HYDROGEOLOGIC CHARACTERIZATION OF A PROPOSED LANDFILL EXPANSION IN PICKENS COUNTY NEAR EASLEY, SOUTH CAROLINA

by Whitney J. Stringfield

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ABSTRACT

This report presents the results of a hydrogeologic study in the Piedmont physiographic province of South Carolina to obtain geologic, hydrologic, and water-quality data from the site of a proposed landfill expansion in Pickens County near Easley, South Carolina.

The geology of the study area is typical of the Piedmont region. The unconsolidated regolith on the site is soil and saprolite, which is a product of the weathered parent rock. The soil ranges in thickness from about 5 to 20 feet. The saprolite ranges in thickness from about 5 to 134 feet. The most abundant parent rock type in the area is a biotite gneiss.

Ground- and surface-water data were collected at the site. Slug tests on the saprolite indicate a mean hydraulic conductivity of 3×10^{-6} feet per second. Transmissivity ranges from 1.2×10^{1} to 2.7×10^{1} cubic feet per day per feet (square feet per day). The ground-water velocity for the site ranges from 3 to 6 feet per year. The closest major stream to the site is Golden Creek. Based on low-flow data for Golden Creek, the estimated minimum 7 consecutive day flow that has a recurrence interval of 10 years ($7Q_{10}$) at station 02186102 is 2.4 cubic feet per second.

Water samples were collected from five monitoring wells at the proposed landfill expansion site and from one stream adjacent to the expansion site. Measured pH units ranged from 5.5 to 8.1, and alkalinity concentrations ranged from 5.1 to 73 milligrams per liter as $CaCO_3$. Other water-quality data obtained included temperature and specific conductance, and 5-day BOD (biochemical oxygen demand), bicarbonate, ammonia-nitrogen, nitrite-nitrogen, nitrite plus nitrate, organic carbon, calcium, magnesium, sodium, potassium, chloride, sulfate, fluoride, and selected trace metal concentrations.

INTRODUCTION

Pickens County is in the Blue Ridge and Piedmont physiographic provinces in northwestern South Carolina (fig. 1) and contains the site for a proposed expansion of a municipal landfill. The study area is located on approximately 40 acres adjacent to an existing landfill, near Easley, S.C. in Pickens County (fig. 2). Pickens County has owned and operated the existing landfill site since 1978. In 1991, the landfill accepted approximately 270 tons per day of municipal solid waste. The landfill is located in a part of the Piedmont physiographic province where ground-water-flow characteristics have not been well defined. To better understand ground-water-flow characteristics at the study area, an investigation was initiated by the U.S. Geological Survey (USGS) in cooperation with Pickens County.

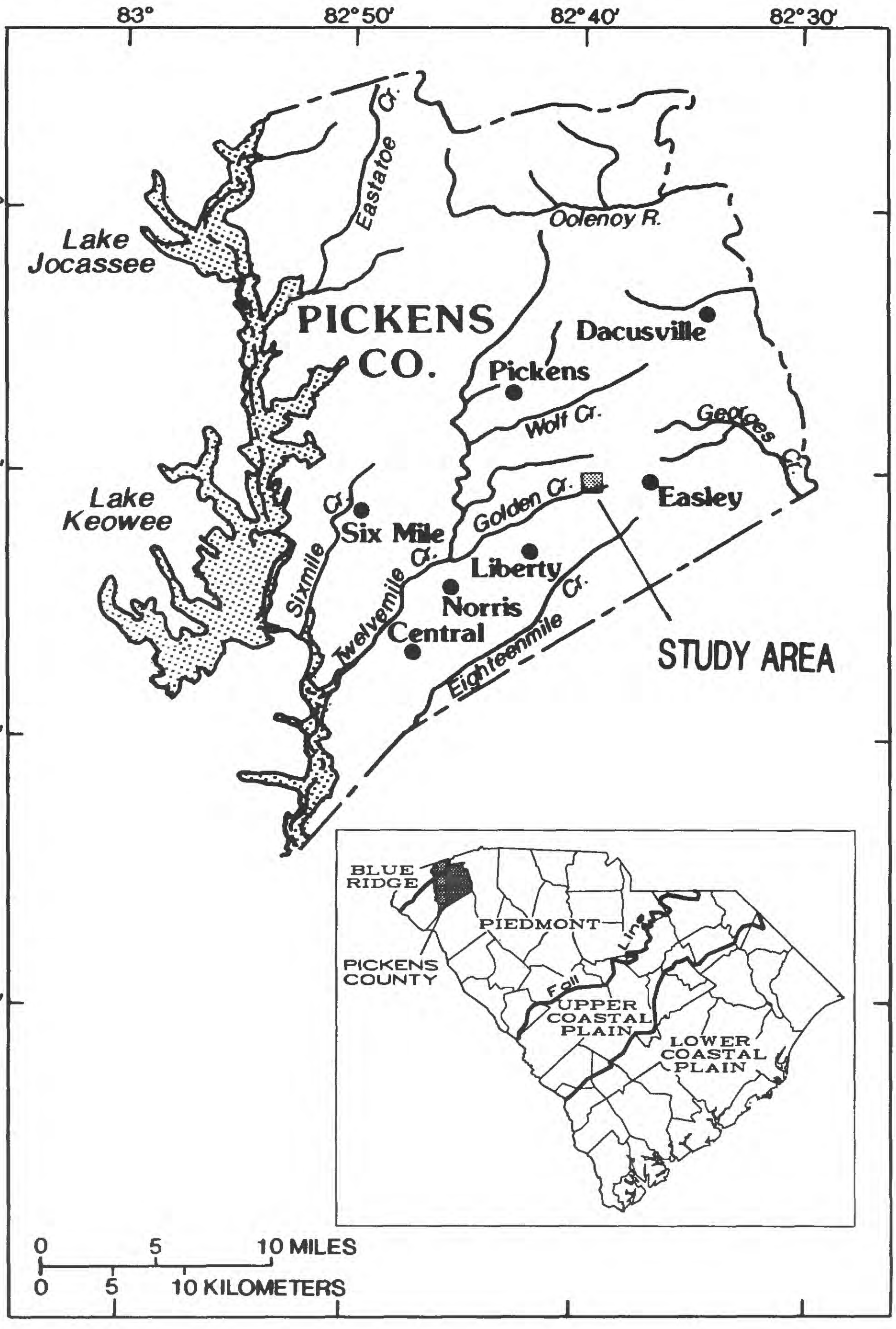

Figure 1.--Location of the major towns and streams in Pickens County and the physiographic provinces in S.C.

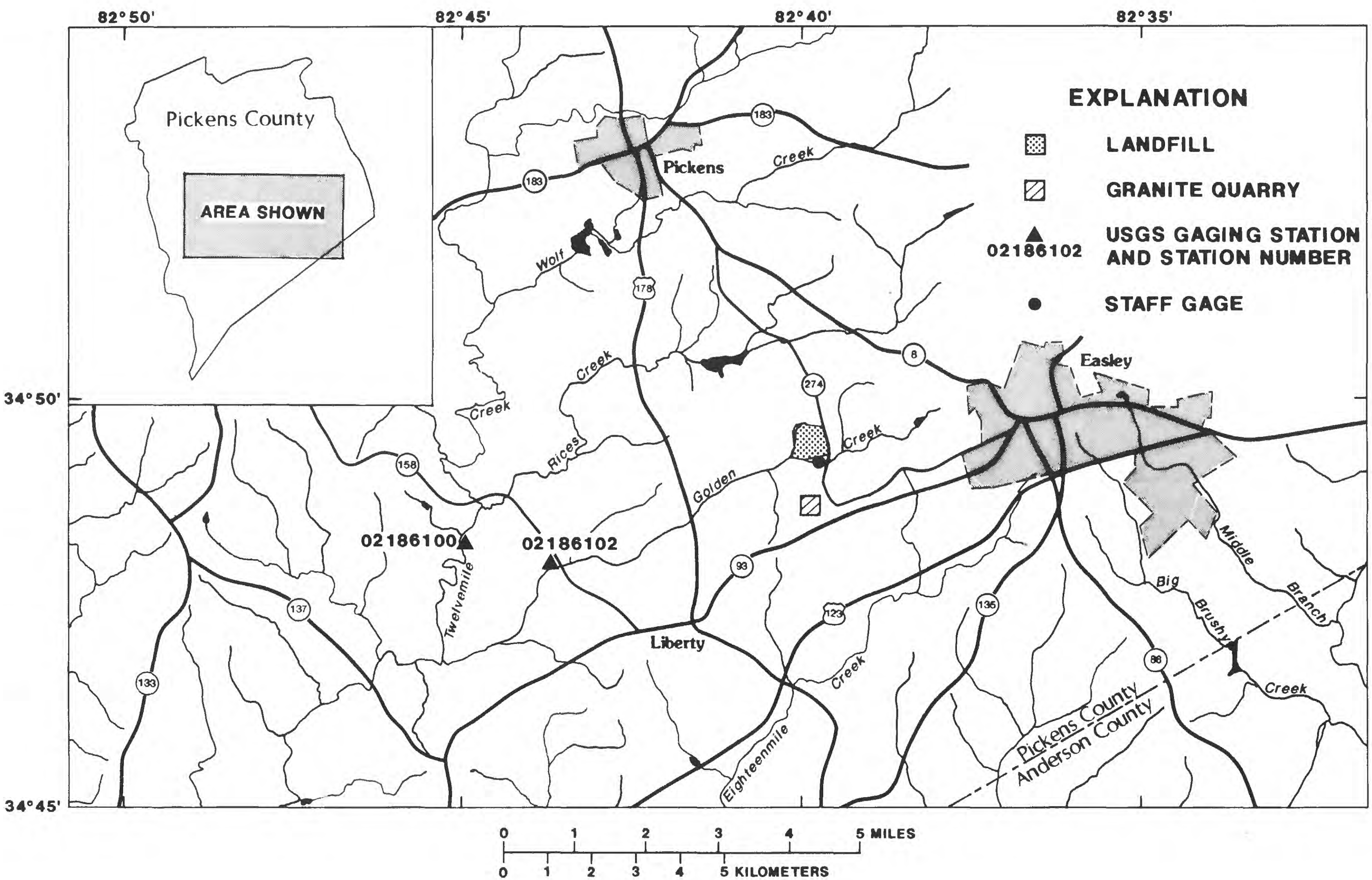

Figure 2.--Landfill site and two U.S. Geological Survey gaging stations in Pickens County, S.C.

Purpose and Scope

This report presents the results of a study to (1) describe the hydrogeologic framework underlying the proposed landfill expansion, (2) measure streamflow, surface-water quality, and define the seasonal-flow characteristics of streams that drain the landfill area, and (3) measure selected chemical conditions of ground water near the landfill expansion. The scope of work included collecting and evaluating existing hydrogeologic data. Additional geologic, hydrologic, and water-quality data were collected and analyzed, and the local geologic framework was defined.

Description of Study Area

The study area is located in the northwestern part of South Carolina on approximately 40 acres. The proposed expansion of the solid-waste landfill in Pickens County is near Easley, S.C., and is located in the Piedmont physiographic province of South Carolina (fig. 1). The proposed landfill expansion site is bounded by state secondary road 274 to the east, Golden Creek to the south, the existing landfill to the north, and surveyed land boundaries to the west (fig. 3). The landfill site is in a rural, undeveloped area, which was previously farmland.

Topography

Topographically, the expansion site is typical of the Piedmont physiographic province, with gently rolling hills dissected by small streams. The highest point on the proposed site is approximately 1,073 ft above sea level and the lowest is approximately 886 ft, which gives a maximum relief of approximately 187 ft. A small stream flows along the western boundary of the proposed landfill expansion and joins Golden Creek south of the landfill site (fig. 3).

Climate

The climate of the area is relatively temperate with warm humid summers and mild winters. The temperature rises to 90 °F or above on many days during the summer, but usually falls to 70 °F or lower during the night. Winters are moderate, with the temperature remaining below freezing throughout the daylight hours only three or four times during a normal year. The mean annual temperature for this area is 60 °F and the mean annual precipitation is 51 inches per year (National Weather Service, 1990).

Hydrology

Major streams in the Piedmont province often flow in broad valley bottoms containing alluvial sediments. Tributaries flow from ridge areas to these major streams. Streamflow in the province is generally to the southeast.

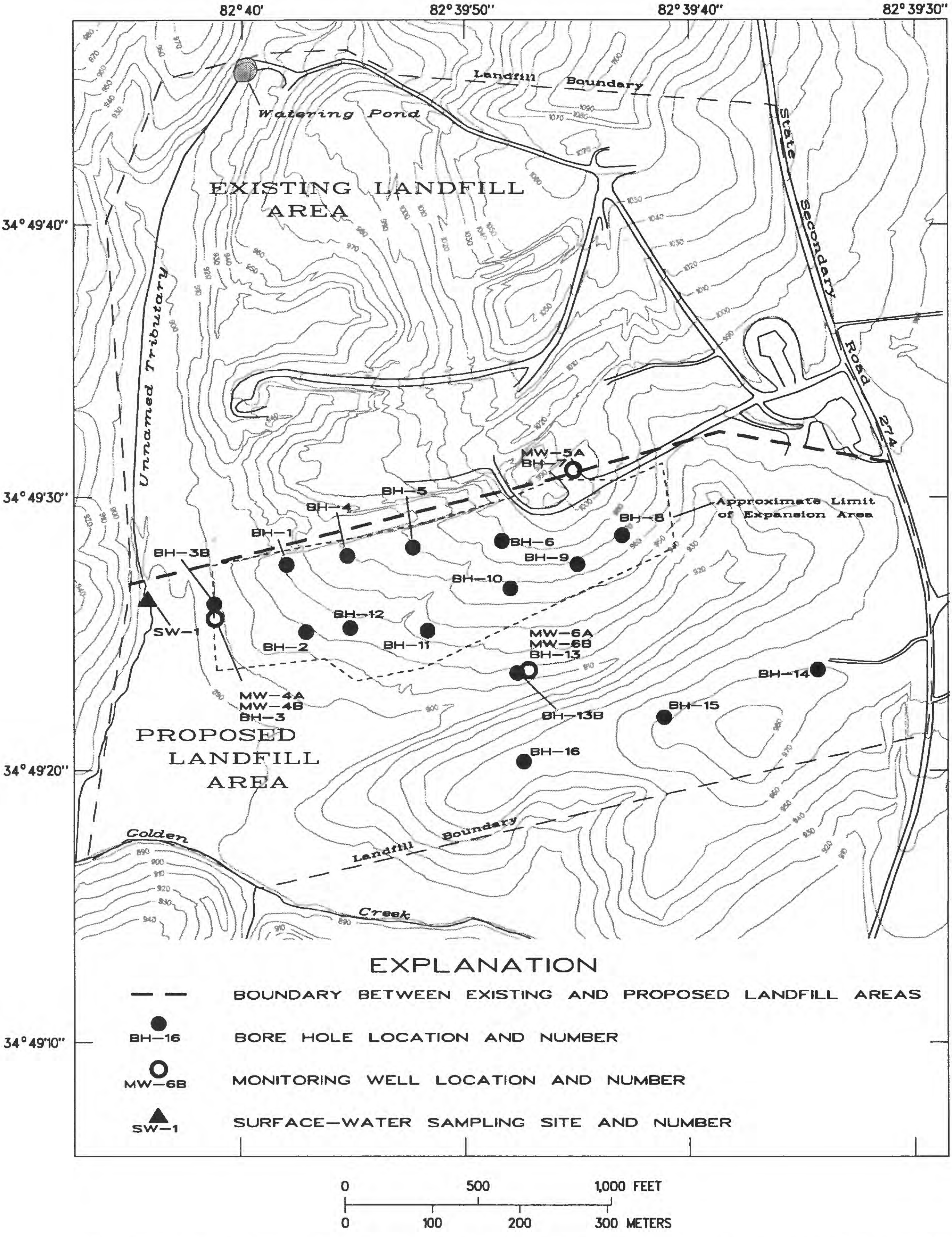

Figure 3.--Location of boreholes and monitoring wells at the proposed landfill expansion site in Pickens County, S.C.

The closest major stream to the site is Golden Creek, which is a tributary to Twelvemile Creek and ultimately a tributary to the Seneca River that forms Lake Hartwell. The head of Golden Creek is 2 mi upstream of the site, and the confluence with Twelvemile Creek is about 6 mi downstream of the site (fig. 2).

Geology

Bedrock of the region is predominantly medium- to high-grade-metamorphic rocks (especially gneiss and (or) migmatites and subordinate schists). The bedrock is overlain by unconsolidated regolith consisting of soil, weathered bedrock (saprolite), and alluvial deposits of variable thickness (Overstreet and Bell, 1965; Donn and others, 1992). Interstream uplands in the region represent an ancient erosional surface, or plateau, which has been uplifted and moderately dissected by more recent erosion.

Ground Water

Ground water in the Piedmont province principally is under unconfined conditions in soil, saprolite, and alluvial deposits. These deposits are directly recharged by precipitation, which percolates downward to the water table, with principal recharge in topographically high areas (ridge tops and hill slopes) and discharge areas in and near streams in valley bottoms. Ground water also is under semi-confined conditions at depth in thick regolith and in fractures in the bedrock.

METHODS OF STUDY

Eighteen boreholes were drilled at the proposed landfill expansion site to obtain hydrogeologic information (fig. 3). Five of the boreholes were completed as monitoring wells in order to study ground-water and aquifer characteristics. A staff gage was installed and a flow measurement was made on Golden Creek. Volumetric-streamflow measurements were made at the outflow of the watering pond. These flow measurements were compared to long-term flow data from a nearby gaging station to estimate streamflow characteristics at the landfill expansion site. Water-quality samples were taken from ground- and surface-water sources for chemical analysis. More detailed methods of data collection are described below.

Geologic Data Collection

Geology at the site was determined by visual examination of subsurface soil samples collected from sites of boreholes (fig. 3) and from geophysical logs of two deep monitoring wells (fig. 4). Boreholes were drilled to a depth of 50 ft below the water table or to bedrock. Core samples were extracted every 5 ft by using a split-spoon sampler. Samples were examined and described at the time of sample collection and stored in sample jars.

Gamma logs were run on two deep monitoring wells. One of the monitoring wells, MW-5A, is upgradient of the site; the other monitoring wells, MW-4A, is downgradient.

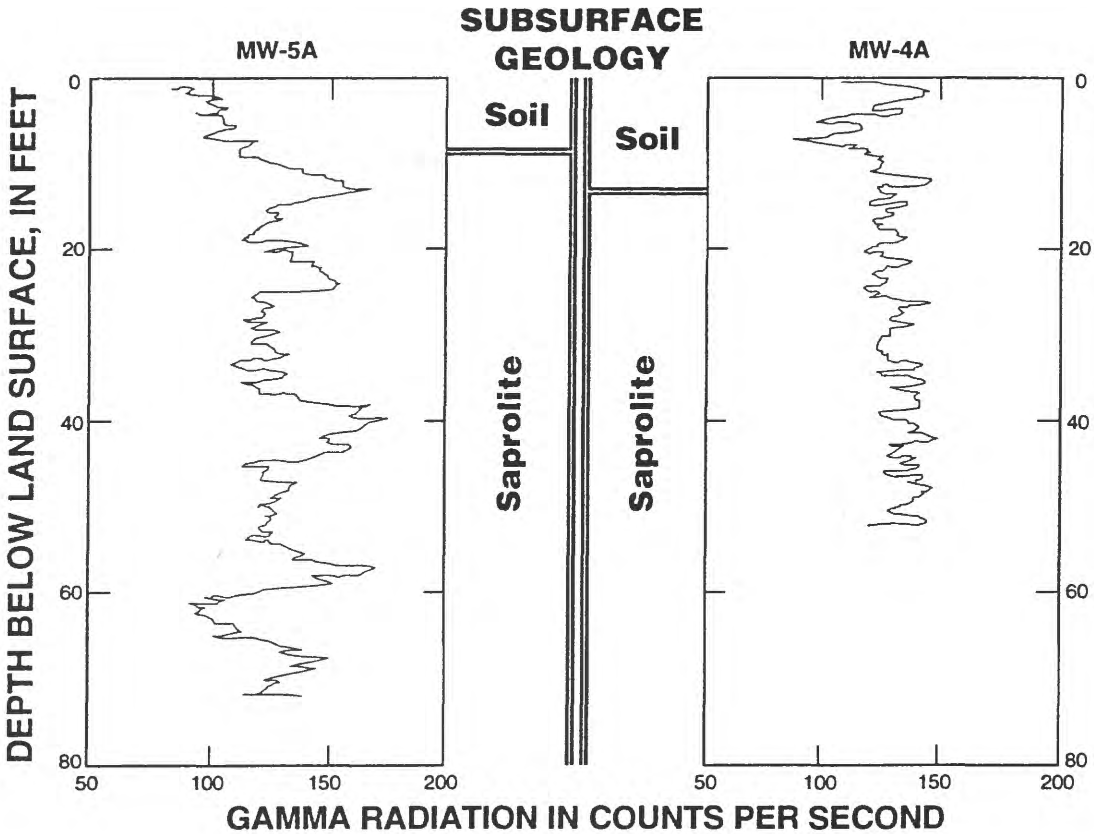

Figure 4.--Geophysical logs and subsurface geology for monitoring wells MW-5A and MW-4A.

Ground-Water Data Collection

Ground-water monitoring wells were installed in five of the boreholes. The wells were installed from one to two weeks after boring was completed. Water-level data and water samples were collected from the wells to determine ground-water-flow rates and directions, ground-water quality, and depth to ground water below land surface. Monitoring well locations are shown in figure 3 and a schematic diagram of the well construction is presented in figure 5 in conjunction with monitoring well depths (table 1).

Monitoring well clusters, consisting of one shallow and one deep well, were installed at two locations. Wells MW-4B and MW-6B were installed as shallow wells with the top of the 10-ft well screen below the water table. The deep saprolite wells installed in these clusters were MW-4A and MW-6A and were drilled to a minimum depth of 50-ft below the water table. Well MW-5A was installed at an upgradient location between the existing landfill and the proposed landfill expansion to obtain water-quality and water-level data.

Monitoring wells were developed in accordance with standard procedures described by the South Carolina Department of Health and Environmental Control (1985). A hand pump was used and development continued until pump flow was clear and relatively free of sediment. The location and elevation of each borehole and monitoring well were surveyed by first-order levels (table 2).

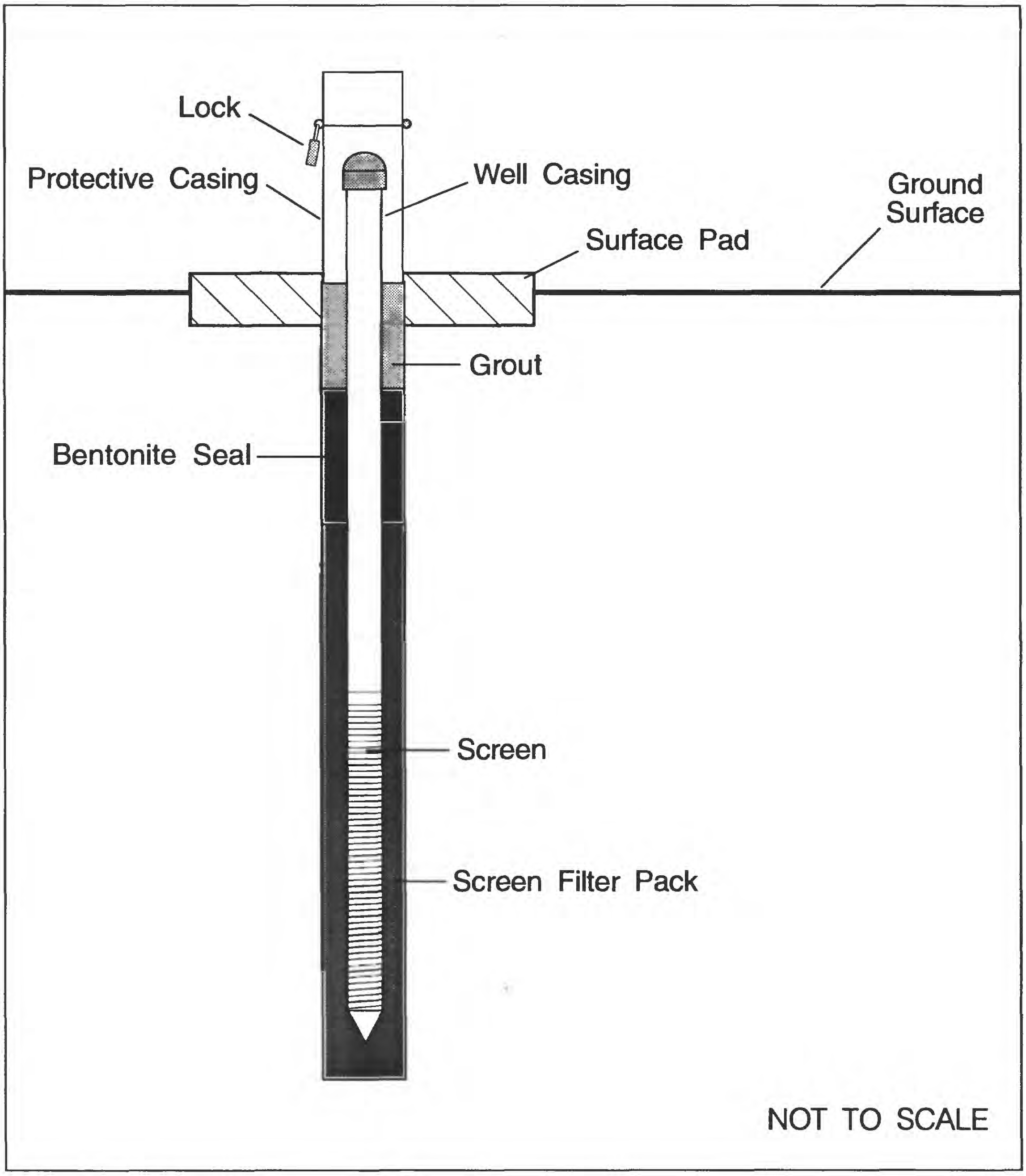

Figure 5.--Schematic diagram of monitoring well construction.

Table 1.--Various depths in monitoring wells at the proposed landfill expansion site in Pickens County, South Carolina

[Depth in feet below land surface; MW, monitoring well]

Well number	Depth to top of bentonite seal (feet)	Depth to top of screen filter pack (feet)	Depth to top of screen (feet)	Depth to bottom of screen (feet)	Total depth (feet)
MW-4A	44	46	48	58	58
MW-4B	7	9	10	20	20
MW-5A	63	65	67	77	77
MW-6A	51	53	55	65	65
MW-6B	7	9	10	20	20

Table 2.--Locations and depths of monitoring wells and boreholes at the proposed landfill expansion site in Pickens County, South Carolina

[BH, borehole; MW, monitoring well]

Borehole and monitoring well number (fig. 3)	Latitude	Longitude	Elevation (above sea level, in feet)	Depth (below land surface, in feet)
BH-1	34°49'27"	82°39'58"	927.4	97
BH-2	34°49'25"	82°39'57"	912.8	71
BH-4	34°49'28"	82°39'55"	945.3	11
BH-5	34°49'28"	82°39'52"	959.8	19
BH-6	34°49'28"	82°39'48"	970.8	22
BH-8	34°49'29"	82°39'43"	960.9	88
BH-9	34°49'28"	82°39'45"	957.4	141
BH-10	34°49'27"	82°39'48"	951.7	86
BH-11	34°49'25"	82°39'52"	929.4	66
BH-12	34°49'25"	82°39'55"	922.8	76
BH-14	34°49'24"	82°39'34"	970.1	28
BH-15	34°49'22"	82°39'41"	971.6	46
BH-16	34°49'20"	82°39'47"	959.2	10
MW-4A/BH-3	34°49'25"	82°40'01"	895.3	58
MW-4B/BH-3B	34°49'25"	82°40'01"	895.4	20
MW-5A/BH-7	34°49'31"	82°39'45"	999.7	77
MW-6A/BH-13	34°49'24"	82°39'47"	918.8	65
MW-6B/BH-13B	34°49'24"	82°39'47"	917.5	20

In situ hydraulic conductivity values were determined by means of slug tests in wells MW-4A and MW-6A. A solid cylinder was inserted into the well causing the water level to rise almost instantaneously. The water level was allowed to decline to the static level over time. The water level decline was monitored by using an electric tape. The value for the radius of the well casing and of the well screen is 0.083 ft and the length of the well screen is more than 8 times its radius (L/R>8). Values were calculated by using the procedures described by Hvorslev (1951). It was assumed that the wells do not fully penetrate the unconfined aquifer.

Surface-Water Measurements

The surface-water data collected on Golden Creek consisted of stage and streamflow measurements. A staff gage was installed (fig. 2) and stage records were obtained from direct readings by an observer on a daily basis. Forty flow measurements were made at station 02186102 from 1953 to 1967, in addition to three flow measurements made at the U.S. Highway 178 crossing of Golden Creek from 1945 to 1948 (Johnson and others, 1968). A flow measurement on Golden Creek was made at the landfill expansion site on December 13, 1990. Measurements of flow were made with a current meter, by using the general methods adopted by the U.S. Geological Survey (Carter and Davidian, 1968). At the northern edge of the existing landfill, volumetric-streamflow measurements at the outflow of the watering pond were made by using a 5-gallon bucket and a stopwatch.

Water-Quality Sample Collection

Water samples for chemical analysis were collected from all monitoring wells at the expansion site and from the small stream to the west of the proposed landfill expansion site. Methods for collecting and analyzing water samples were based on the general methods adopted by the U.S. Geological Survey, (Skougstad and others, 1979). Values for temperature, pH, specific conductance, and alkalinity were obtained on site (Wood, 1976). Alkalinity analyses were made by using a fixed-endpoint (pH 4.5) titration.

HYDROGEOLOGIC CHARACTERIZATION OF THE LANDFILL EXPANSION SITE

After the data were collected and analyzed, the results from the geologic, hydrologic, and water-quality investigations were compiled. The findings are discussed below.

Geology

Soil comprises all of the land surface and ranges from silty and sandy clay to a silty and clayey sand. Soil thickness across the expansion site ranges from approximately 5 ft to 20 ft with an average thickness of 10 ft. The soil is underlain by saprolite that overlies a granitic biotite gneiss bedrock. The geophysical logs in figure 4 help to identify the soil unit from the saprolite unit on the basis of differences in radiation intensity. The soil-saprolite contact at monitoring well 5A is approximately 8 ft below land surface and at monitoring well 4A is approximately 15 ft below land surface.

The saprolite ranges in thickness across the site from approximately 5 ft at BH-4 to at least 134 ft at BH-9. Borehole BH-9 was drilled to a depth of 141 ft and bedrock was not encountered. This thicker than expected saprolite interval may be the result of differential weathering of bedrock (Donn and others, 1992). The saprolite was uniform in composition throughout the rest of the study area and consisted primarily of silty sands with varying amounts of mica, weathered feldspar, and zones of silt, silty clay, and clayey sand. No structural features were evident in any of the core samples taken. Geologic sections and their locations are illustrated in figures 6 through 14.

Depths to bedrock were found to be irregular across the site and varied from 11 to more than 141 ft below ground surface. The depth to bedrock was defined as auger refusal during borehole drilling. No core samples were taken from bedrock, but based on examination of rock from the adjacent quarry (fig. 2), bedrock beneath the site consists of granitic biotite gneiss. Deeply weathered quartz veins were exposed 100 ft north of the landfill expansion site in a cliff exposure.

Ground Water

Ground-water elevation data collected from monitoring wells from September 1991 to April 1992 (table 3) showed very little fluctuation. Water-level data collected from the boreholes in late July and August 1991 (table 4) were used to prepare the water-level elevation contours shown in figure 15. Ground water in the saprolite at the site is under unconfined conditions and the water table is generally a subdued replica of the surface topography.

The general trend of ground-water flow at the landfill site is from the northeast to the southwest. Ground-water flow in the saprolite is inferred to be perpendicular to the (potentiometric surface) water-table contours shown in figure 15. Local ground-water users within a mile radius of the landfill expansion site are upgradient of the flow. Water levels measured at the two nested wells were used to calculate vertical ground-water gradients using the equation:

$$i = \frac{E3d - E3s}{\left(\frac{E1s - E2s}{2} + E2s\right) - \left(\frac{E1d - E2d}{2} + E2d\right)}, \qquad (1)$$

where

i is the vertical gradient;
E1s or E1d is the elevation of bottom of bentonite seal in a shallow well(s) or a deep well(d);
E2s or E2d is the elevation of bottom of well screen in shallow wells(s) or a deep well(d); and
E3s or E3d is the elevation of water level in a shallow well(s) or a deep well(d).

This formula is adapted from Freeze and Cherry (1979). The denominator represents the adjustment required by the presence of a screened interval rather than a single water-level monitoring point (RMT,1991).

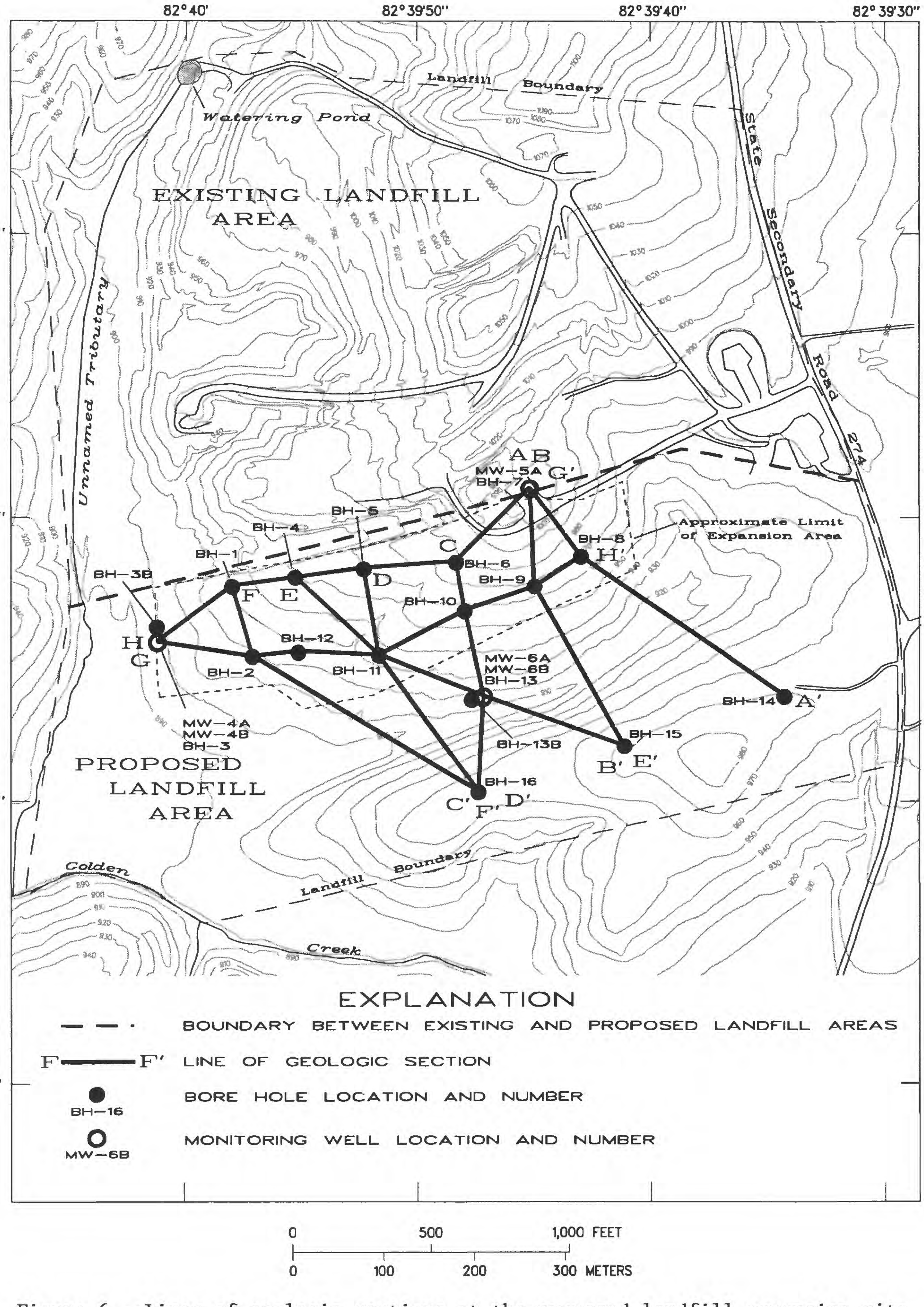

Figure 6.--Lines of geologic sections at the proposed landfill expansion site in Pickens County, S.C.

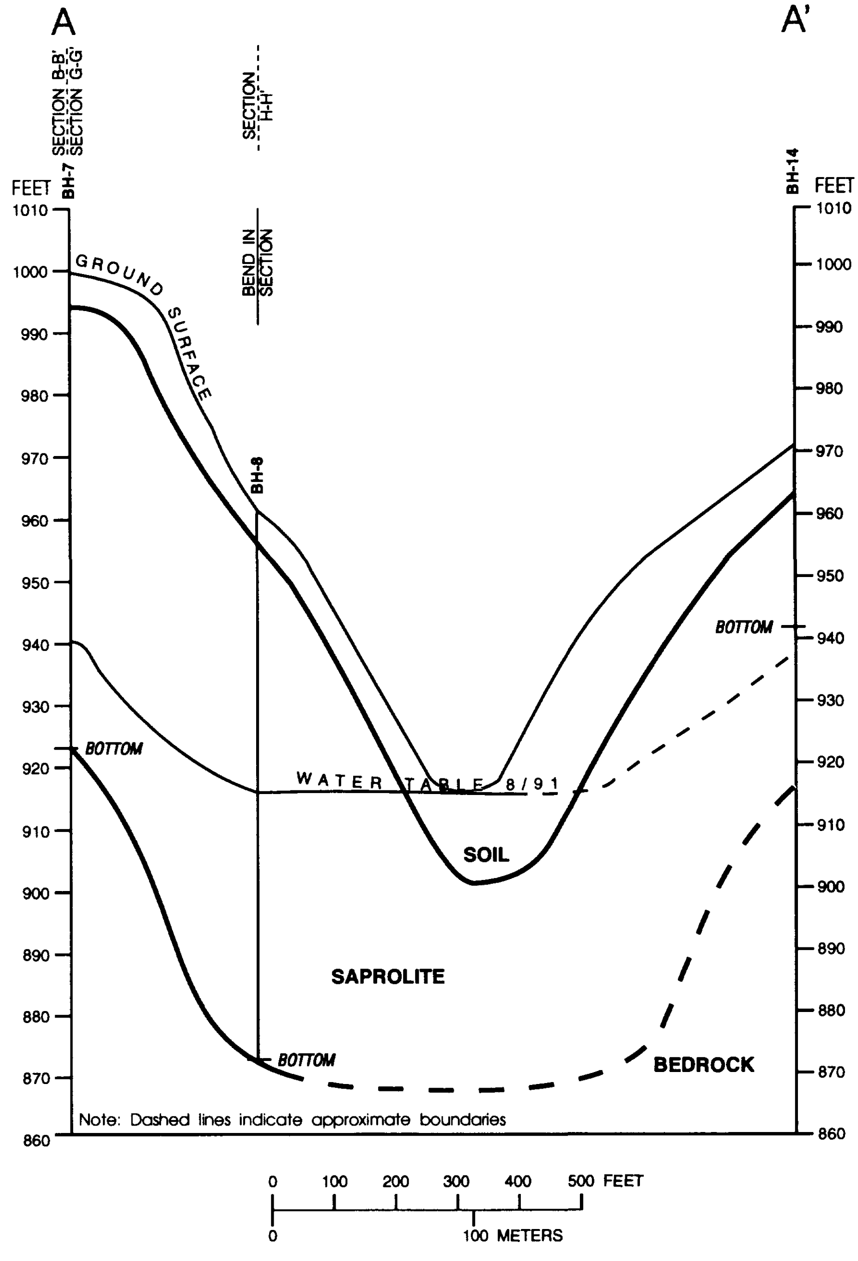

Figure 7.--Geologic section A-A'.

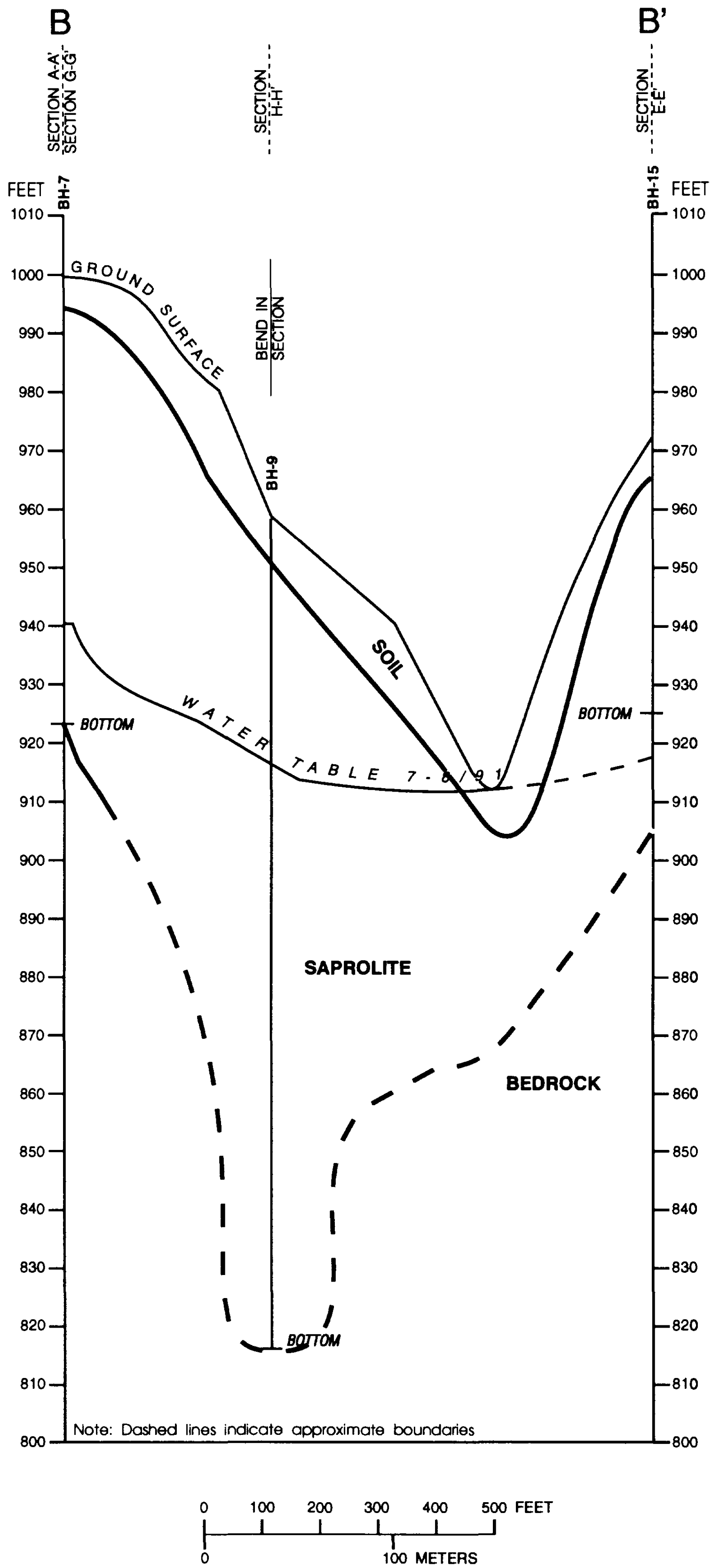

Figure 8.--Geologic section B-B'.

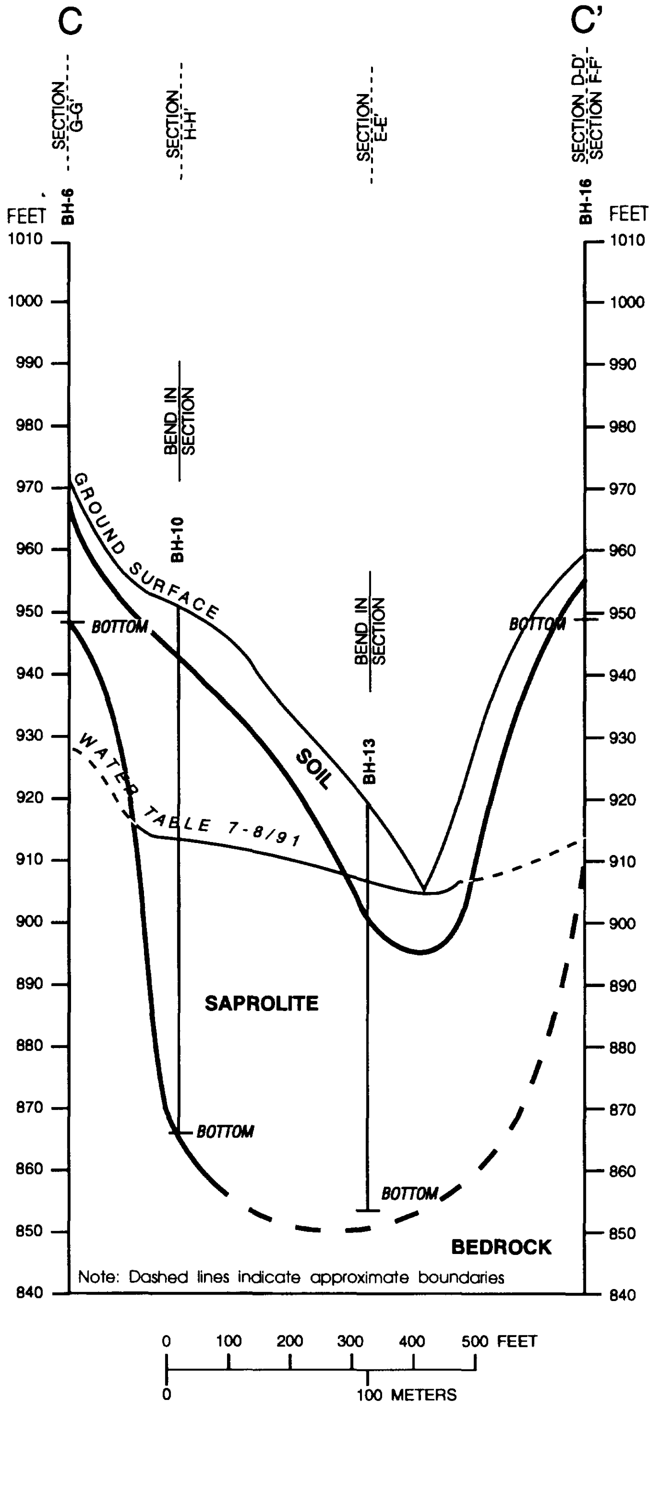

Figure 9.--Geologic section C-C'.

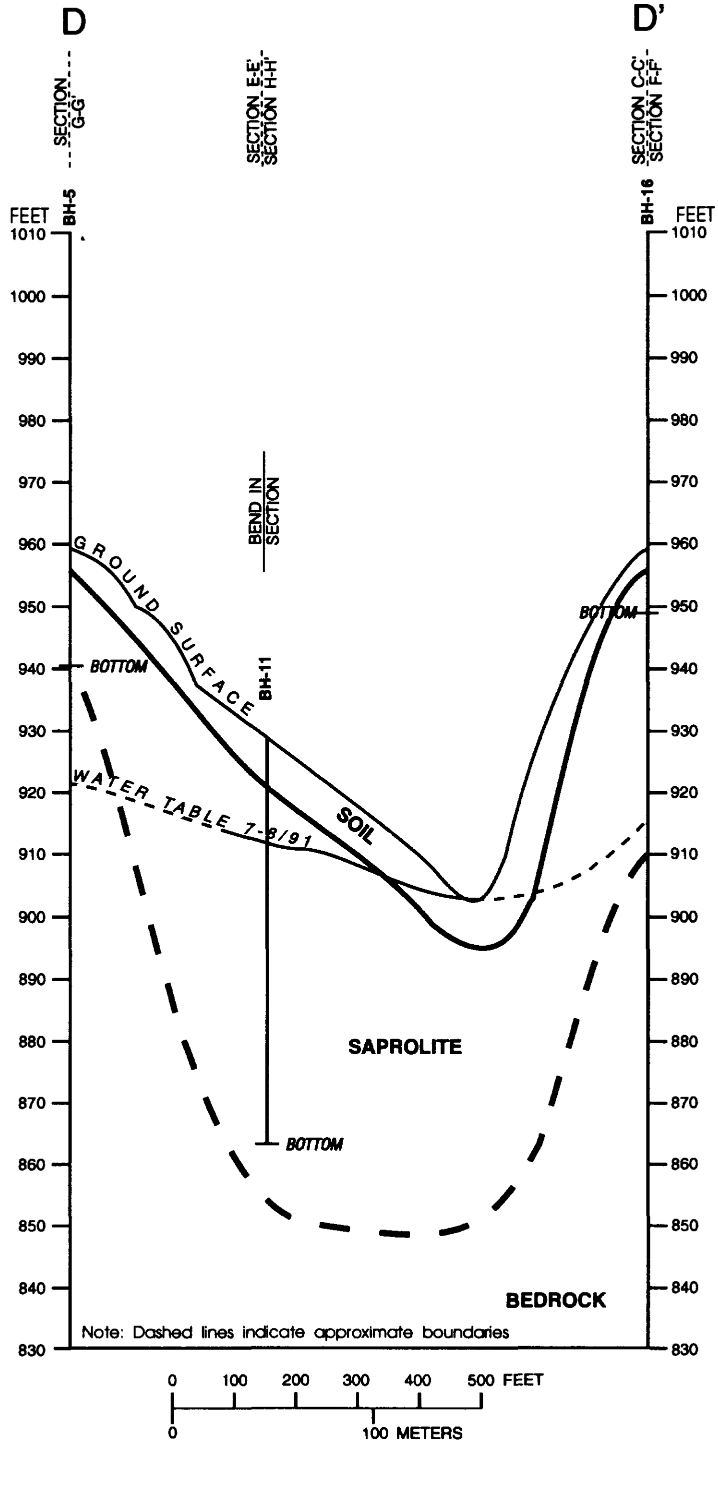

Figure 10.--Geologic section D-D'.

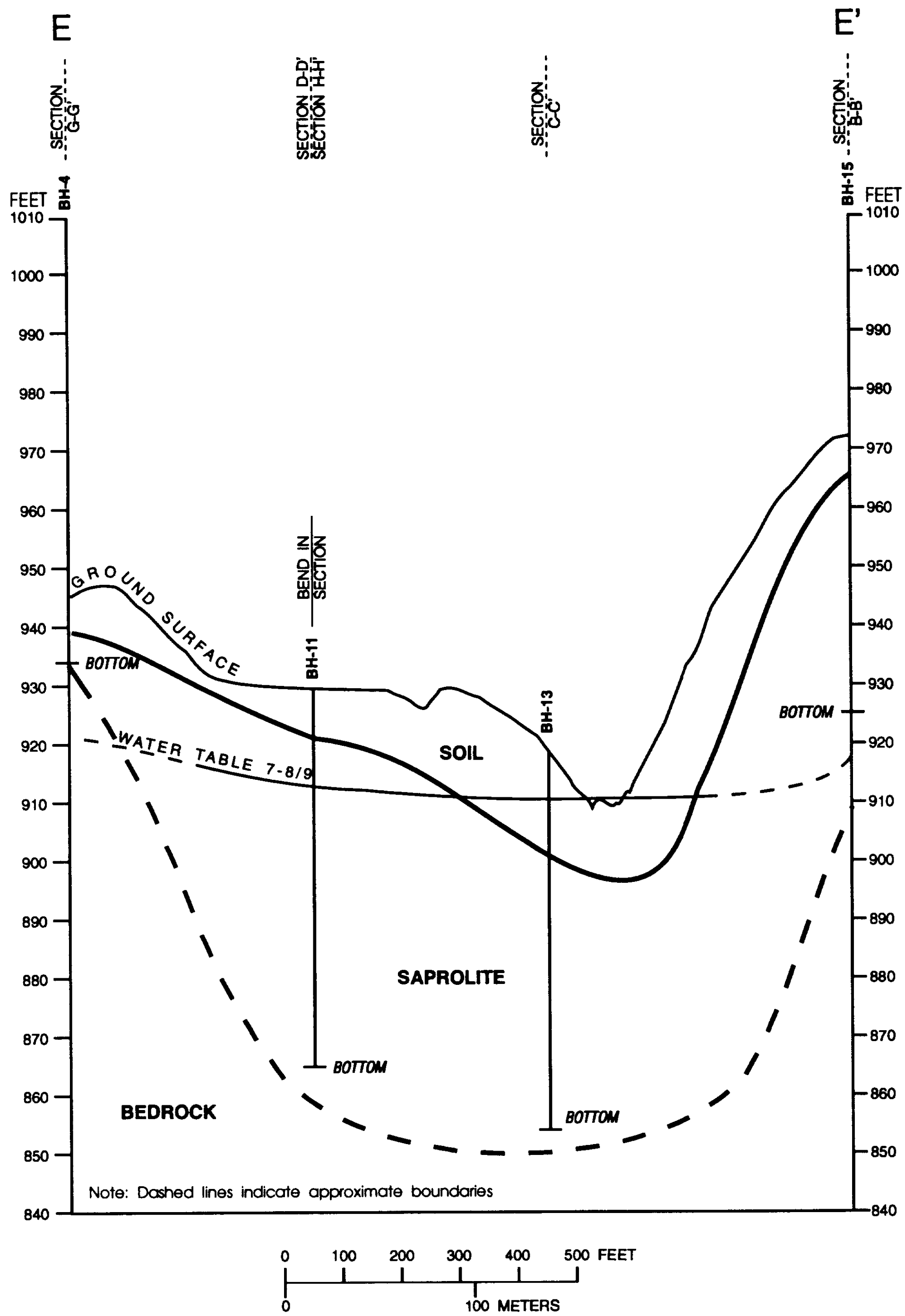

Figure 11.--Geologic section E-E'.

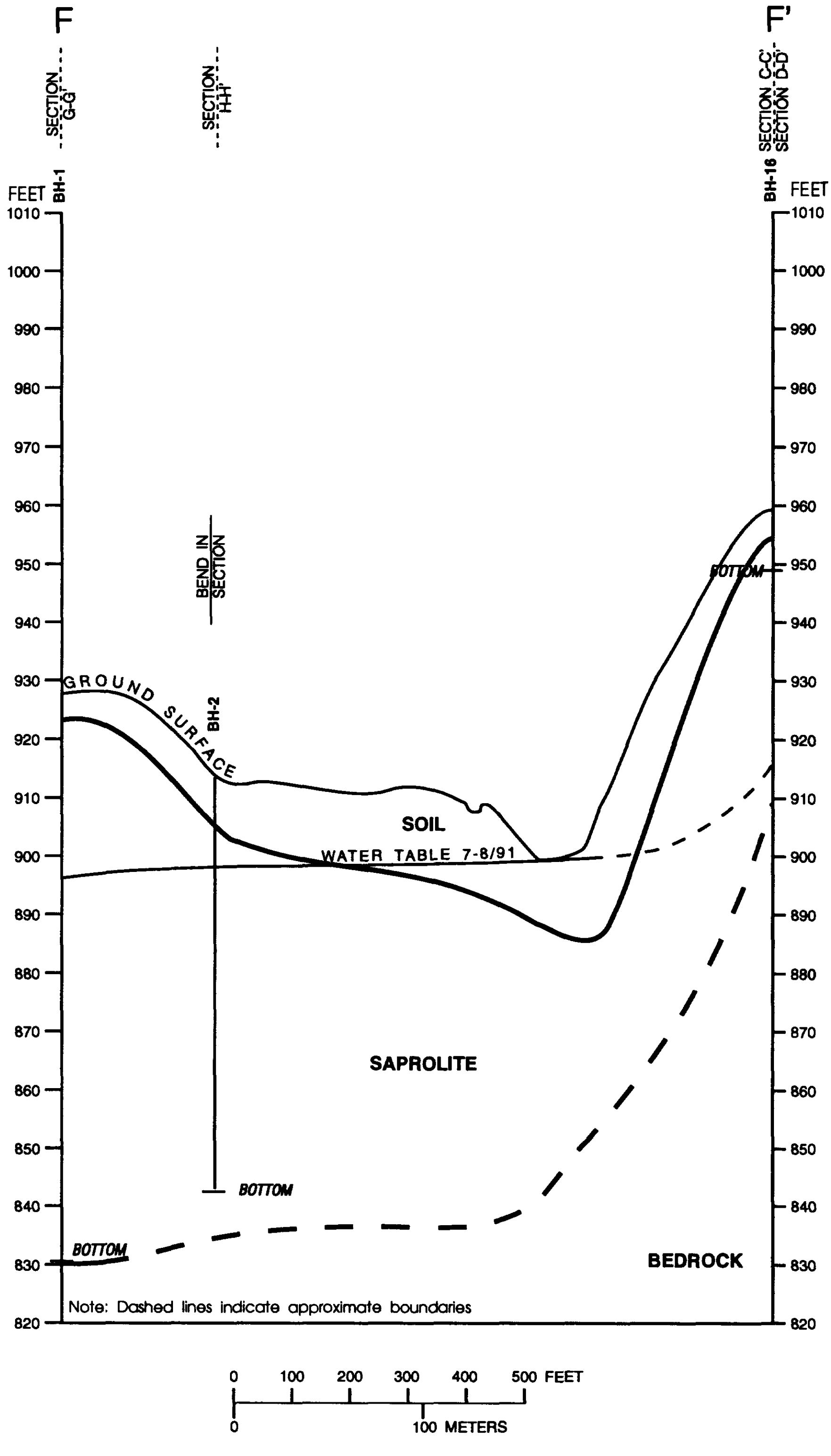

Figure 12.--Geologic section F-F'.

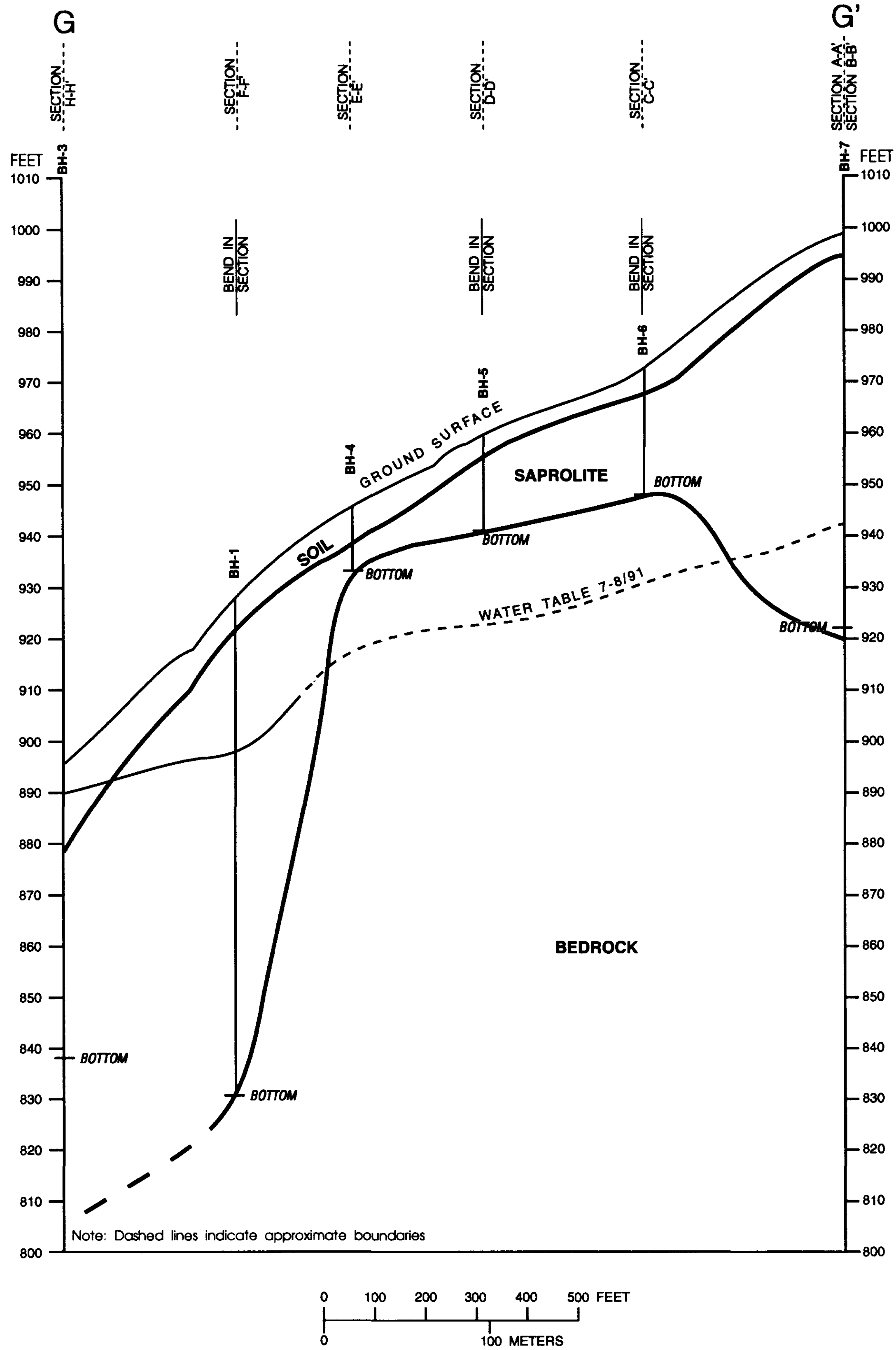

Figure 13.--Geologic section G-G'.

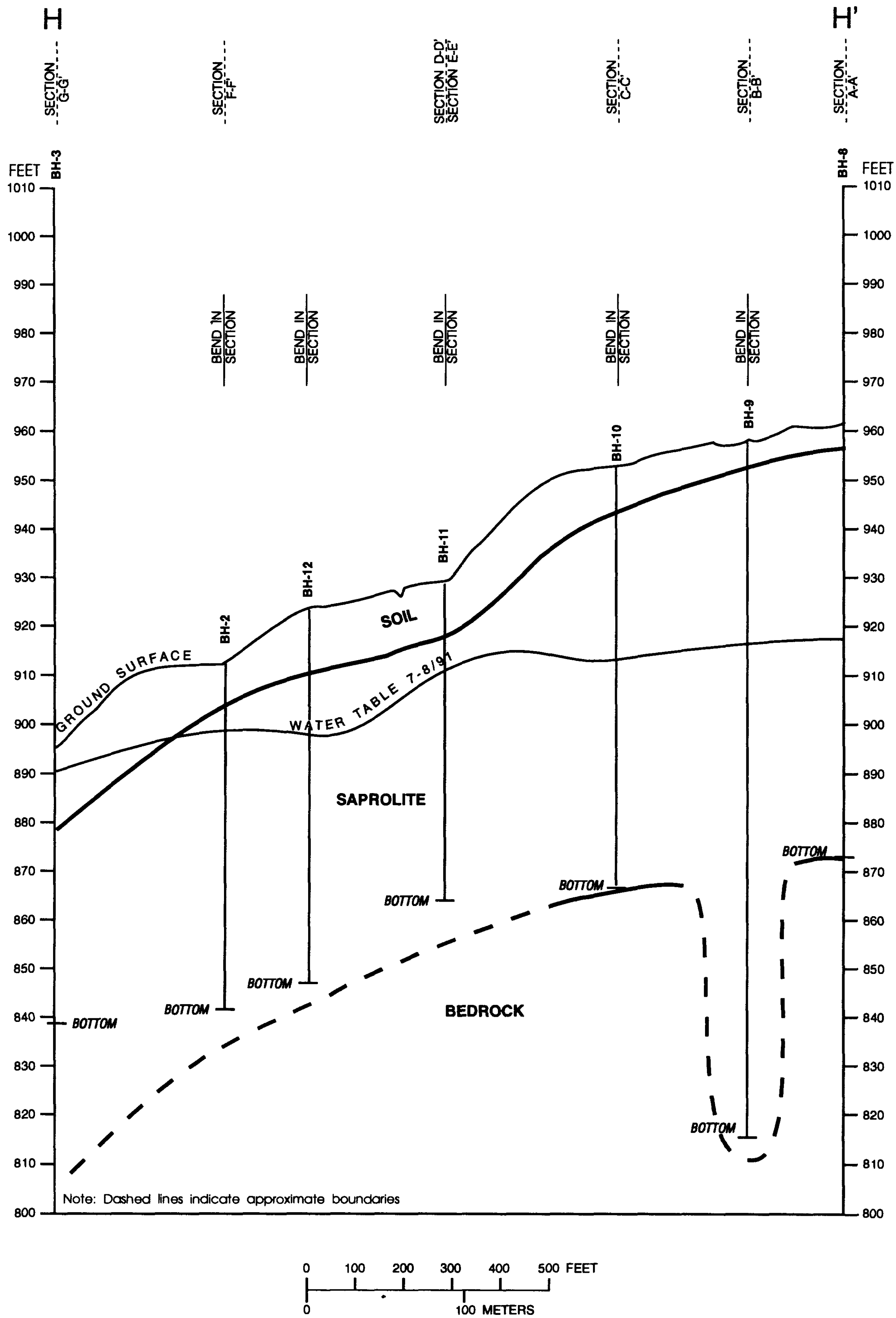

Figure 14.--Geologic section H-H'.

Table 3.--Ground-water elevations in monitoring wells

[MW, monitoring well]

Monitoring well number	Depth (below land surface, in feet)	Date of sampling							
		9/24/91	10/22/91	11/14/91	12/19/91	1/28/92	2/20/92	3/20/92	4/22/92
		Elevation (above sea level, in feet)							
MW-4A	58	890.2	890.0	889.9	889.9	889.8	889.9	890.4	890.3
MW-4B	20	890.4	890.2	890.1	890.0	890.0	890.0	890.5	890.5
MW-5A	77	940.4	940.5	940.7	940.6	940.4	940.1	939.7	939.6
MW-6A	65	909.5	909.0	908.6	908.7	908.6	908.9	909.9	909.8
MW-6B	20	909.4	909.0	908.7	908.6	908.6	908.9	910.1	909.7

Table 4.--Ground-water elevations in boreholes with respect to sea level

[BH, borehole]

Borehole number	Date of sampling	Elevation (above sea level, in feet)
BH-1	7/25/91	896.4
BH-2	8/2/91	898.8
BH-3	8/21/91	890.3
BH-3B	8/21/91	890.4
BH-4	7/22/91	dry
BH-5	7/22/91	dry
BH-6	7/22/91	dry
BH-7	8/22/91	940.2
BH-8	8/1/91	916.9
BH-9	7/26/91	917.4
BH-10	7/26/91	913.7
BH-11	8/6/91	911.4
BH-12	8/6/91	897.8
BH-13	8/9/91	909.9
BH-13B	8/9/91	909.9
BH-14	8/7/91	dry
BH-15	8/7/91	dry
BH-16	8/8/91	dry

Water-level elevations were measured in well cluster MW-6A/6B and MW-4A/4B on September 24, 1991. The vertical gradient at the well cluster nearest the intermittent stream, MW-6A/6B, was calculated as +0.002 foot per foot. This represents upward ground-water flow and is indicative of a discharge area. However, due to the intermittent stream nearby, there are times when MW-6A/6B is indicative of a recharge area. Well cluster MW-4A/4B is located at the west margin of the landfill expansion site close to a tributary to Golden Creek. The vertical gradient here was calculated as -0.005 foot per foot. This represents downward ground-water flow and is indicative of a recharge area.

In situ hydraulic conductivity values were determined in test wells MW-4A and MW-6A (fig. 15). Hydraulic conductivity values were 5×10^{-6} and 2×10^{-6} feet per second, respectively using the procedures described by Hvorslev (1951).

By using the hydraulic conductivity values from MW-4A and MW-6A, transmissivity within the immediate area of the monitoring wells was calculated. An approximate thickness of 60 ft was used for both wells. Transmissivity for MW-4A was 2.7×10^{1} ft^2/d and 1.2×10^{1} ft^2/d for MW-6A.

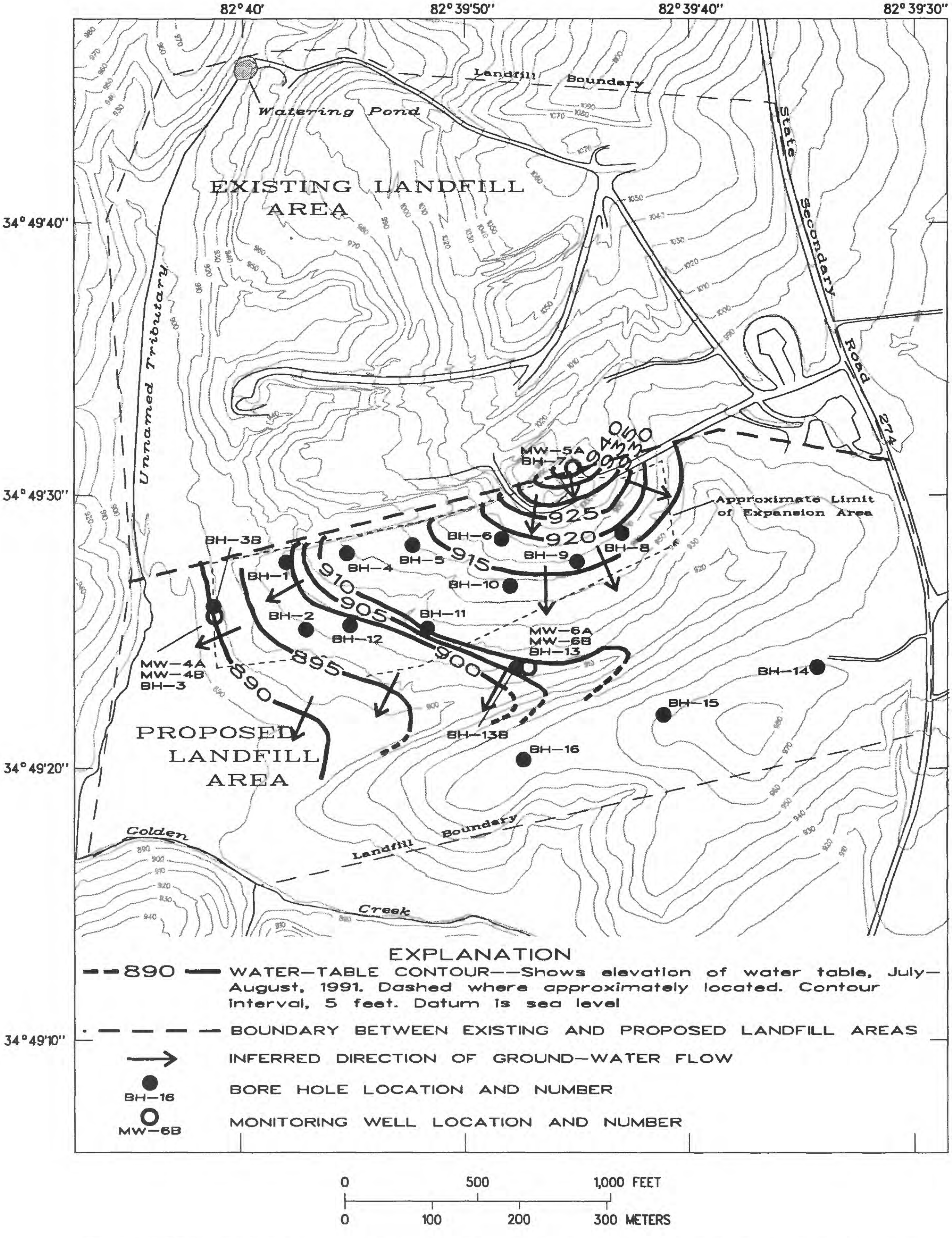

Figure 15.--Inferred ground-water flow direction and water-level elevation contours in Pickens County, S.C.

Ground-water velocities were calculated by using the equation published by Heath (1983):

$$V = \frac{K\,i}{n}, \qquad (2)$$

where

V is the ground-water velocity (length/time);
K is the hydraulic conductivity (length/time);
i is the hydraulic gradient (length/length); and
n is the porosity (percentage).

A gradient of 0.02 foot per foot was found in the western part of the study area, and a gradient from 0.04 to 0.08 foot per foot was found in the eastern part. An average gradient of 0.04 foot per foot and an average hydraulic conductivity of 3×10^{-6} feet per second were used to calculate ground-water velocity. A range of porosity values from 34 to 57 percent was chosen to represent the variable subsurface conditions (Mercer and Thomas, 1982). The calculated values of ground-water velocity for the site range from 3 to 6 feet per year.

Surface Water

Low-flow data for Golden Creek (Johnson and others, 1968) indicate that the estimated 7-day average, 10-year ($7Q_{10}$) recurrence interval low flow at station 02186102, 3 mi downstream from the proposed landfill expansion site, is 2.4 ft^3/s with a $7Q_{10}$ of 0.21 cubic feet per second per square mile [$(ft^3/s)/mi^2$]. This value is estimated, but is based on 40 flow measurements made at station 02186102 from 1953 to 1967, combined with 3 flow measurements made at U.S. Highway 178 crossing of Golden Creek from 1945 to 1948 (Johnson and others, 1968). The drainage area at station 02186102 and at U.S. Highway 178 is approximately 11.6 mi^2 and 7.5 mi^2, respectively. A flow measurement made at state secondary road 274 crossing of Golden Creek on December 13, 1990, was approximately 2.5 ft^3/s. The drainage area at this site is 3.9 mi^2. Stream stage in Golden Creek has remained relatively constant during 1991 with slight fluctuations of 1 ft reported by an observer during severe thunderstorms. At the northern edge of the existing landfill, 58 volumetric-streamflow measurements at the outflow of the watering pond were made, averaging 0.07 ft^3/s or 33 gal/min.

Water Quality

Five monitoring wells and one stream site were chosen for collection of water-quality samples. The monitoring wells are in the expansion site, and the stream parallels the western boundary of the landfill and flows into Golden Creek (fig. 3). Analytical results are summarized in table 5. Variability exists in the ground-water chemistry across the site. Values of pH in water samples from the sites were generally neutral to slightly acidic, but ranged from 5.5 to 8.1. Alkalinities were as low as 5.1 mg/L (as $CaCO_3$) in low pH waters. Biological oxygen demand concentrations ranged from 0.9 to 1.4 mg/L. Dissolved $NO_2 + NO_3$ (as N) ranged from 0.021 to 0.32 mg/L, and dissolved ammonia ranged from 0.02 to 0.08 mg/L. Arsenic, selenium, and silver concentrations were below or near the detection limit of 1 $\mu g/L$.

Table 5.--Chemical analyses of surface- and ground-water samples collected October 9, 1991

[μS/cm, microsiemens per centimeter; °C, Celsius; mg/L, milligram per liter; IT-FLD, incremental titration in the field; MW, monitoring well; SW, surface-water collection site; μg/L, micrograms per liter; <, less than; NA, not applicable]

Station name	Depth (below land surface, in feet)	Specific Conductance, field (μs/cm at 25 °C)	Field pH (standard units)	Temperature, (°C)	Five-day biochemical oxygen demand (mg/L)	Alkalinity (mg/L as $CaCO_3$)	Calcium, total recoverable (mg/L as Ca)
MW-4A	58	74	7.0	18	1.1	36	4.7
MW-4B	20	30	5.7	20	.9	9.7	1.8
MW-5A	77	150	8.1	15	1.1	73	4.5
MW-6A	65	104	7.0	18	1.4	56	15
MW-6B	20	23	5.5	18	1.4	5.1	1.5
SW-1	NA	68	6.5	16	.9	20	3.6

Station name	Depth (below land surface, in feet)	Magnesium, total recoverable (mg/L as Mg)	Sodium, total recoverable (mg/L as Na)	Potassium, total (mg/L as K)	Bicarbonate, IT-FLD (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)
MW-4A	58	11	14	24	37	0.6	2.3
MW-4B	20	.7	5	2	10	1	3
MW-5A	77	6.4	28	17	72	2	3.1
MW-6A	65	15	11	24	55	.7	1.6
MW-6B	20	4	3.2	7.3	7	.6	1.2
SW-1	NA	1.5	5	1.5	28	.9	3.6

Station name	Depth (below land surface, in feet)	Fluoride, dissolved (mg/L as F)	Nitrogen nitrite, dissolved (mg/L as N)	Nitrogen nitrite plus nitrate dissolved (mg/L as N)	Nitrogen ammonia, dissolved (mg/L as N)	Arsenic, total (μg/L as As)	Barium, total (μg/L as Ba)
MW-4A	58	0.60	<0.01	0.32	0.08	<1	300
MW-4B	20	<.10	<.01	.08	.02	<1	<100
MW-5A	77	2.7	<.01	.02	.02	<1	300
MW-6A	65	.20	<.01	.18	.04	3	800
MW-6B	20	<.10	<.01	.02	.02	3	200
SW-1	NA	<.10	<.01	.23	.07	<1	<100

Table 5.--Chemical analyses of surface- and ground-water samples collected October 9, 1991--Continued

[μS/cm, microsiemens per centimeter; °C, Celsius; mg/L, milligram per liter; IT-FLD, incremental titration in the field; MW, monitoring well; SW, surface-water collection site; μg/L, micrograms per liter; <, less than; NA, not applicable]

Station name	Depth (below land surface, in feet)	Cadmium, total (μg/L as Cd)	Chromium, total (μg/L as Cr)	Iron, total (μg/L as Fe)	Lead, total (μg/L as Pb)	Manganese, total (μg/L as Mn)	Mercury, total recoverable (μg/L as Hg)
MW-4A	58	<1	11	42,000	23	1,400	<0.10
MW-4B	20	<1	4	2,400	9	120	<.10
MW-5A	77	3	9	40,000	16	1,200	<.10
MW-6A	65	2	13	85,000	30	2,800	.20
MW-6B	20	1	9	19,000	22	420	<.10
SW-1	NA	<1	2	6,000	<1	530	<.10

Station name	Depth (below land surface, in feet)	Nickel, total (μg/L as Ni)	Selenium, total (μg/L as Se)	Silver, total (μg/L as Ag)	Zinc, total (μg/L as Zn)	Total organic carbon (mg/L as C)
MW-4A	58	8	<1	<1	190	0.4
MW-4B	20	<1	<1	<1	10	.4
MW-5A	77	6	<1	<1	170	1.8
MW-6A	65	19	<1	<1	340	.4
MW-6B	20	2	<1	<1	70	.3
SW-1	NA	<1	<1	<1	10	.7

Barium and zinc concentrations ranged from less than the detection limit of 100 μg/L to 800 μg/L and from 10 μg/L to 340 μg/L, respectively. The highest concentrations of barium and zinc were found in the three deepest wells. Total organic carbon was found in a concentration of 1.8 mg/L in the deepest well and at concentrations of 0.3 and 0.4 mg/L at the remaining well sites. Concentrations of major cations were generally higher in association with higher values of alkalinity, pH, and depth. Chemical analyses of the ground- and surface-water samples show no signs of contamination.

SUMMARY AND CONCLUSIONS

Pickens County is located in the northwestern Blue Ridge and Piedmont physiographic provinces of South Carolina. The study area is located in Pickens County on approximately 40 acres near Easley, S.C. An initial collection of geologic, hydrologic, and water-quality data has been completed.

The geology of the study area is typical of the Piedmont region. The bedrock of the region is predominantly composed of medium- to high-grade metamorphic rocks. The most abundant parent rock type in the area is a biotite gneiss. Soil comprises all of the land surface and saprolite ranges in thickness from 5 to 134 feet. Ground water at the site is under unconfined conditions and the water table is generally a subdued replica of the surface topography. The general trend of ground-water flow at the landfill expansion site is from northeast to southwest. Slug tests on wells taping the saprolite indicate a mean hydraulic conductivity of 3×10^{-6} feet per second and transmissivity ranges from 1.2×10^{1} to 2.7×10^{1} feet squared per day. The ground-water velocity for the site ranges from 3 to 6 feet per year.

The closest major stream to the site is Golden Creek. Based on low-flow data for Golden Creek, the estimated minimum 7 consecutive day flow with a 10-year recurrence interval at station 02186102 is 2.4 cubic feet per second. Volumetric-streamflow measurements at the outflow of the watering pond, which is to the north of Golden Creek, averaged 0.07 cubic foot per second.

Water samples were collected from five monitoring wells at the proposed landfill expansion site and from one stream adjacent to the expansion site. Values of pH were generally neutral to slightly acidic but ranged from as low as 5.5 standard pH units to as high as 8.1 standard pH units. Alkalinities were as low as 5.1 milligrams per liter as $CaCO_3$ in high pH waters. Chemical analyses of the ground- and surface-water samples show no signs of contamination.

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

Multiply	By	To Obtain
acre	4,047	square meter
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
foot per second (ft/s)	30.48	centimeter per second
foot squared per day (ft^2/d)*	0.0929	meter squared per day
gallon per minute (gal/min)	0.06309	liter per second
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer

ABBREVIATED WATER-QUALITY UNITS

Water temperature is expressed in degrees Fahrenheit. Conversion from degrees Fahrenheit (°F) to degrees Celsius (°C) as follows:

$$°C = 5/9\ (°F-32)$$

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

Specific electrical conductance of water is expressed in microsiemens per centimeter (µS/cm) at 25 degrees Celsius.

Chemical concentration in water is expressed in micrograms per liter (µg/L) and milligrams per liter (mg/L).

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*The standard unit for transmissivity is cubic foot per day per square foot times foot of aquifer thickness $[(ft^3/d)/ft^2]ft$. In this report, the mathematically reduced form, foot squared per day (ft^2/d) is used for convenience.