18	4.11	SEP 21	2.72	MAR 28	4.09
MAR 17	3.54	OCT 19	2.35		

Well Q07
Lat: 39° 21′ 07″ long: 76° 20′ 34″ Location: Disposal area
Measuring point elevation: 28.41 Measuring point: top of well casing
Highest water level: 15.15 feet on MAY 18, 1988 Screen interval: 14.0 - 24.0 feet
Lowest water level: 9.26 feet on OCT 19, 1988 Records available: MAR 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
MAR 17, 1988	14.17	AUG 19	--	JAN 31, 1989	12.27
APR 20	14.68	SEP 21	9.96	FEB 27	13.60
MAY 18	15.15	OCT 19	9.26	MAR 28	14.62
JUN 24	12.76	NOV 21	9.50		
JUL 18	11.06	DEC 15	10.31		

Well Q08
Lat: 39° 21′ 04″ long: 76° 20′ 32″ Location: Disposal area
Measuring point elevation: 39.77 Measuring point: top of well casing
Highest water level: 24.90 feet on FEB 27, 1989 Screen interval: 5.0 - 15.0 feet
Lowest water level: dry--MAR 1988; Records available: MAR 1988-MAR 1989
SEP 1988-JAN 1989

Date	Water level	Date	Water level	Date	Water level
MAR 17,1988	dry	AUG 19	--	JAN 31, 1989	dry
APR 20	23.14	SEP 21	dry	FEB 27	24.90
MAY 18	23.82	OCT 19	dry	MAR 28	24.09
JUN 24	23.21	NOV 21	dry		
JUL 18	22.58	DEC 15	dry		

Well Q09A
Lat: 39° 21′ 03″ long: 76° 20′ 29″ Location: Disposal area
Measuring point elevation: 38.31 Measuring point: top of well casing
Highest water level: 32.17 feet on MAY 18, 1988 Screen interval: 5.0 - 20.0 feet
Lowest water level: dry--APR 1988; SEP-OCT 1988 Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	17.73	JUL 18	16.40	DEC 15	16.44
MAR 17	16.34	AUG 19	--		
APR 20	dry	SEP 21	dry	JAN 31, 1989	21.35
MAY 18	32.17	OCT 19	dry	FEB 27	29.46
JUN 24	16.43	NOV 21	28.28	MAR 28	31.86

Table 8.--*Ground-water levels at Graces Quarters, October 1987 through March 1989*--Continued

[Measuring point elevation is in feet above sea level, water levels in feet above or below (-) sea level; missing data are represented by dashes (--); screen interval from land surface; lat: latitude; long: longitude; latitude and longitude: degrees (°), minutes (′), seconds (″); for location of observation wells, see figure 6; for hydrographs of selected wells, see figures 13-23]

Well Q09B
Lat: 39° 21′ 03″ long: 76° 20′ 29″ Location: Disposal area
Measuring point elevation: 38.68 Measuring point: floor of shelter
Highest water level: 1.87 feet on MAY 18, 1988 Screen interval: 140.0 - 150.0 feet
Lowest water level: -4.11 feet on JUL 18, 1988 Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	-2.99	JUL 18	-4.11	DEC 15	-2.91
MAR 17	.74	AUG 19	--		
APR 20	--	SEP 21	-3.28	JAN 31, 1989	-3.37
MAY 18	1.87	OCT 19	-3.48	FEB 27	-2.84
JUN 24	-3.06	NOV 21	-3.63	MAR 28	-2.76

Well Q10
Lat: 39° 21′ 01″ long: 76° 20′ 33″ Location: Dump
Measuring point elevation: 29.85 Measuring point: top of well casing
Highest water level: 7.53 feet on MAY 18, 1988 Screen interval: 21.0 - 31.0 feet
Lowest water level: 3.55 feet on NOV 21, 1988 Records available: MAR 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
MAR 17	5.48	AUG 19	--	JAN 31, 1989	4.49
APR 20	6.69	SEP 21	4.15	FEB 27	5.53
MAY 18	7.53	OCT 19	3.81	MAR 28	7.06
JUN 24	5.97	NOV 21	3.55		
JUL 18	4.84	DEC 15	3.83		

Well Q11
Lat: 39° 20′ 59″ long: 76° 20′ 35″ Location: Dump
Measuring point elevation: 23.11 Measuring point: top of well casing
Highest water level: 4.94 feet on MAY 18, 1989 Screen interval: 18.0 - 28.0 feet
Lowest water level: 1.87 feet on NOV 21, 1988 Records available: MAR 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
MAR 17, 1988	3.52	AUG 19	--	JAN 31, 1989	2.80
APR 20	4.27	SEP 21	2.24	FEB 27	3.69
MAY 18	4.94	OCT 19	1.94	MAR 28	4.86
JUN 24	3.29	NOV 21	1.87		
JUL 18	2.71	DEC 15	2.35		

Well Q12
Lat: 39° 20′ 58″ long: 76° 20′ 31″ Location: Dump
Measuring point elevation: 22.85 Measuring point: top of well casing
Highest water level: 10.88 feet on MAY 18, 1988 Screen interval: 20.0 - 30.0 feet
Lowest water level: 4.85 feet on OCT 19, 1988 Records available: MAR 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
MAR 17, 1988	9.42	AUG 19	--	JAN 31, 1989	8.99
APR 20	9.90	SEP 21	6.66	FEB 27	9.92
MAY 18	10.88	OCT 19	4.85	MAR 28	10.71
JUN 24	8.12	NOV 21	7.98		
JUL 18	7.58	DEC 15	6.95		

Table 8.--*Ground-water levels at Graces Quarters, October 1987 through March 1989*--Continued

[Measuring point elevation is in feet above sea level, water levels in feet above or below (-) sea level; missing data are represented by dashes (--); screen interval from land surface; lat: latitude; long: longitude; latitude and longitude: degrees (°), minutes (′), seconds (″); for location of observation wells, see figure 6; for hydrographs of selected wells, see figures 13-23]

Well Q13
Lat: 39° 21′ 02″ long: 76° 20′ 28″
Measuring point elevation: 40.16
Highest water level: 3.67 feet on MAY 18, 1988
Lowest water level: 2.16 feet on NOV 21, 1988

Location: Disposal area
Measuring point: floor of shelter
Screen interval: 33.0 - 43.0 feet
Records available: MAR 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
MAR 17, 1988	3.01	AUG 19	--	JAN 31, 1989	2.48
APR 20	3.41	SEP 21	2.55	FEB 27	2.82
MAY 18	3.67	OCT 19	2.35	MAR 28	3.30
JUN 24	3.41	NOV 21	2.16		
JUL 18	3.07	DEC 15	2.26		

Well Q14
Lat: 39° 20′ 51″ long: 76° 20′ 29″
Measuring point elevation: 13.23
Highest water level: 9.37 feet on MAY 18, 1988
Lowest water level: 2.32 feet on NOV 21, 1988

Location: Primary test area
Measuring point: top of well casing
Screen interval: 20.0 - 30.0 feet
Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	4.72	JUL 18	4.11	DEC 15	3.02
MAR 17	6.16	AUG 19	--		
APR 20	6.74	SEP 21	2.91	JAN 31, 1989	4.05
MAY 18	9.37	OCT 19	2.49	FEB 27	5.70
JUN 24	5.21	NOV 21	2.32	MAR 28	8.86

Well Q15
Lat: 39° 20′ 45″ long: 76° 20′ 17″
Measuring point elevation: 13.58
Highest water level: 9.24 feet on MAR 28, 1989
Lowest water level: 1.13 feet on NOV 21, 1988

Location: Primary test area
Measuring point: top of well casing
Screen interval: 17.0 - 22.0 feet
Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	6.99	JUL 18	3.14	DEC 15	1.61
MAR 17	7.55	AUG 19	--		
APR 20	8.43	SEP 21	1.84	JAN 31, 1989	3.63
MAY 18	9.14	OCT 19	1.24	FEB 27	7.74
JUN 24	4.76	NOV 21	1.13	MAR 28	9.24

Well Q16A
Lat: 39° 20′ 47″ long: 76° 20′ 24″
Measuring point elevation: 14.92
Highest water level: 4.56 feet on MAY 18, 1988
Lowest water level: 1.18 feet on NOV 21, 1988

Location: Primary test area
Measuring point: floor of shelter
Screen interval: 77.3 - 87.3 feet
Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	2.95	JUL 18	2.18	DEC 15	2.22
MAR 17	2.88	AUG 19	--		
APR 20	3.79	SEP 21	1.66	JAN 31, 1989	2.28
MAY 18	4.56	OCT 19	1.39	FEB 27	3.38
JUN 24	2.42	NOV 21	1.18	MAR 28	4.18

Table 8.--*Ground-water levels at Graces Quarters, October 1987 through March 1989*--Continued

[Measuring point elevation is in feet above sea level, water levels in feet above or below (-) sea level; missing data are represented by dashes (--); screen interval from land surface; lat: latitude; long: longitude; latitude and longitude: degrees (°), minutes (′), seconds (″); for location of observation wells, see figure 6; for hydrographs of selected wells, see figures 13-23]

Well Q16B
Lat: 39° 20′ 47″ long: 76° 20′ 24″
Measuring point elevation: 14.29
Highest water level: 11.15 feet on MAY 18, 1988
Lowest water level: 1.75 feet on OCT 19, 1988

Location: Primary test area
Measuring point: floor of shelter
Screen interval: 5.0 - 20.0 feet
Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	9.48	JUL 18	3.79	DEC 15	2.53
MAR 17	7.59	AUG 19	--		
APR 20	7.93	SEP 21	2.10	JAN 31, 1989	4.72
MAY 18	11.15	OCT 19	1.75	FEB 27	9.27
JUN 24	5.22	NOV 21	1.88	MAR 28	10.09

Well Q17
Lat: 39° 20′ 56″ long: 76° 20′ 38″
Measuring point elevation: 16.61
Highest water level: 13.21 feet on MAY 18, 1988
Lowest water level: 3.09 feet on NOV 21, 1988

Location: HD test annuli
Measuring point: top of well casing
Screen interval: 9.0 - 14.0 feet
Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	7.92	JUL 18	5.53	DEC 15	3.95
MAR 17	9.22	AUG 19	--		
APR 20	9.98	SEP 21	3.92	JAN 31, 1989	5.80
MAY 18	13.21	OCT 19	3.40	FEB 27	9.79
JUN 24	7.22	NOV 21	3.09	MAR 28	12.66

Well Q18A
Lat: 39° 20′ 54″ long: 76° 20′ 45″
Measuring point elevation: 10.86
Highest water level: 7.92 feet on MAY 18, 1988
Lowest water level: 1.85 feet on OCT 19, 1988

Location: HD test annuli
Measuring point: floor of shelter
Screen interval: 10.0 - 20.0 feet
Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	5.71	JUL 18	2.85	DEC 15	3.19
MAR 17	5.71	AUG 19	--		
APR 20	5.99	SEP 21	2.17	JAN 31, 1989	4.53
MAY 18	7.92	OCT 19	1.85	FEB 27	6.17
JUN 24	7.13	NOV 21	2.41	MAR 28	7.33

Well Q18B
Lat: 39° 20′ 54″ long: 76° 20′ 45″
Measuring point elevation: 10.51
Highest water level: 4.73 feet on MAY 18, 1988
Lowest water level: 1.36 feet on OCT 19, 1988

Location: HD test annuli
Measuring point: floor of shelter
Screen interval: 65.0 - 75.0 feet
Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	3.28	JUL 18	1.88	DEC 15	2.25
MAR 17	3.35	AUG 19	--		
APR 20	3.87	SEP 21	1.62	JAN 31, 1989	2.66
MAY 18	4.73	OCT 19	1.36	FEB 27	3.63
JUN 24	2.50	NOV 21	1.65	MAR 28	4.42

Table 8.--*Ground-water levels at Graces Quarters, October 1987 through March 1989*--Continued

[Measuring point elevation is in feet above sea level, water levels in feet above or below (-) sea level; missing data are represented by dashes (--); screen interval from land surface; lat: latitude; long: longitude; latitude and longitude: degrees (°), minutes ('), seconds ("); for location of observation wells, see figure 6; for hydrographs of selected wells, see figures 13-23]

Well Q19A
Lat: 39° 21' 13" long: 76° 20' 48" **Location: Background well**
Measuring point elevation: 42.98 **Measuring point: floor of shelter**
Highest water level: 2.23 feet on MAY 18, 1988 Screen interval: 159.0 - 169.0 feet
Lowest water level: -5.51 feet on OCT 19, 1988 Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
JAN 15, 1988	-6.65	JUL 18	-5.35	DEC 15	-5.11
FEB 18	-5.29	AUG 19	--		
MAR 17	-0.78	SEP 21	-5.46	JAN 31, 1989	-5.41
APR 20	--	OCT 19	-5.51	FEB 27	-4.80
MAY 18	2.23	NOV 21	-5.46	MAR 28	-4.77
JUN 24	-4.85				

Well Q20A
Lat: 39° 20' 41" long: 76° 20' 50" Location: Background well
Measuring point elevation: 12.92 Measuring point: floor of shelter
Highest water level: 4.17 feet on MAY 18, 1988 Screen interval: 80.0 - 90.0 feet
Lowest water level: 1.17 feet on OCT 19, 1988 Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	2.75	JUL 18	1.64	DEC 15	1.97
MAR 17	2.88	AUG 19	--		
APR 20	--	SEP 21	1.36	JAN 31, 1989	2.35
MAY 18	4.17	OCT 19	1.17	FEB 27	3.20
JUN 24	2.17	NOV 21	1.32	MAR 28	3.91

Well Q20B
Lat: 39° 20' 41" long: 76° 20' 50" Location: Background well
Measuring point elevation: 13.34 Measuring point: floor of shelter
Highest water level: 8.67 feet on MAY 18, 1988 Screen interval: 4.0 - 14.0 feet
Lowest water level: 1.98 feet on OCT 19, 1988 Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	5.15	JUL 18	3.60	DEC 15	3.03
MAR 17	5.99	AUG 19	--		
APR 20	6.73	SEP 21	2.45	JAN 31, 1989	4.28
MAY 18	8.67	OCT 19	1.98	FEB 27	5.73
JUN 24	4.88	NOV 21	2.12	MAR 28	7.90

Well Q21
Lat: 39° 20' 56" long: 76° 20' 30" Location: Secondary test area
Measuring point elevation: 25.13 Measuring point: top of well casing
Highest water level: 13.51 feet on MAY 18, 1988 Screen interval: 8.0 - 18.0 feet
Lowest water level: 8.42 feet on NOV 21, 1988 Records available: MAR 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
MAR 17, 1988	13.06	AUG 19	--	JAN 31, 1989	9.62
APR 20	11.67	SEP 21	8.93	FEB 27	10.97
MAY 18	13.51	OCT 19	8.64	MAR 28	13.09
JUN 24	10.71	NOV 21	8.42		
JUL 18	9.86	DEC 15	8.71		

Table 8.--*Ground-water levels at Graces Quarters, October 1987 through March 1989*--Continued

[Measuring point elevation is in feet above sea level, water levels in feet above or below (-) sea level; missing data are represented by dashes (--); screen interval from land surface; lat: latitude; long: longitude; latitude and longitude: degrees (°), minutes (′), seconds (″); for location of observation wells, see figure 6; for hydrographs of selected wells, see figures 13-23]

Well Q22
Lat: 39° 21′ 02″ long: 76° 20′ 38″
Measuring point elevation: 36.25
Highest water level: 30.26 feet on MAR 28, 1989
Lowest water level: 24.06 feet on OCT 19, 1988

Location: Bunker
Measuring point: top of well casing
Screen interval: 5.0 - 15.0 feet
Records available: MAR 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
MAR 17, 1988	26.85	AUG 19	--	JAN 31, 1989	28.62
APR 20	27.66	SEP 21	24.49	FEB 27	29.57
MAY 18	29.52	OCT 19	24.06	MAR 28	30.26
JUN 24	26.58	NOV 21	24.63		
JUL 18	24.96	DEC 15	24.48		

Well Q23
Lat: 39° 20′ 50″ long: 76° 20′ 21″
Measuring point elevation: 31.10
Highest water level: 10.20 feet on MAY 18, 1988
Lowest water level: dry--FEB, MAR, SEP-DEC 1988; JAN-MAR 1989

Location: Test site, northern dump
Measuring point: top of well casing
Screen interval: 10.0 - 20.0 feet
Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	dry	JUL 18	9.33	DEC 15	dry
MAR 17	dry	AUG 19	--		
APR 20	9.17	SEP 21	dry	JAN 31, 1989	dry
MAY 18	10.20	OCT 19	dry	FEB 27	dry
JUN 24	9.55	NOV 21	dry	MAR 28	dry

Well Q24
Lat: 39° 20′ 51″ long: 76° 20′ 20″
Measuring point elevation: 30.49
Highest water level: 8.48 feet on MAY 18, 1988
Lowest water level: 6.65 feet on DEC 15, 1988

Location: Test site, northern dump
Measuring point: top of well casing
Screen interval: 11.0 - 21.0 feet
Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	7.56	JUL 18	8.37	DEC 15	6.65
MAR 17	7.85	AUG 19	--		
APR 20	8.19	SEP 21	7.20	JAN 31, 1989	7.42
MAY 18	8.48	OCT 19	7.61	FEB 27	7.61
JUN 24	8.24	NOV 21	7.44	MAR 28	8.03

Well Q25
Lat: 39° 20′ 49″ long: 76° 20′ 19″
Measuring point elevation: 35.52
Highest water level: 8.89 feet on MAY 18, 1988
Lowest water level: 7.50 feet on FEB 18, 1988

Location: Test site, northern dump
Measuring point: top of well casing
Screen interval: 17.0 - 27.0 feet
Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	7.50	JUL 18	8.85	DEC 15	7.73
MAR 17	7.74	AUG 19	--		
APR 20	8.14	SEP 21	7.59	JAN 31, 1989	7.58
MAY 18	8.54	OCT 19	8.07	FEB 27	7.57
JUN 24	8.89	NOV 21	7.88	MAR 28	7.94

Table 8.--*Ground-water levels at Graces Quarters, October 1987 through March 1989*--Continued

[Measuring point elevation is in feet above sea level, water levels in feet above or below (-) sea level; missing data are represented by dashes (--); screen interval from land surface; lat: latitude; long: longitude; latitude and longitude: degrees (°), minutes (′), seconds (″); for location of observation wells, see figure 6; for hydrographs of selected wells, see figures 13-23]

Well Q26
Lat: 39° 20′ 43″ long: 76° 20′ 16″ **Location: Test site, southern dump**
Measuring point elevation: 5.33 **Measuring point: top of well casing**
Highest water level: 3.99 feet on MAR 28, 1989 Screen interval: 12.0 - 17.0 feet
Lowest water level: 0.47 feet on SEP 21, 1988 Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	2.99	JUL 18	0.75	DEC 15	1.91
MAR 17	3.25	AUG 19	--		
APR 20	3.62	SEP 21	.47	JAN 31, 1989	2.56
MAY 18	3.74	OCT 19	.67	FEB 27	3.34
JUN 24	1.57	NOV 21	1.63	MAR 28	3.99

Well Q27
Lat: 39° 20′ 43″ long: 76° 20′ 14″ Location: Test site, southern dump
Measuring point elevation: 9.28 Measuring point: top of well casing
Highest water level: 6.10 feet on MAR 28, 1989 Screen interval: 8.0 - 13.0 feet
Lowest water level: -1.90 feet on OCT 19, 1988 Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	4.54	JUL 18	-0.50	DEC 15	-0.92
MAR 17	4.64	AUG 19	--		
APR 20	5.67	SEP 21	-1.54	JAN 31, 1989	1.71
MAY 18	5.94	OCT 19	-1.90	FEB 27	4.69
JUN 24	.82	NOV 21	-1.82	MAR 28	6.10

Well Q28
Lat: 39° 20′ 42″ long: 76° 20′ 15″ Location: Test site, southern dump
Measuring point elevation: 7.12 Measuring point: top of well casing
Highest water level: 3.57 feet on MAR 28, 1989 Screen interval: 15.0 - 20.0 feet
Lowest water level: 0.95 feet on OCT 19, 1988 Records available: FEB 1988-MAR 1989

Date	Water level	Date	Water level	Date	Water level
FEB 18, 1988	2.90	JUL 18	1.06	DEC 15	1.85
MAR 17	2.83	AUG 19	--		
APR 20	3.23	SEP 21	1.08	JAN 31, 1989	2.41
MAY 18	3.44	OCT 19	.95	FEB 27	3.10
JUN 24	1.64	NOV 21	1.55	MAR 28	3.57

Table 9.--*Pumpage from production wells near Graces Quarters*

[GAP no. = Ground-water Appropriation Permit; Screen interval is from depth below land surface. Use of water: AG = Agriculture (farming), AQ = Aquaculture, CO = Commercial, IN = Industrial, IR = Irrigation; gal/d = gallons per day; dashes (--) denote unavailable data; for location of production wells, see figures 8-10]

USGS well no.	State permit no.	GAP no.	Owner	Screen interval (feet)	Use of water	Aquifer	Pumpage status	Pumpage reported (gal/d)	Pumpage appropriated (gal/d)
BA Eg 144	BA-72-0354	BA72G007	U.S. Army	166-186	IN	Patapsco	Inactive	--	5,300
BA Eg 146	BA-73-7660	BA79G001	Gunpowder State Park	200-210	CO	Patuxent	Active	800 (APR-OCT)	5,000
BA Eg 150	BA-73-1990	BA75G012	Marshy Pt. Nursery	245-255	IR	Patapsco	Active	11,000 (APR-OCT)	25,000
BA Eg 188	BA-81-2838	BA84G026	T&A Excav.	90-100	CO	Patapsco	Active	--	150
BA Eg 198	BA-81-7396	BA87G064	Moore Precast Concrete	213-220	CO	Patuxent	Active	--	200
BA Fg 153	--	BA87G014	Baltimore Gas & Elec.	70-105	AQ	Patapsco	Active	[1] 167,225 (AUG)	36,000
BA Fg 164	BA-81-6866	--	C. Ritter	237-250	AG	Patuxent?	Active	--	--

[1] The reported pumping value is probably inaccurate because it is based on a constant withdrawal rate of 150 gallons per minute; however, the well is pumped only long enough to fill holding tanks, so the value is probably lower than reported.

Table 10.--*Slug-test data, June through September 1988*

[Water level recovery measured in feet above the transducer; second = seconds from start of test; for location of observation wells, see figure 6]

Well Q07
Equilibrium water level: 10.09 ft
Date: June 30, 1988

Time (second)	Water level (feet)	Time (second)	Water level (feet)
0.2	8.27	40.0	8.33
.4	8.27	50.0	8.33
.6	8.29	60.0	8.34
.8	8.27	70.0	8.34
1.0	8.29	80.0	8.35
1.2	8.28	90.0	8.35
1.4	8.29	100.0	8.35
1.6	8.29	110.0	8.35
1.8	8.29	120.0	8.36
2.0	8.30	130.0	8.36
2.2	8.30	140.0	8.36
2.4	8.29	150.0	8.37
2.6	8.29	160.0	8.37
2.8	8.29	170.0	8.37
3.0	8.30	180.0	8.37
4.0	8.29	280.0	8.39
5.0	8.30	380.0	8.40
6.0	8.30	480.0	8.42
7.0	8.30	580.0	8.43
8.0	8.30	680.0	8.44
9.0	8.30	780.0	8.45
10.0	8.30	880.0	8.46
20.0	8.31	980.0	8.47
30.0	8.32		

Well Q09B
Equilibrium water level: 8.57 ft
Date: June 23, 1988

Time (second)	Water level (feet)	Time (second)	Water level (feet)
0.2	7.31	30.0	7.37
.4	7.32	40.0	7.37
.6	7.32	50.0	7.37
.8	7.32	60.0	7.38
1.0	7.32	70.0	7.38
2.0	7.33	80.0	7.38
3.0	7.33	180.0	7.40
4.0	7.33	280.0	7.42
5.0	7.34	380.0	7.43
6.0	7.34	480.0	7.44
7.0	7.34	580.0	7.45
8.0	7.34	680.0	7.46
9.0	7.35	780.0	7.47
10.0	7.35	880.0	7.48
20.0	7.36	980.0	7.49

Well Q10
Equilibrium water level: 10.77 ft
Date: June 6, 1988

Time (second)	Water level (feet)	Time (second)	Water level (feet)
0.2	8.86	26.0	8.97
.4	8.86	27.0	8.97
.6	8.86	28.0	8.98
.8	8.87	29.0	8.98
1.0	8.87	30.0	8.98
2.0	8.87	40.0	9.02
3.0	8.88	50.0	9.04
4.0	8.89	60.0	9.07
5.0	8.89	70.0	9.10
6.0	8.90	80.0	9.12
7.0	8.90	90.0	9.15
8.0	8.90	100.0	9.17
9.0	8.91	110.0	9.19
10.0	8.91	120.0	9.21
11.0	8.91	130.0	9.23
12.0	8.92	140.0	9.25
13.0	8.92	150.0	9.27
14.0	8.93	160.0	9.29
15.0	8.93	170.0	9.31
16.0	8.93	180.0	9.33
17.0	8.94	280.0	9.48
18.0	8.94	380.0	9.62
19.0	8.94	480.0	9.73
20.0	8.95	580.0	9.82
21.0	8.95	680.0	9.89
22.0	8.95	780.0	9.96
23.0	8.96	880.0	10.01
24.0	8.96	980.0	10.05
25.0	8.96		

Well Q11
Equilibrium water level: 9.07 ft
Date: June 30, 1988

Time (second)	Water level (feet)	Time (second)	Water level (feet)
0.2	7.62	18.0	7.43
.4	6.84	19.0	7.43
.6	7.58	20.0	7.44
.8	7.01	21.0	7.44
1.0	7.47	22.0	7.45
1.2	7.10	23.0	7.45
1.4	7.40	24.0	7.46
1.6	7.16	25.0	7.46
1.8	7.35	26.0	7.47
2.0	7.22	27.0	7.47
2.2	7.33	28.0	7.48
2.4	7.24	29.0	7.48
2.6	7.31	30.0	7.48
2.8	7.27	40.0	7.51
3.0	7.31	50.0	7.53
3.2	7.28	60.0	7.55
3.4	7.34	70.0	7.56
3.6	7.30	80.0	7.57
3.8	7.31	90.0	7.58
4.0	7.30	100.0	7.59
4.2	7.31	110.0	7.60
4.6	7.32	120.0	7.61
4.8	7.32	130.0	7.62
5.0	7.32	140.0	7.63
6.0	7.33	150.0	7.64
7.0	7.34	160.0	7.65
8.0	7.35	170.0	7.65
9.0	7.36	180.0	7.66
10.0	7.37	280.0	7.73
11.0	7.38	380.0	7.78
12.0	7.38	480.0	7.82
13.0	7.39	580.0	7.86
14.0	7.40	680.0	7.89
15.0	7.41	780.0	7.92
16.0	7.41	880.0	7.94
17.0	7.42	980.0	7.96

Table 10.--*Slug-test data, June through September 1988*--Continued

[Water level recovery measured in feet above the transducer; second = seconds from start of test; for location of observation wells, see figure 6]

Well Q12
Equilibrium water level: 10.16 ft
Date: June 30, 1988

Time (second)	Water level (feet)	Time (second)	Water level (feet)
1.0	8.33	100.0	8.35
2.0	8.32	110.0	8.35
3.0	8.34	120.0	8.35
4.0	8.33	130.0	8.36
5.0	8.34	140.0	8.36
6.0	8.34	150.0	8.36
7.0	8.34	160.0	8.36
9.0	8.34	170.0	8.36
10.0	8.34	180.0	8.36
20.0	8.34	280.0	8.36
30.0	8.35	380.0	8.36
40.0	8.35	480.0	8.36
50.0	8.35	580.0	8.36
60.0	8.35	680.0	8.36
70.0	8.35	780.0	8.37
80.0	8.35	880.0	8.37
90.0	8.35	980.0	8.37

Well Q13
Equilibrium water level: 8.37 ft
Date: September 9, 1988

Time (second)	Water level (feet)	Time (second)	Water level (feet)
0.2	6.77	16.0	7.20
.4	6.79	17.0	7.22
.6	6.82	18.0	7.24
.8	6.76	19.0	7.27
1.0	6.80	20.0	7.29
1.2	6.76	21.0	7.31
1.4	6.82	22.0	7.34
1.6	6.82	23.0	7.36
1.8	6.84	24.0	7.38
2.0	6.84	25.0	7.40
2.2	6.87	26.0	7.42
2.4	6.85	27.0	7.44
2.6	6.86	28.0	7.46
2.8	6.86	29.0	7.48
3.0	6.87	30.0	7.50
3.2	6.88	40.0	7.67
3.4	6.89	50.0	7.80
3.6	6.88	60.0	7.89
3.8	6.90	70.0	7.95
4.0	6.89	80.0	8.00
4.2	6.91	90.0	8.04
4.4	6.91	100.0	8.07
4.6	6.92	110.0	8.10
4.8	6.93	120.0	8.13
5.0	6.93	130.0	8.15
5.2	6.94	140.0	8.17
5.4	6.95	150.0	8.18
5.6	6.95	160.0	8.20
5.8	6.95	170.0	8.21
6.0	6.96	180.0	8.22
7.0	6.97	280.0	8.30
8.0	6.99	380.0	8.32
9.0	7.02	480.0	8.35
10.0	7.05	580.0	8.35
11.0	7.07	680.0	8.36
12.0	7.10	780.0	8.37
13.0	7.12	880.0	8.36
14.0	7.15	980.0	8.37
15.0	7.17		

Table 10.--*Slug-test data, June through September 1988*--Continued

[Water level recovery measured in feet above the transducer; second = seconds from start of test; for location of observation wells, see figure 6]

Well Q14
Equilibrium water level: 8.29 ft
Date: September 12, 1988

Time (second)	Water level (feet)	Time (second)	Water level (feet)
0.2	6.55	13.0	6.84
.4	6.55	14.0	6.86
.6	6.55	15.0	6.88
.8	6.56	16.0	6.90
1.0	6.56	17.0	6.92
1.2	6.57	18.0	6.94
1.4	6.58	19.0	6.96
1.6	6.58	20.0	6.98
1.8	6.58	21.0	7.00
2.0	6.59	22.0	7.02
2.2	6.60	23.0	7.03
2.4	6.61	24.0	7.05
2.6	6.61	25.0	7.07
2.8	6.61	26.0	7.09
3.0	6.62	27.0	7.10
3.2	6.63	28.0	7.12
3.4	6.63	29.0	7.14
3.6	6.63	30.0	7.15
3.8	6.64	40.0	7.31
4.0	6.65	50.0	7.43
4.2	6.65	60.0	7.55
4.4	6.66	70.0	7.64
4.6	6.66	80.0	7.72
4.8	6.67	90.0	7.80
5.0	6.67	100.0	7.86
5.2	6.68	110.0	7.91
5.4	6.68	120.0	7.96
5.6	6.69	130.0	8.00
5.8	6.69	140.0	8.04
6.0	6.70	150.0	8.07
7.0	6.70	160.0	8.09
8.0	6.72	170.0	8.11
9.0	6.75	180.0	8.13
10.0	6.77	280.0	8.23
11.0	6.79	380.0	8.25
12.0	6.82	480.0	8.26

Well Q15
Equilibrium water level: 8.38 ft
Date: September 12, 1988

Time (second)	Water level (feet)	Time (second)	Water level (feet)
0.2	7.01	16.0	7.32
.4	7.03	17.0	7.33
.6	7.03	18.0	7.34
.8	7.03	19.0	7.35
1.0	7.03	20.0	7.36
1.2	7.04	21.0	7.37
1.4	7.05	22.0	7.38
1.6	7.06	23.0	7.39
1.8	7.07	24.0	7.40
2.0	7.08	25.0	7.41
2.2	7.08	26.0	7.42
2.4	7.09	27.0	7.43
2.6	7.09	28.0	7.44
2.8	7.10	29.0	7.45
3.0	7.10	30.0	7.45
3.2	7.11	40.0	7.53
3.4	7.12	50.0	7.59
3.6	7.12	60.0	7.65
3.8	7.13	70.0	7.70
4.0	7.13	80.0	7.74
4.2	7.14	90.0	7.78
4.4	7.14	100.0	7.81
4.6	7.15	110.0	7.84
4.8	7.15	120.0	7.87
5.0	7.15	130.0	7.90
5.2	7.16	140.0	7.92
5.4	7.16	150.0	7.94
5.6	7.17	160.0	7.96
5.8	7.17	170.0	7.98
6.0	7.18	180.0	8.00
7.0	7.18	280.0	8.14
8.0	7.20	380.0	8.21
9.0	7.22	480.0	8.26
10.0	7.24	580.0	8.30
11.0	7.25	680.0	8.33
12.0	7.26	780.0	8.35
13.0	7.28	880.0	8.37
14.0	7.29	980.0	8.38
15.0	7.31		

Table 10.--*Slug-test data, June through September 1988*--Continued

[Water level recovery measured in feet above the transducer; second = seconds from start of test; for location of observation wells, see figure 6]

Well Q16A
Equilibrium water level: 8.51 ft
Date: September 9, 1988

Time (second)	Water level (feet)	Time (second)	Water level (feet)
0.2	6.71	22.0	6.91
.4	6.72	23.0	6.91
.6	6.74	24.0	6.91
.8	6.75	25.0	6.92
1.0	6.76	26.0	6.92
1.2	6.76	27.0	6.93
1.4	6.76	28.0	6.94
1.6	6.76	29.0	6.94
1.8	6.77	30.0	6.94
2.0	6.76	40.0	6.99
2.2	6.79	50.0	7.03
2.4	6.78	60.0	7.07
2.6	6.78	70.0	7.11
2.8	6.81	80.0	7.15
3.0	6.79	90.0	7.18
4.0	6.80	100.0	7.22
5.0	6.81	110.0	7.25
6.0	6.82	120.0	7.28
7.0	6.82	130.0	7.31
8.0	6.83	140.0	7.34
9.0	6.83	150.0	7.37
10.0	6.84	160.0	7.40
11.0	6.85	170.0	7.42
12.0	6.85	180.0	7.45
13.0	6.86	280.0	7.68
14.0	6.86	380.0	7.85
15.0	6.87	480.0	7.98
16.0	6.87	580.0	8.09
17.0	6.88	680.0	8.16
18.0	6.89	780.0	8.22
19.0	6.89	880.0	8.25
20.0	6.89	980.0	8.28
21.0	6.90		

Well Q18A
Equilibrium water level: 8.44 ft
Date: June 24, 1988

Time (second)	Water level (feet)	Time (second)	Water level (feet)
0.2	6.73	15.0	7.12
.4	6.74	16.0	7.14
.6	6.76	17.0	7.16
.8	6.75	18.0	7.18
1.0	6.76	19.0	7.20
1.2	6.77	20.0	7.23
1.4	6.78	21.0	7.24
1.6	6.79	22.0	7.26
1.8	6.79	23.0	7.28
2.0	6.80	24.0	7.30
2.2	6.80	25.0	7.32
2.4	6.82	26.0	7.34
2.6	6.82	27.0	7.35
2.8	6.83	28.0	7.37
3.0	6.83	29.0	7.39
3.2	6.84	30.0	7.41
3.4	6.84	40.0	7.56
3.6	6.85	50.0	7.69
3.8	6.86	60.0	7.80
4.0	6.86	70.0	7.89
4.2	6.87	80.0	7.96
4.4	6.88	90.0	8.03
4.6	6.88	100.0	8.09
4.8	6.89	110.0	8.14
5.0	6.89	120.0	8.18
5.2	6.90	130.0	8.22
5.4	6.90	140.0	8.25
5.6	6.91	150.0	8.28
5.8	6.91	160.0	8.30
6.0	6.92	170.0	8.32
7.0	6.93	180.0	8.33
8.0	6.95	280.0	8.40
9.0	6.98	380.0	8.43
10.0	7.00	480.0	8.44
11.0	7.03	580.0	8.44
12.0	7.05	680.0	8.43
13.0	7.08	780.0	8.43
14.0	7.10		

Table 10.--*Slug-test data, June through September 1988*--Continued

[Water level recovery measured in feet above the transducer; second = seconds from start of test; for location of observation wells, see figure 6]

Well Q18B
Equilibrium water level: 9.05 ft
Date: June 24, 1988

Time (second)	Water level (feet)	Time (second)	Water level (feet)
0.2	7.32	14.0	7.80
.4	7.34	15.0	7.83
.6	7.35	16.0	7.86
.8	7.37	17.0	7.88
1.0	7.36	18.0	7.91
1.2	7.37	19.0	7.93
1.4	7.37	20.0	7.96
1.6	7.38	21.0	7.98
1.8	7.41	22.0	8.01
2.0	7.42	23.0	8.03
2.2	7.42	24.0	8.06
2.4	7.42	25.0	8.08
2.6	7.43	26.0	8.10
2.8	7.44	27.0	8.12
3.0	7.45	28.0	8.14
3.2	7.46	29.0	8.16
3.4	7.46	30.0	8.18
3.6	7.47	40.0	8.36
3.8	7.48	50.0	8.50
4.0	7.49	60.0	8.61
4.2	7.50	70.0	8.70
4.4	7.50	80.0	8.77
4.6	7.51	90.0	8.83
4.8	7.52	100.0	8.87
5.0	7.53	110.0	8.91
5.2	7.54	120.0	8.93
5.4	7.54	130.0	8.96
5.6	7.55	140.0	8.97
5.8	7.56	150.0	8.99
6.0	7.57	160.0	9.00
7.0	7.57	170.0	9.01
8.0	7.61	180.0	9.02
9.0	7.64	280.0	9.05
10.0	7.67	380.0	9.06
11.0	7.71	480.0	9.05
12.0	7.74	580.0	9.05
13.0	7.77		

Well Q19A
Equilibrium water level: 8.33 ft
Date: June 24, 1988

Time (second)	Water level (feet)	Time (second)	Water level (feet)
0.2	7.62	11.0	7.63
.4	7.62	12.0	7.64
.6	7.62	13.0	7.63
.8	7.63	14.0	7.64
1.0	7.60	15.0	7.64
1.2	7.63	16.0	7.64
1.4	7.62	17.0	7.64
1.6	7.63	18.0	7.64
1.8	7.62	19.0	7.64
2.0	7.62	20.0	7.64
2.2	7.62	30.0	7.65
2.4	7.62	40.0	7.65
2.6	7.62	50.0	7.66
2.8	7.62	60.0	7.66
3.0	7.61	70.0	7.66
3.2	7.62	80.0	7.66
3.4	7.64	90.0	7.66
3.6	7.62	100.0	7.66
3.8	7.64	110.0	7.67
4.0	7.63	120.0	7.67
4.2	7.62	130.0	7.67
4.4	7.63	140.0	7.67
4.6	7.63	150.0	7.68
4.8	7.62	160.0	7.68
5.0	7.64	170.0	7.68
5.2	7.63	180.0	7.68
5.4	7.62	280.0	7.70
5.6	7.63	380.0	7.72
5.8	7.63	480.0	7.74
6.0	7.63	580.0	7.76
7.0	7.63	680.0	7.77
8.0	7.63	780.0	7.79
9.0	7.64	880.0	7.80
10.0	7.63	980.0	7.81

Table 10.--*Slug-test data, June through September 1988*--Continued

[Water level recovery measured in feet above the transducer; second = seconds from start of test; for location of observation wells, see figure 6]

Well Q20A
Equilibrium water level: 8.29 ft
Date: June 6, 1988

Time (second)	Water level (feet)	Time (second)	Water level (feet)
0.2	6.63	14.0	7.48
.4	6.65	15.0	7.52
.6	6.67	16.0	7.56
.8	6.71	17.0	7.59
1.0	6.73	18.0	7.62
1.2	6.73	19.0	7.66
1.4	6.75	20.0	7.69
1.6	6.77	21.0	7.71
1.8	6.79	22.0	7.74
2.0	6.81	23.0	7.77
2.2	6.82	24.0	7.79
2.4	6.84	25.0	7.81
2.6	6.86	26.0	7.83
2.8	6.87	27.0	7.86
3.0	6.89	28.0	7.88
3.2	6.91	29.0	7.90
3.4	6.92	30.0	7.91
3.6	6.94	40.0	8.05
3.8	6.95	50.0	8.13
4.0	6.97	60.0	8.18
4.2	6.98	70.0	8.22
4.4	7.00	80.0	8.24
4.6	7.01	90.0	8.25
4.8	7.03	100.0	8.26
5.0	7.04	110.0	8.27
5.2	7.05	120.0	8.27
5.4	7.07	130.0	8.28
5.6	7.08	140.0	8.28
5.8	7.09	150.0	8.28
6.0	7.11	160.0	8.28
7.0	7.13	170.0	8.28
8.0	7.18	180.0	8.28
9.0	7.24	280.0	8.29
10.0	7.29	380.0	8.29
11.0	7.34	480.0	8.29
12.0	7.39	580.0	8.29
13.0	7.44		

Well Q26
Equilibrium water level: 9.97 ft
Date: September 12, 1988

Time (second)	Water level (feet)	Time (second)	Water level (feet)
0.2	8.11	40.0	8.17
.4	8.09	50.0	8.17
.6	8.12	60.0	8.18
.8	8.12	70.0	8.18
1.0	8.12	80.0	8.18
2.0	8.13	90.0	8.18
3.0	8.13	100.0	8.18
4.0	8.14	130.0	8.18
5.0	8.14	140.0	8.19
6.0	8.14	180.0	8.19
7.0	8.14	280.0	8.19
8.0	8.14	380.0	8.20
9.0	8.15	480.0	8.20
10.0	8.15	580.0	8.20
20.0	8.16	680.0	8.21
30.0	8.16	980.0	8.21

Well Q28
Equilibrium water level: 10.26 ft
Date: September 12, 1988

Time (second)	Water level (feet)	Time (second)	Water level (feet)
0.2	8.42	90.0	8.48
.4	8.41	100.0	8.48
.6	8.42	110.0	8.48
.8	8.44	120.0	8.48
1.0	8.44	130.0	8.49
2.0	8.44	140.0	8.49
3.0	8.44	150.0	8.49
4.0	8.44	160.0	8.49
5.0	8.44	170.0	8.49
9.0	8.44	180.0	8.49
10.0	8.45	280.0	8.50
20.0	8.45	380.0	8.50
21.0	8.46	480.0	8.51
30.0	8.46	580.0	8.51
40.0	8.47	680.0	8.52
50.0	8.47	780.0	8.52
60.0	8.47	880.0	8.53
70.0	8.47	980.0	8.53
80.0	8.48		

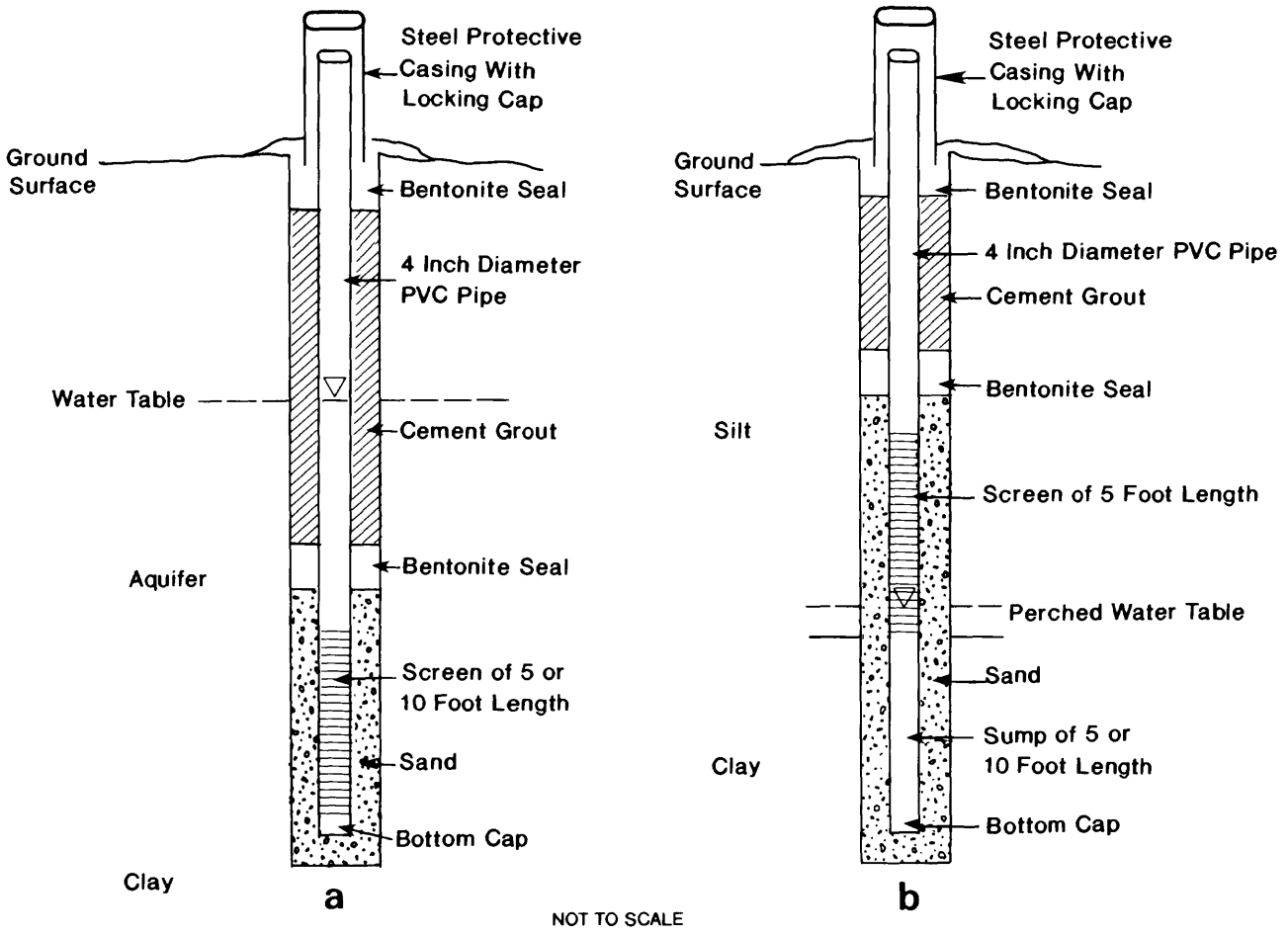

Figure 4.--(A) Standard construction of a well and (B) specialized construction of a well with a sump.

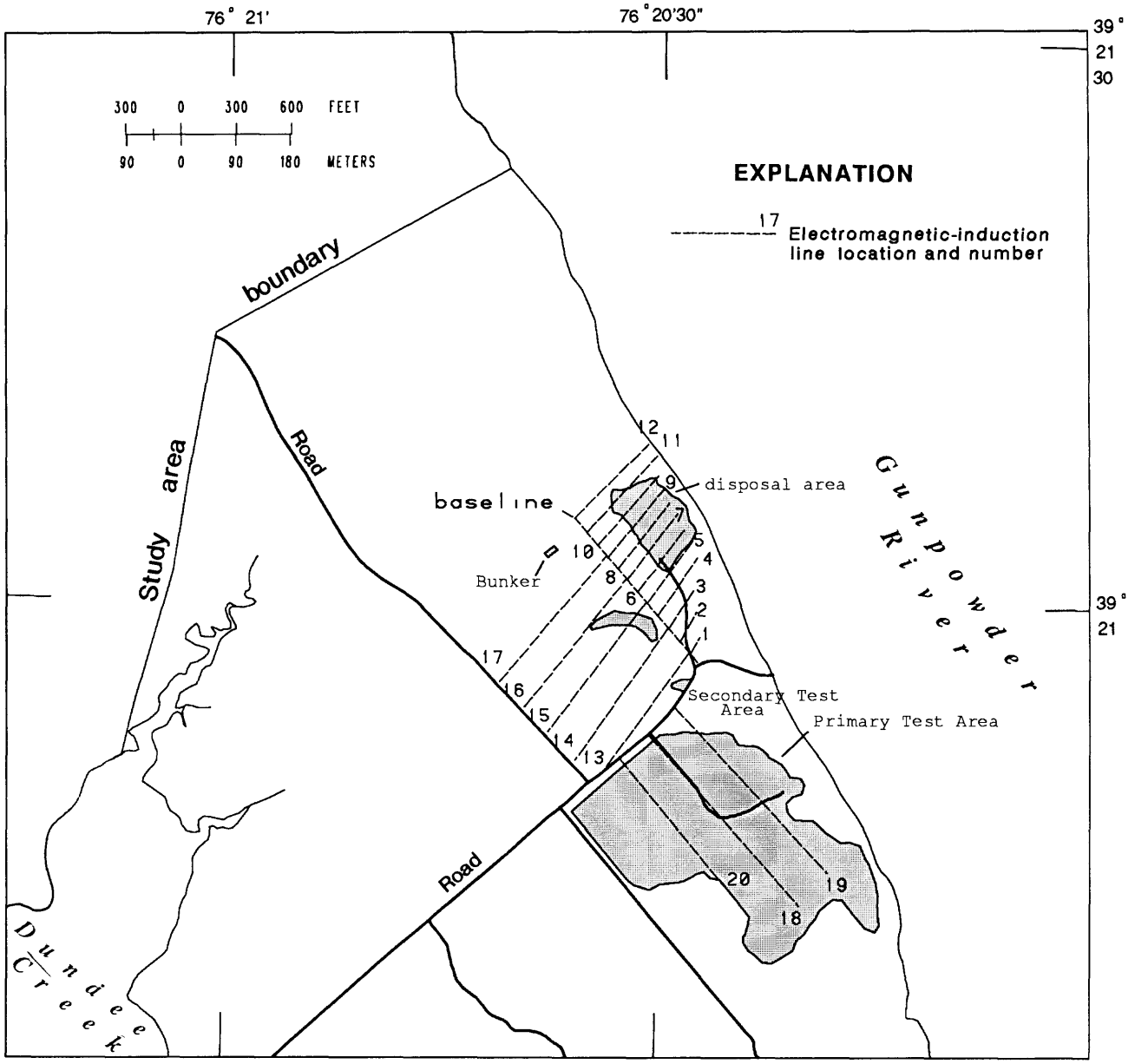

Figure 5.--Location of electromagnetic-induction lines for the surveys conducted April and October 1987.

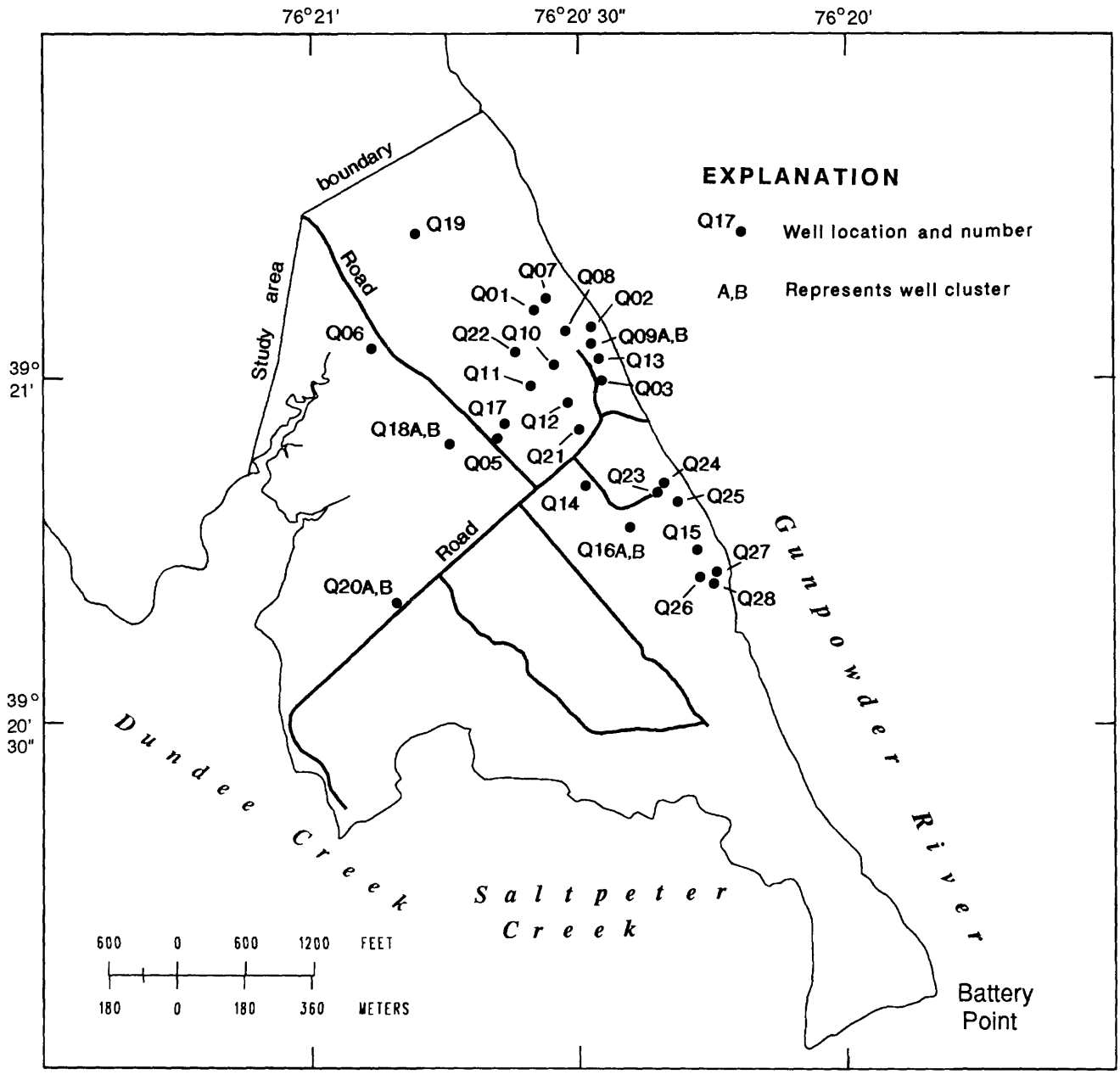

Figure 6.--Location of observation wells.

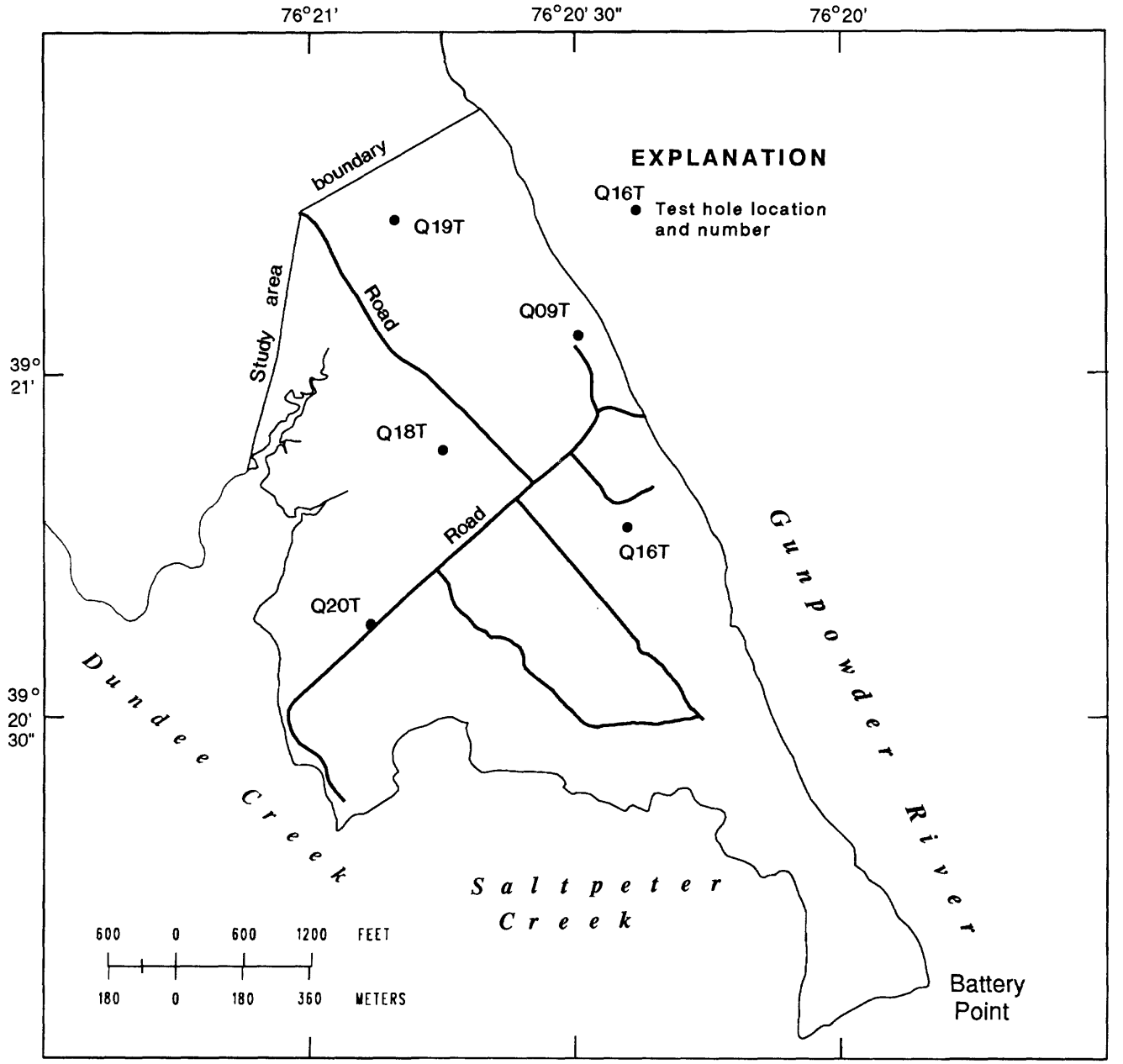

Figure 7.--Location of test holes.

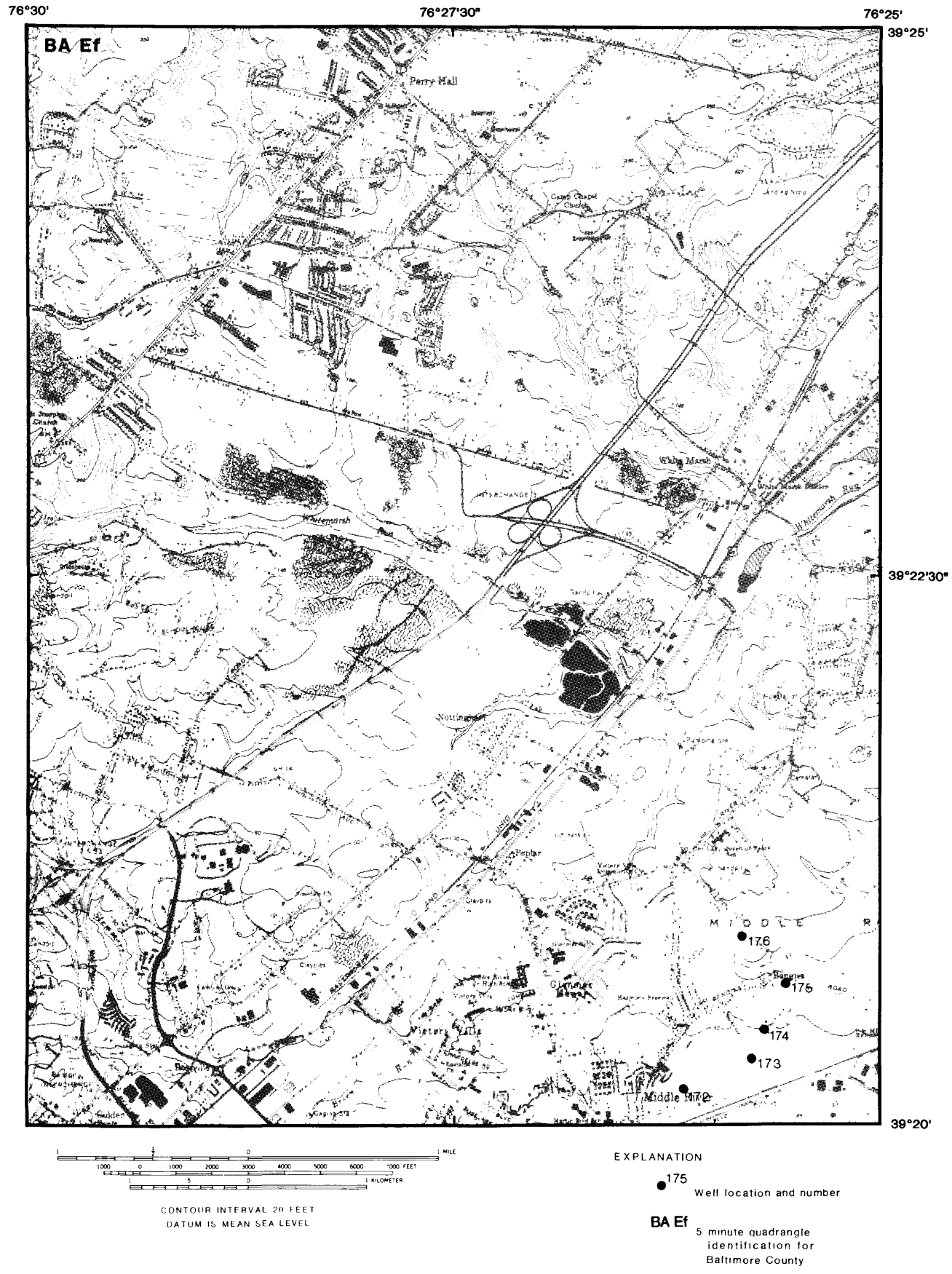

Figure 8.--Location of offsite wells in quadrangle Ef.

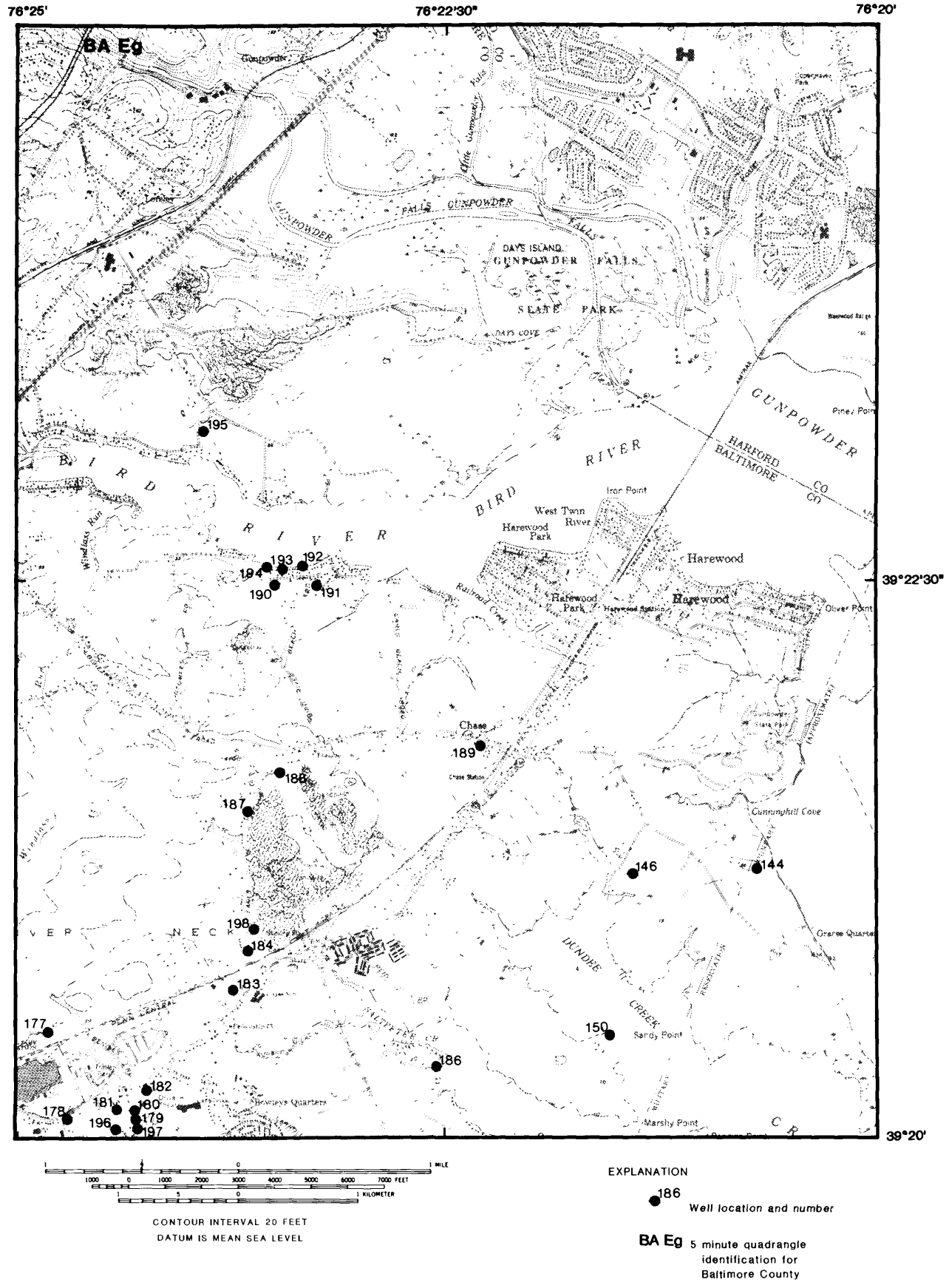

Figure 9.--Location of offsite wells in quadrangle Eg.

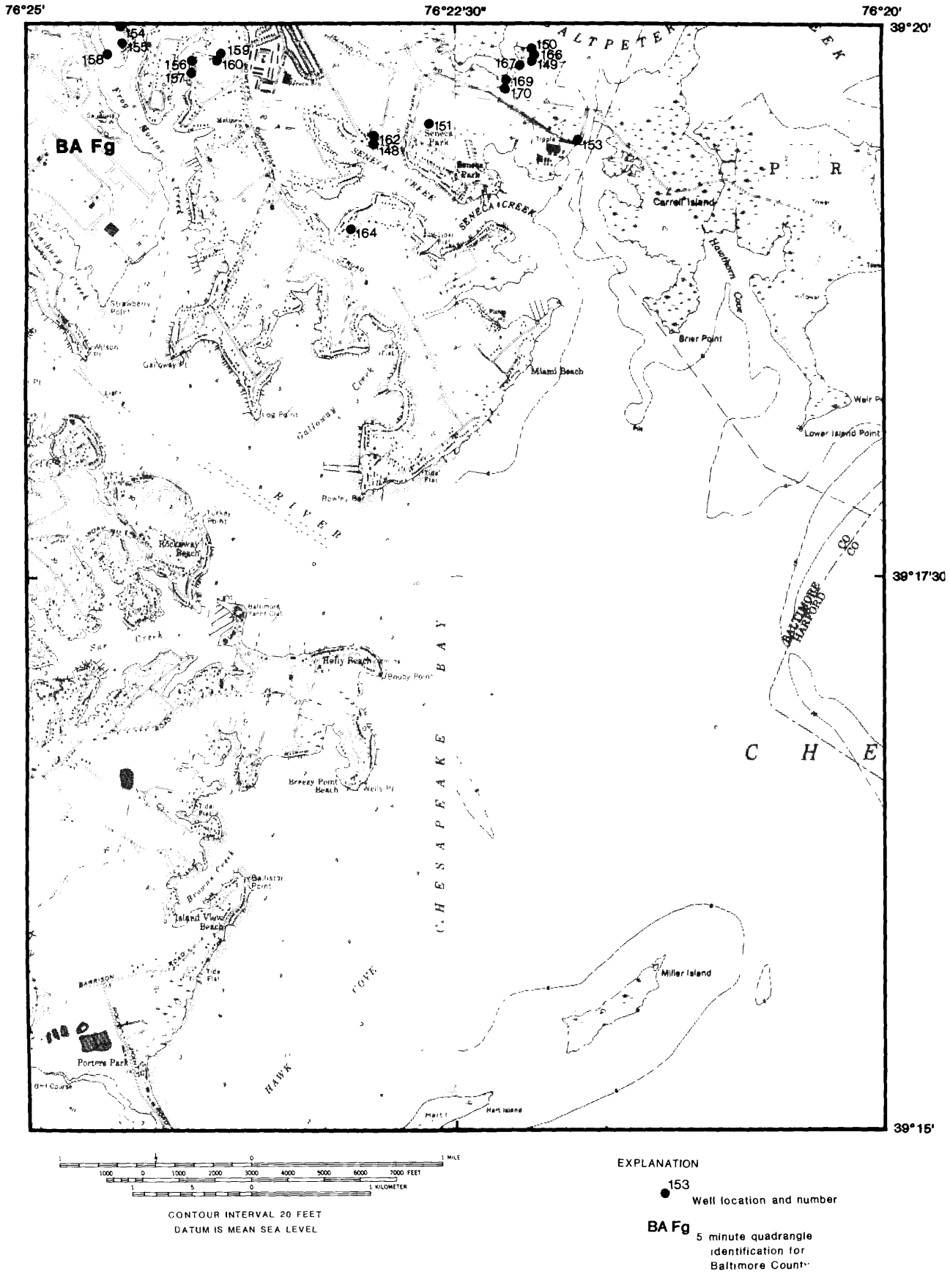

Figure 10.--Location of offsite wells in quadrangle Fg.

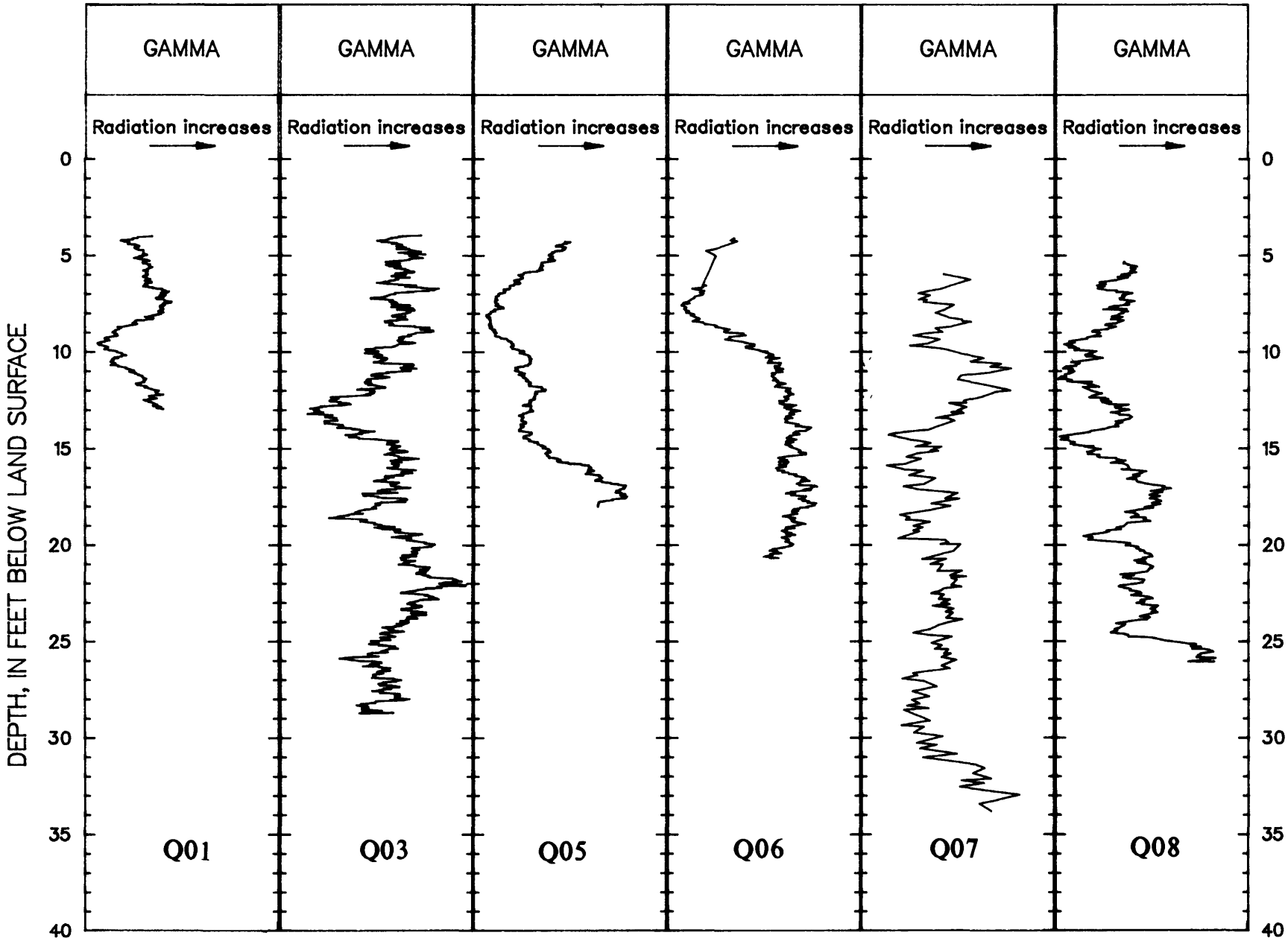

Figure 11.--Geophysical logs of selected wells.

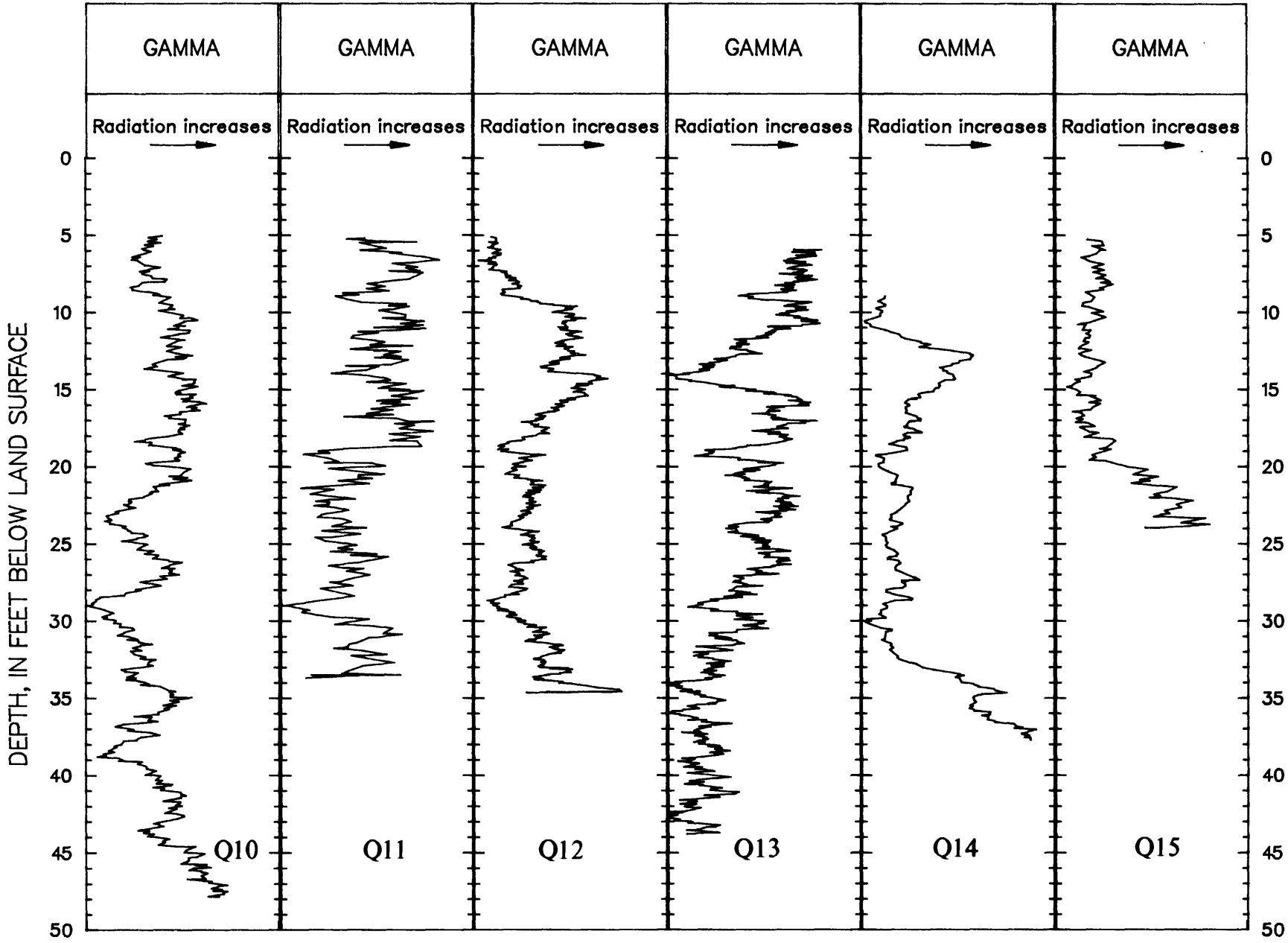

Figure 11.--Geophysical logs of selected wells--Continued.

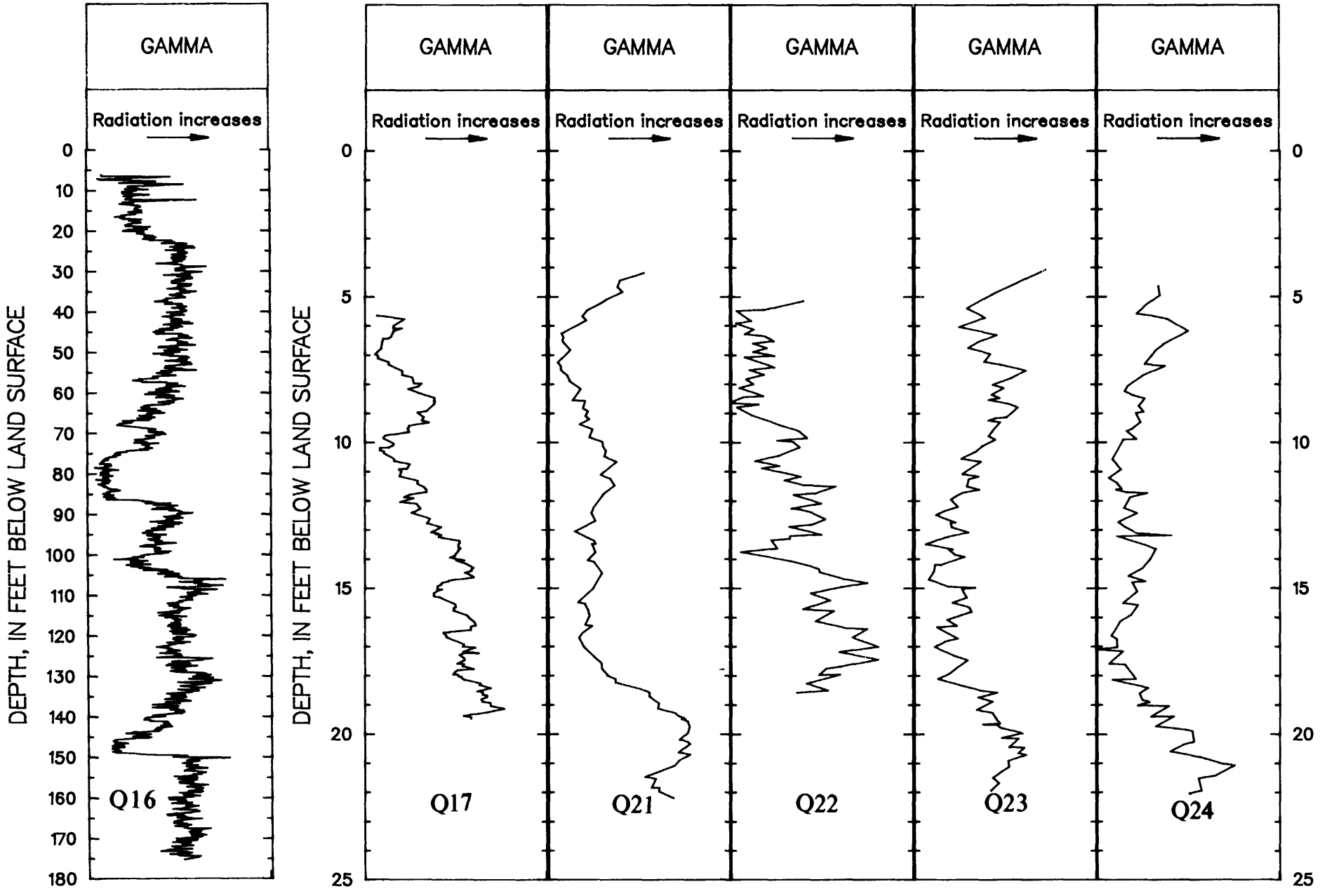

Figure 11.--Geophysical logs of selected wells--Continued.

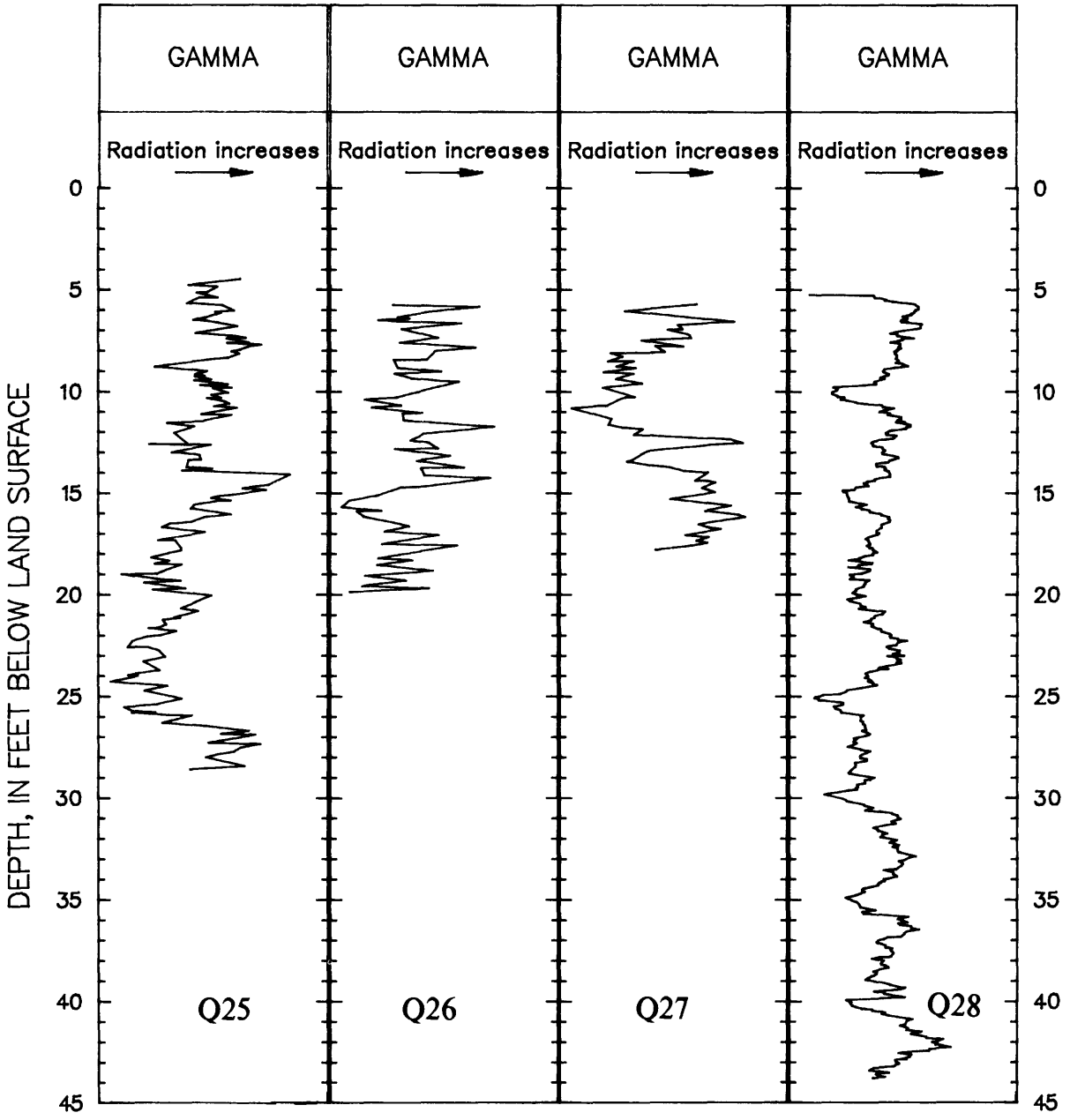

Figure 11.--Geophysical logs of selected wells. --Continued.

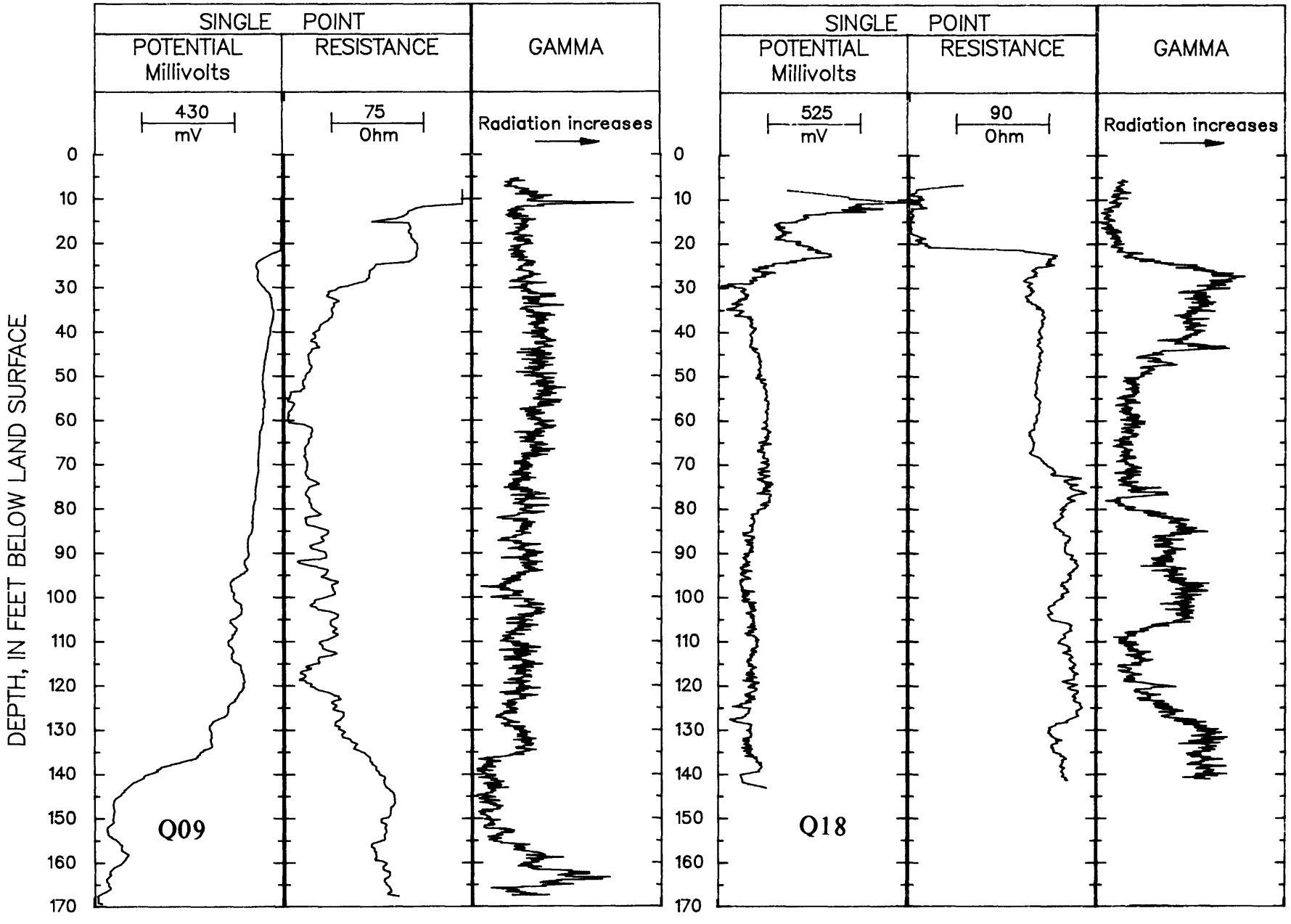

Figure 11.--Geophysical logs of selected wells--Continued.

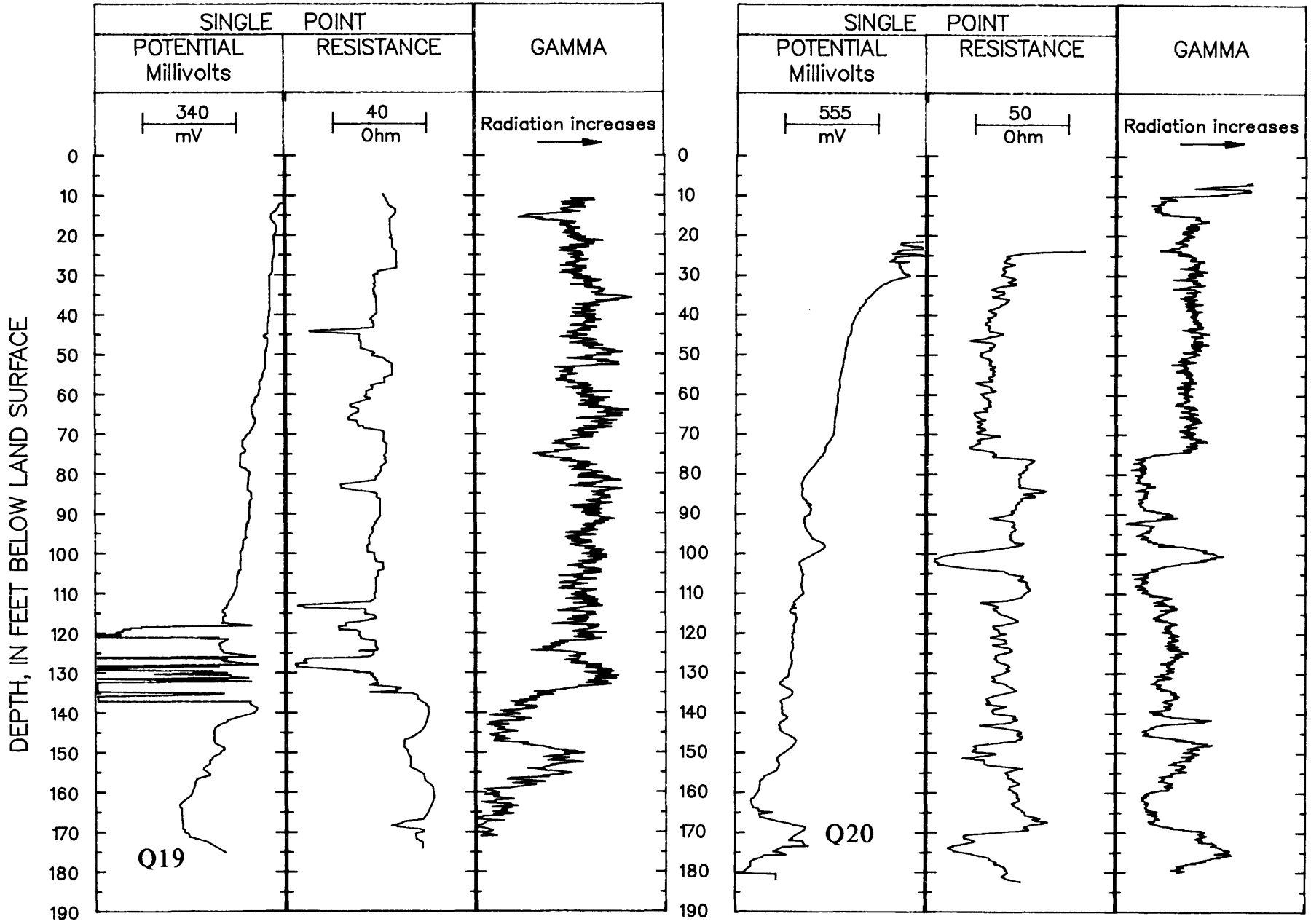

Figure 11.--Geophysical logs of selected wells--Continued.

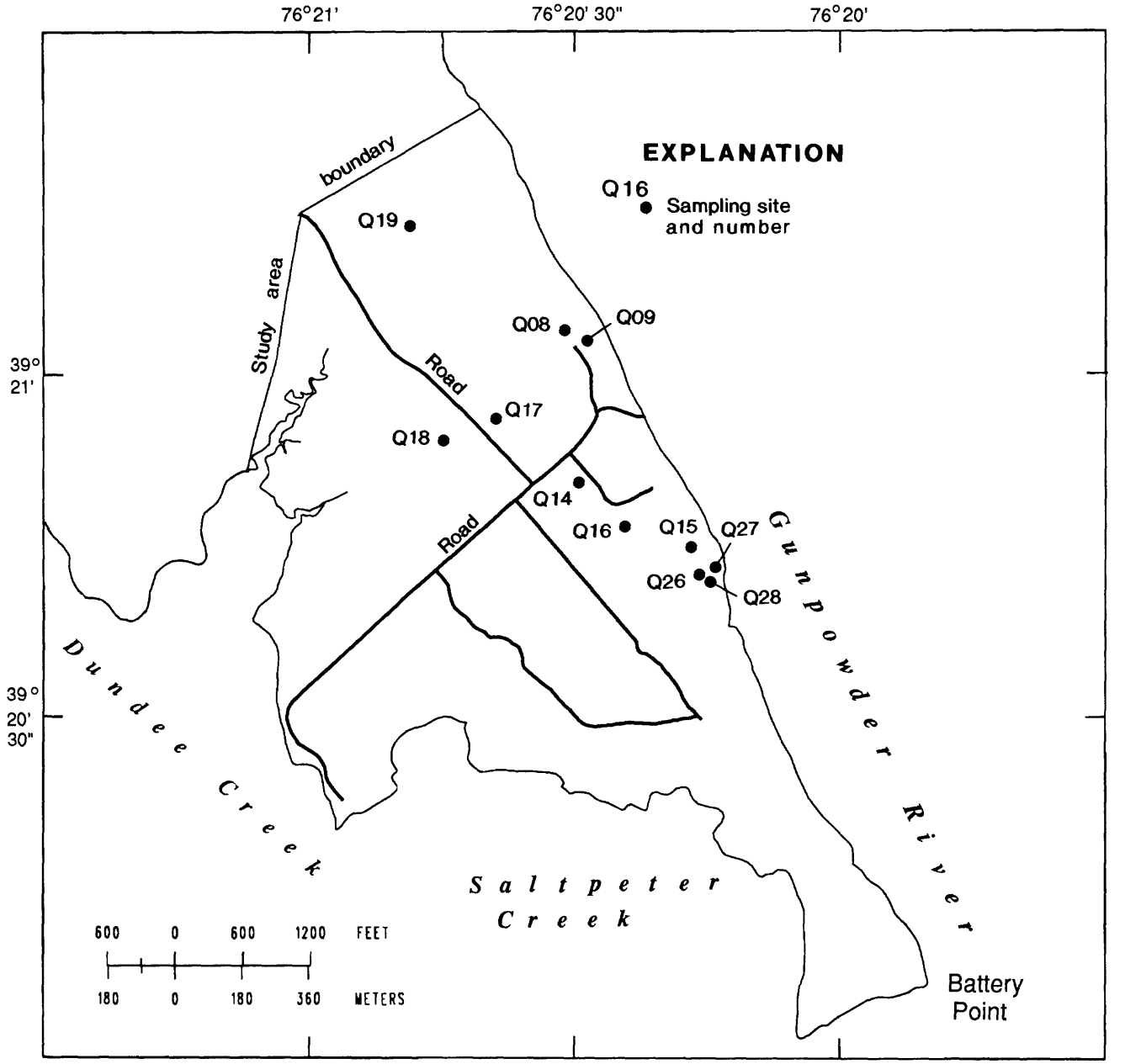

Figure 12.--Location of sampling sites for physical property analysis of core sediments.

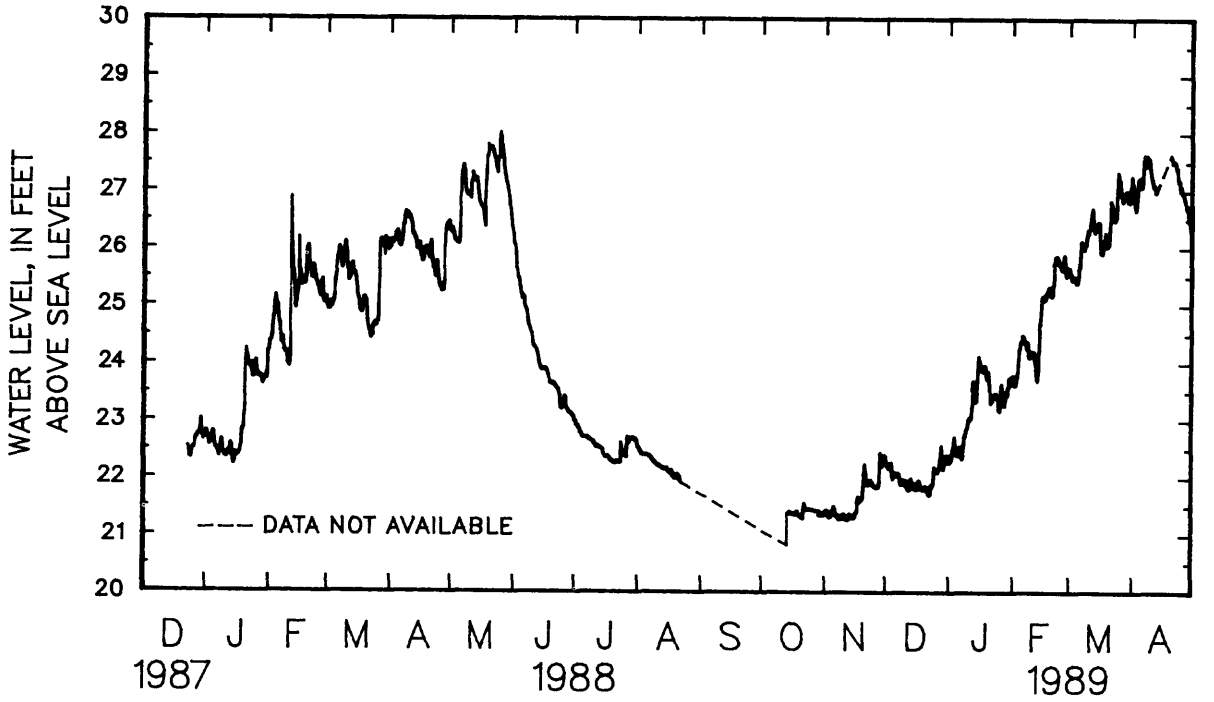

Figure 13.--Hydrograph for well Q01.

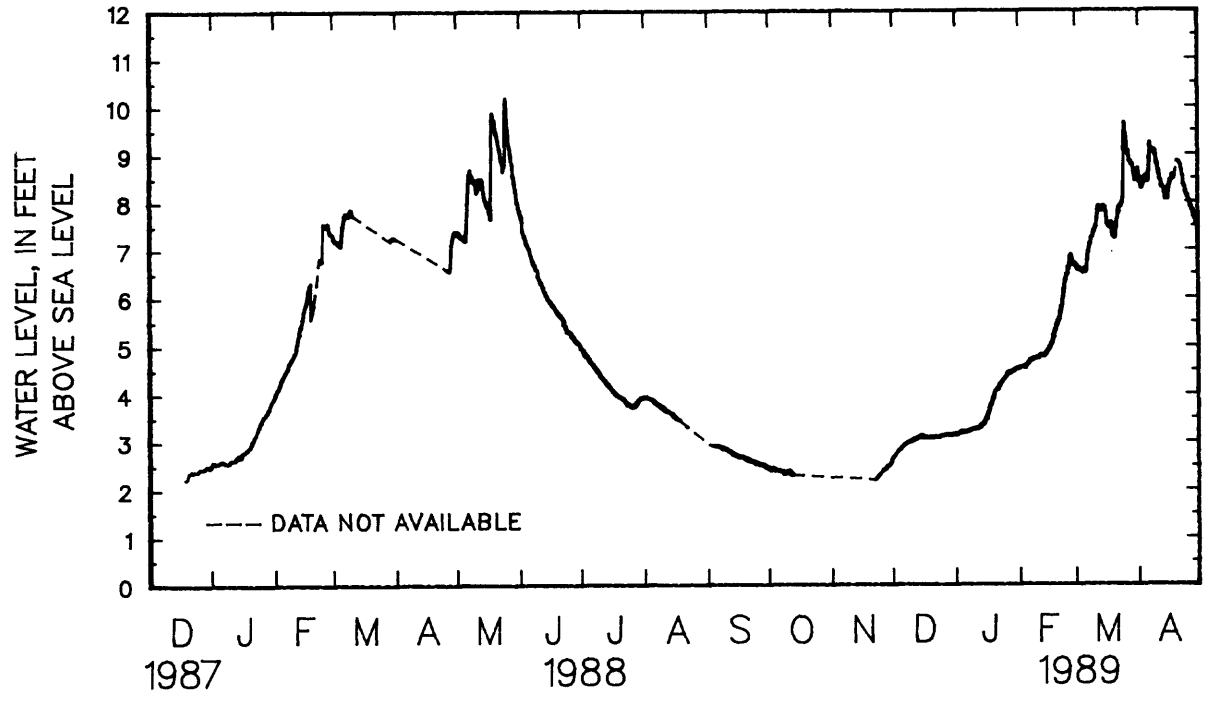

Figure 14.--Hydrograph for well Q05.

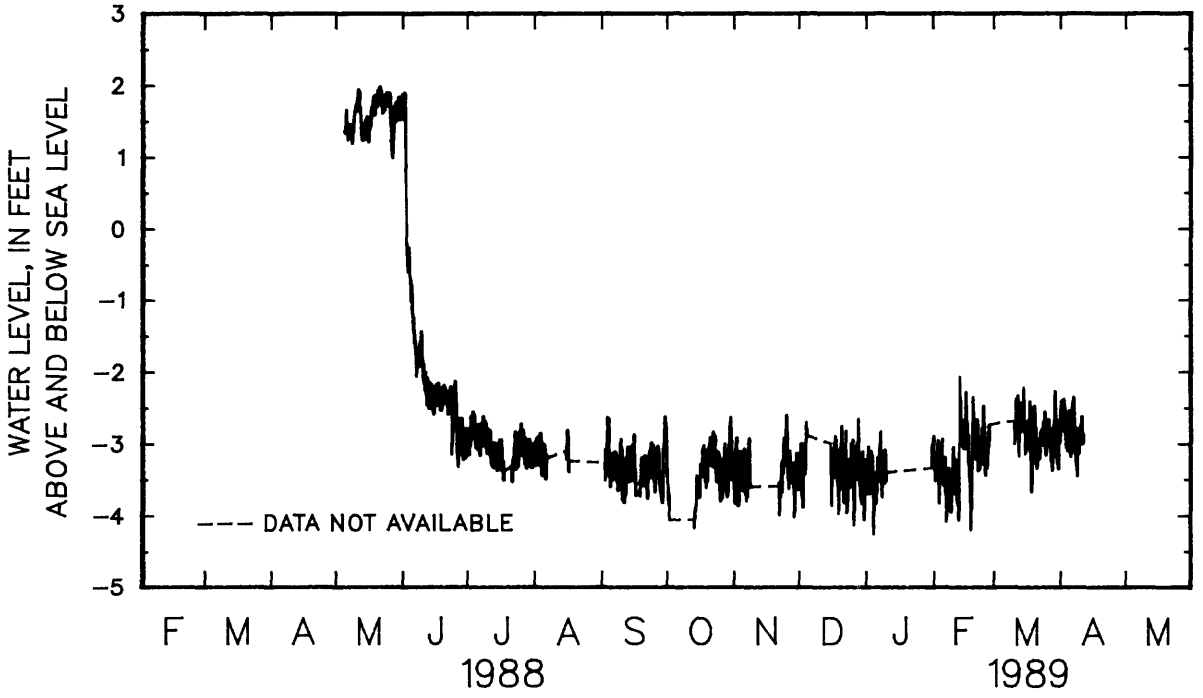

Figure 15.--Hydrograph for well Q09B.

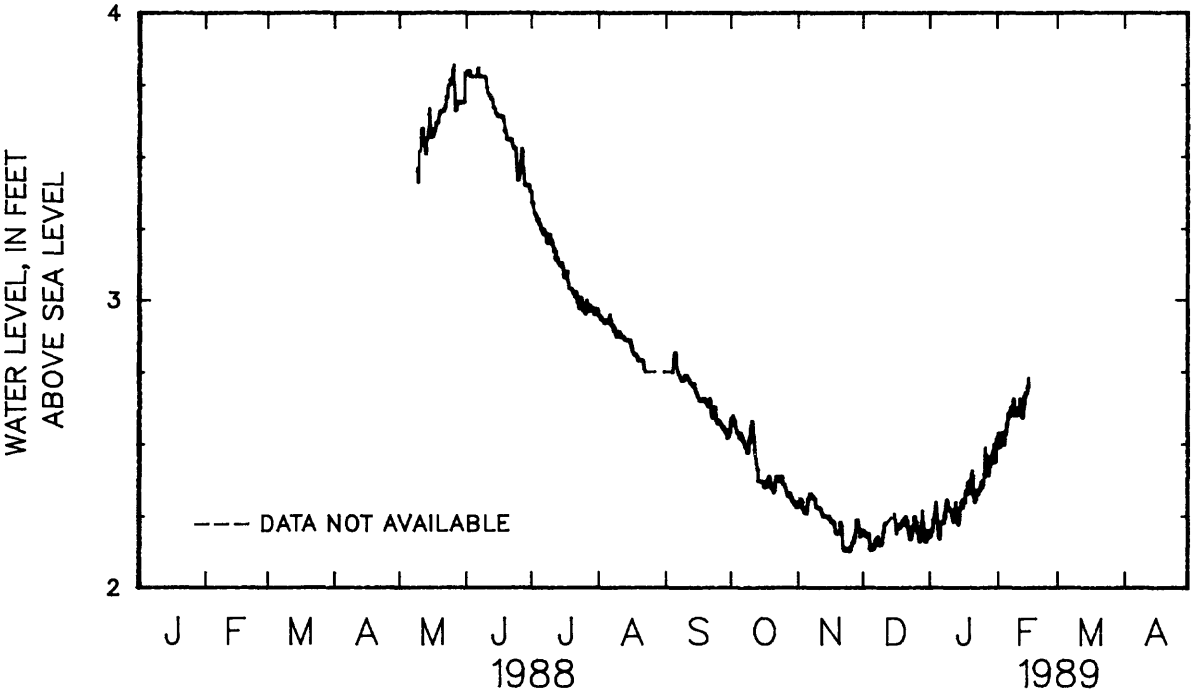

Figure 16.--Hydrograph for well Q13.

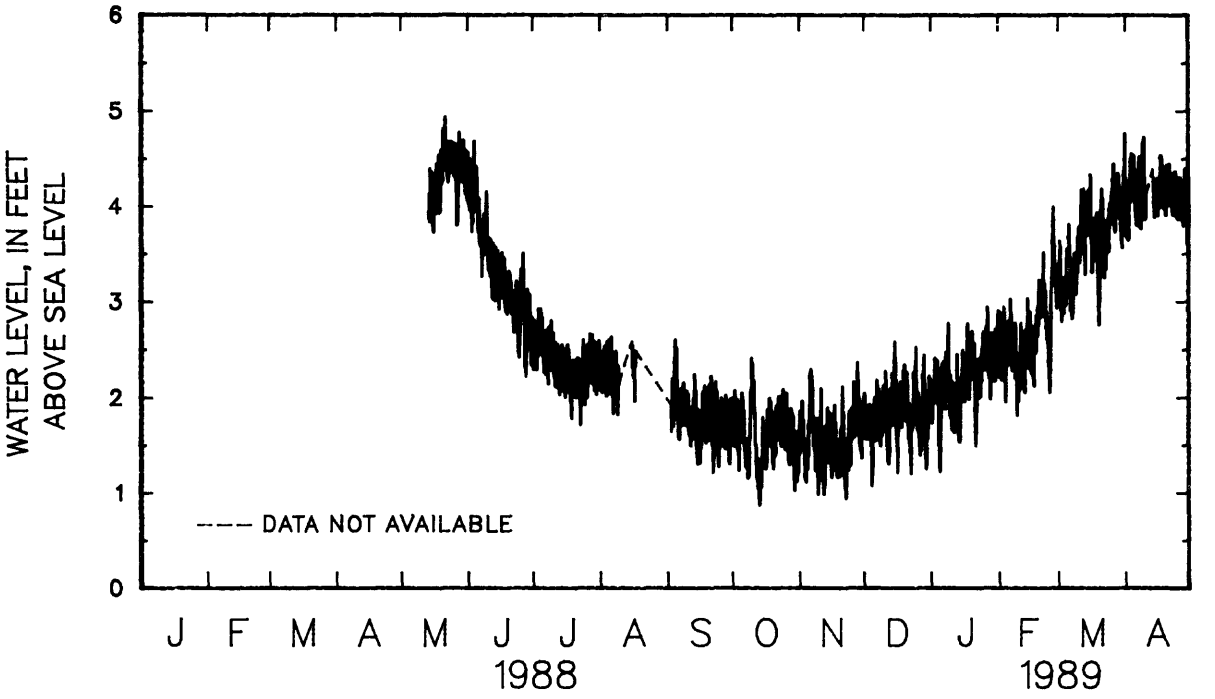

Figure 17.--Hydrograph for well Q16A.

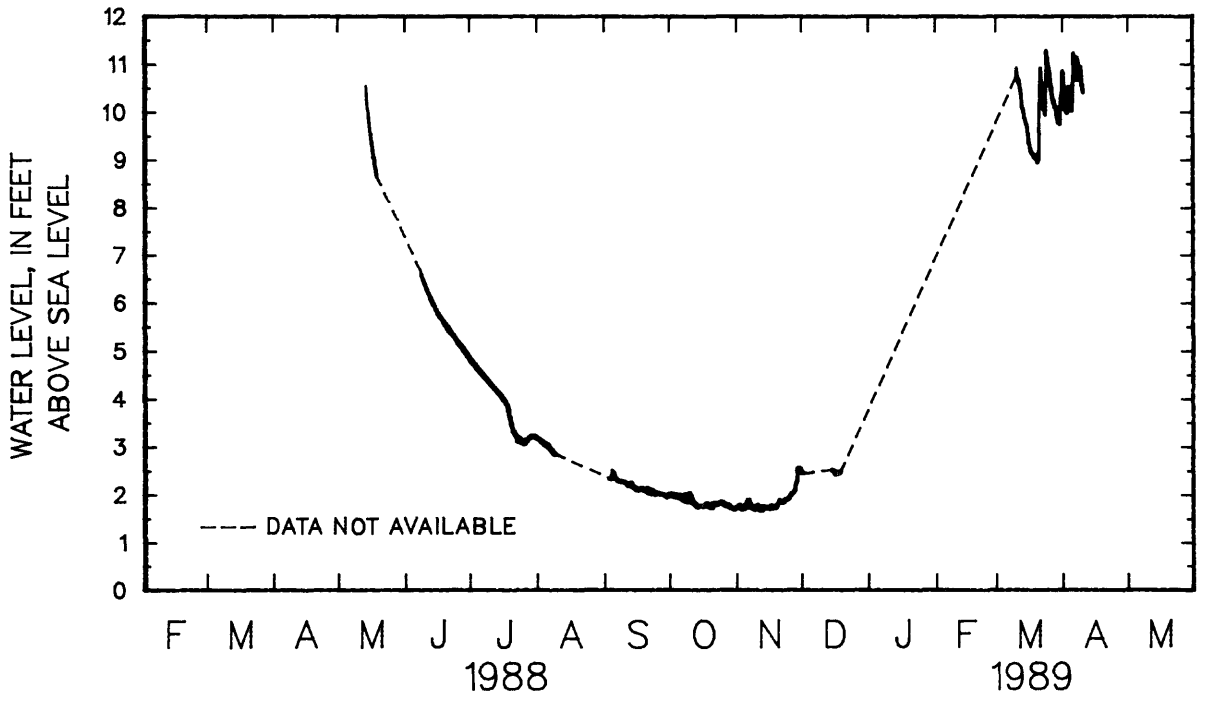

Figure 18.--Hydrograph for well Q16B.

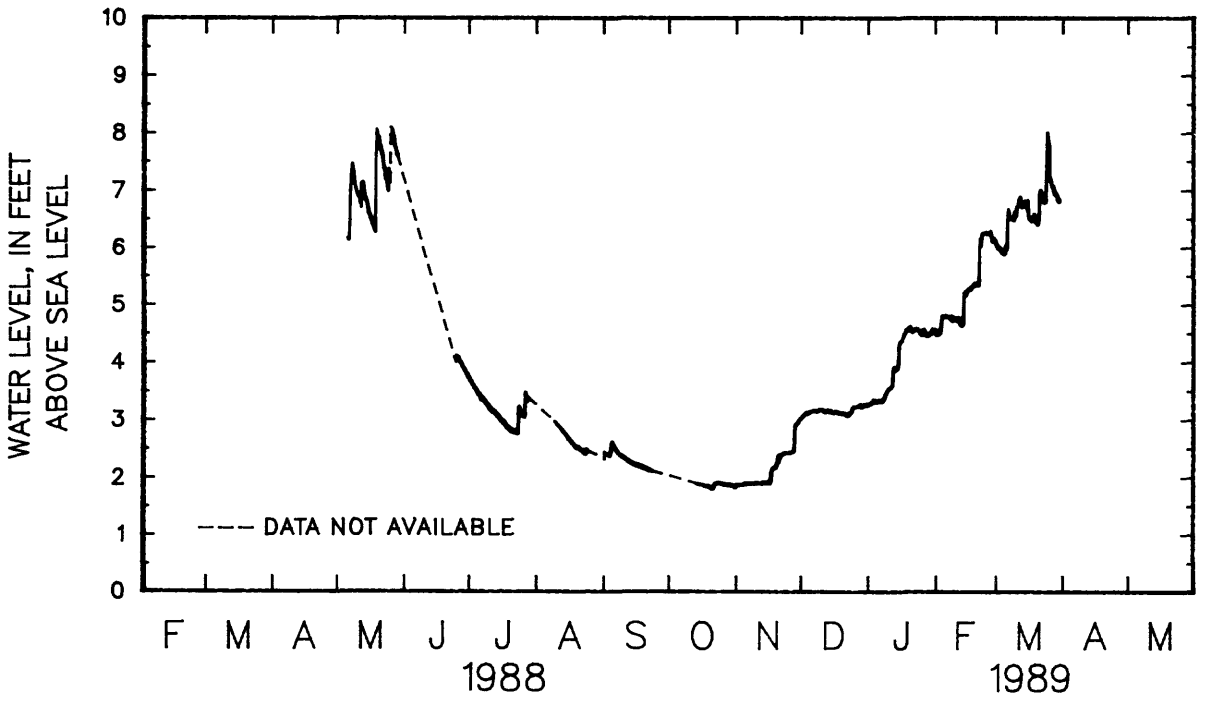

Figure 19.--Hydrograph for well Q18A.

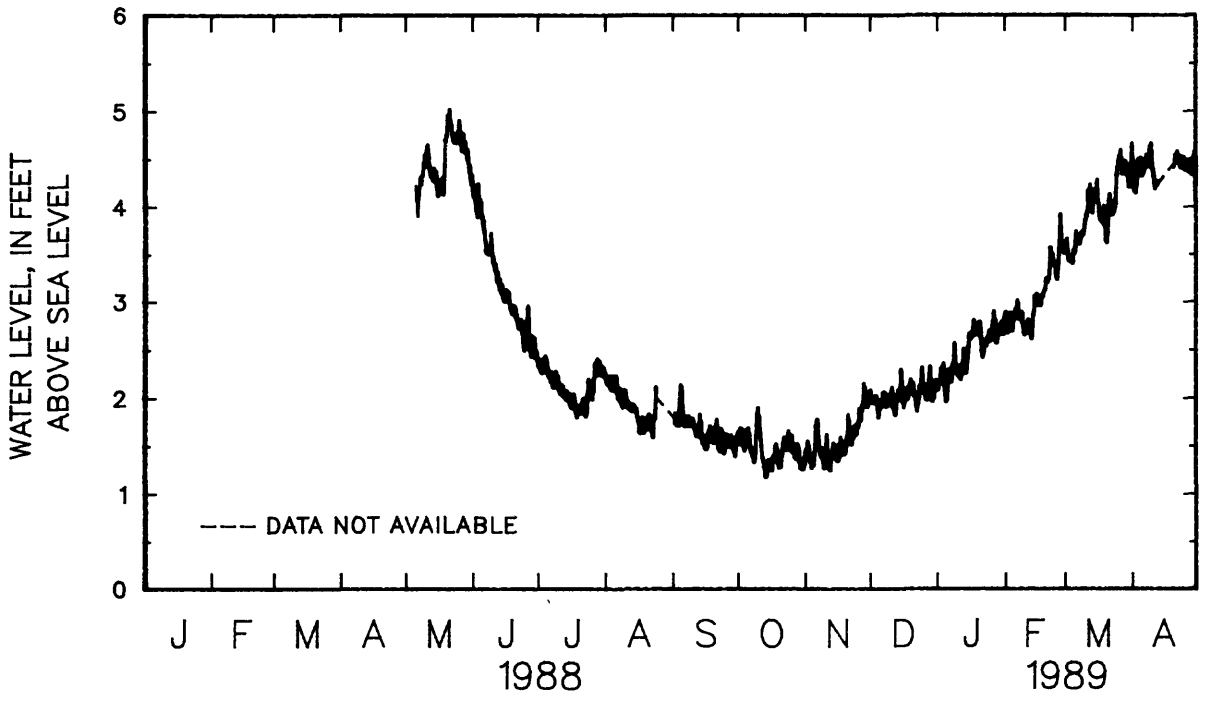

Figure 20.--Hydrograph for well Q18B.

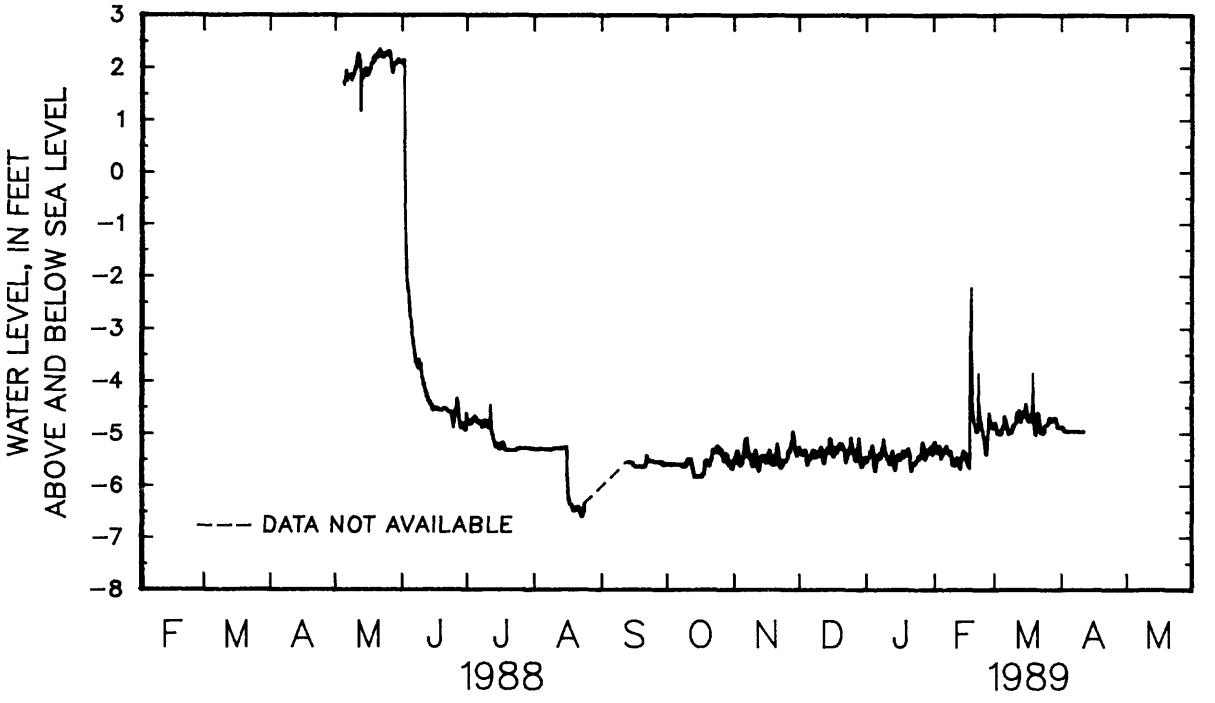

Figure 21.--Hydrograph for well Q19A.

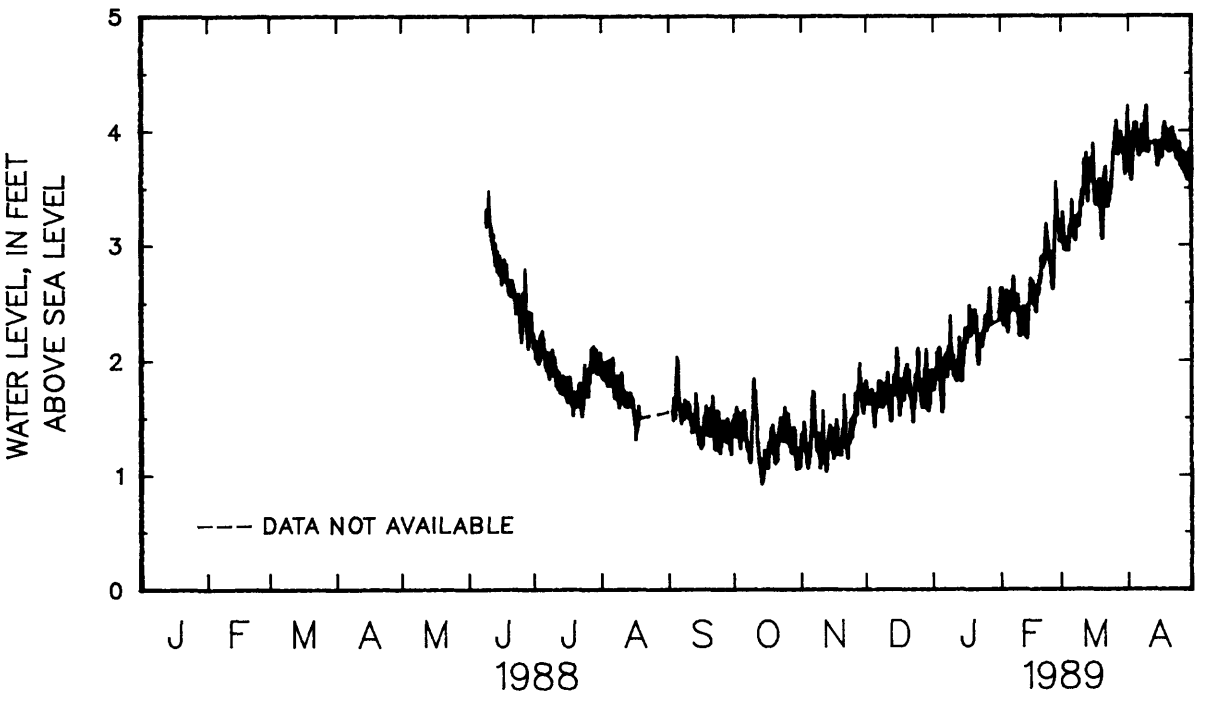

Figure 22.--Hydrograph for well Q20A.

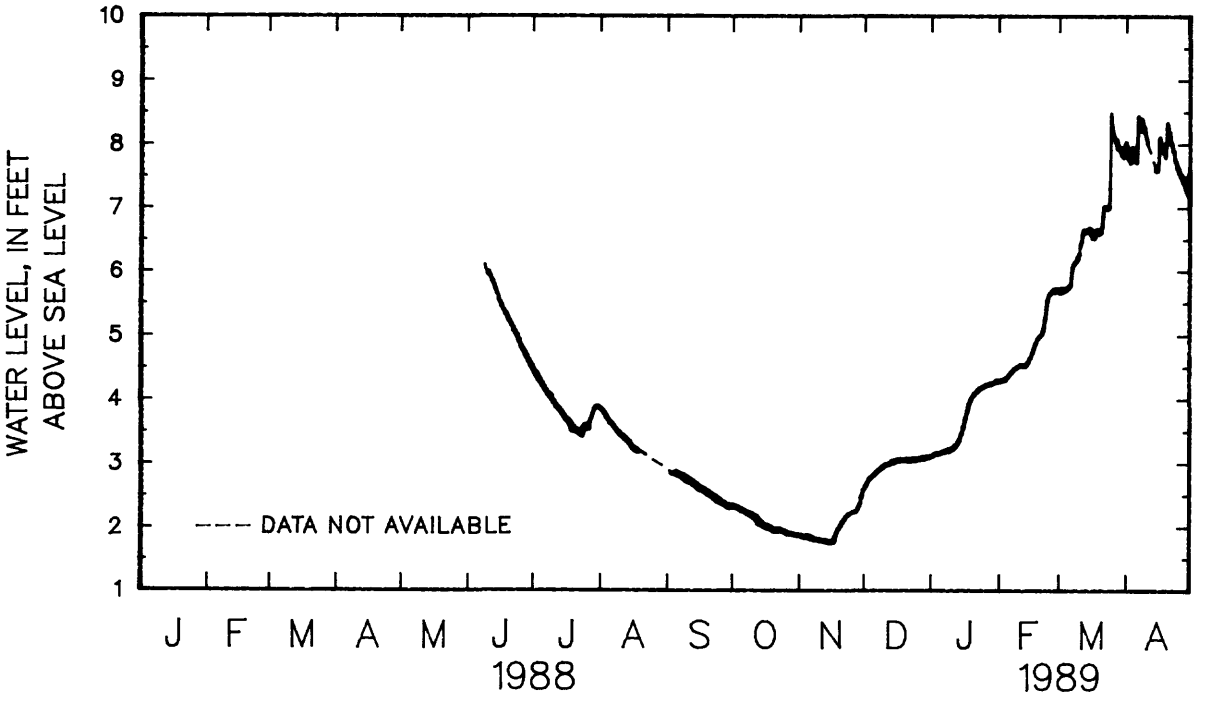

Figure 23.--Hydrograph for well Q20B.

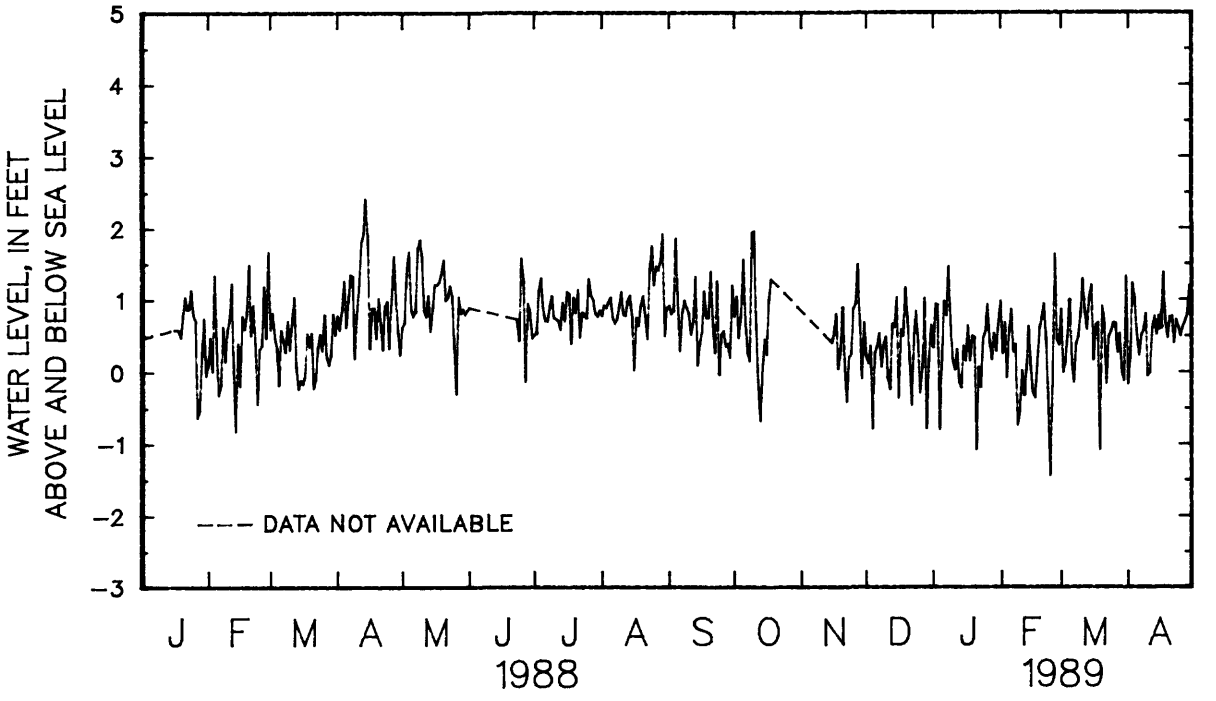

Figure 24.--Tidal data (mean daily fluctuations) from January 1988 through April 1989.

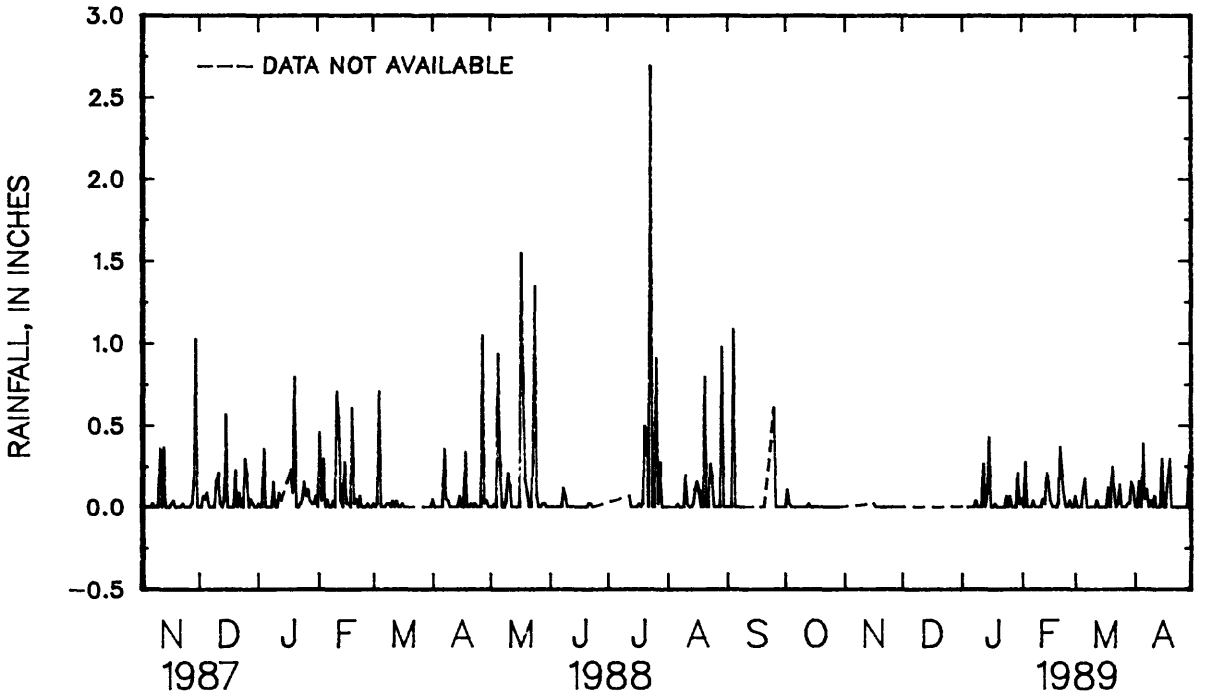

Figure 25.--Precipitation data (daily totals) from November 1987 through April 1989.