GENERAL DESCRIPTION OF THE GEOHYDROLOGY AND BURIAL TRENCHES AT THE LOW-LEVEL RADIOACTIVE WASTE BURIAL FACILITY NEAR BARNWELL, SOUTH CAROLINA

By Bryan B. McDonald

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CONVERSION FACTORS AND ABBREVIATIONS OF UNITS

The following factors may be used to convert the inch-pound units published herein to the International System of units (SI).

Multiply inch-pound units	By	To obtain SI units
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
foot per day (ft/d)	0.3048	meter per day (m/d)
cubic foot (ft^3)	0.02832	cubic meter (m^3)
cubic foot per second (ft^3/s)	0.0283	cubic meter per second (m^3/s)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
degree Fahrenheit (°F)	°C = 5/9 (°F-32)	degree Celsius (°C)
picocurie (pCi)	0.037	becquerel (Bq)

GENERAL DESCRIPTION OF THE GEOHYDROLOGY AND BURIAL TRENCHES AT THE LOW-LEVEL RADIOACTIVE WASTE BURIAL FACILITY NEAR BARNWELL, SOUTH CAROLINA

by Bryan B. McDonald

ABSTRACT

The Barnwell low-level radioactive solid waste burial site is located in Barnwell County, South Carolina, 5 miles west of the city of Barnwell. Approximately 1,050 feet of stratified gravel, sand, silt, clay, and limestone, ranging in age from Late Cretaceous to Holocene, underlie the burial site.

Ground water within the study area occurs under water table, semi-confined, and artesian conditions. Overland flow and most precipitation that recharges the ground-water system at the burial site is discharged to Marys Branch Creek. This creek originates as a spring about 3,000 feet south of the burial site and flows to the southwest into Lower Three Runs. Lower Three Runs discharges into the Savannah River.

Waste shipments to the site were reduced from 200,000 cubic feet per month for the period 1971 to 1979 to 100,000 cubic feet per month by October 1981. The wastes consist of both nonfuel cycle and nuclear fuel-cycle wastes.

The standard trench dimensions at the burial site are 100 feet wide by 1,000 feet long and 22 feet deep. Trench bottoms are a minimum of 5 feet above the water table.

Seven soil mapping units occur at the waste disposal facility. The three major soil types are all well drained and cover approximately 84 percent of the study area.

INTRODUCTION

This report was prepared in cooperation with the U.S. Environmental Protection Agency. It, and data from the Barnwell area, are to be used in conjunction with PRESTO-EPA (Prediction of Radiation Effects from Shallow Trench Operations) computer code to obtain a more complete understanding of the potential environmental effects of low-level radioactive waste disposal in a geohydrologic and climatic environmental system typical of the Coastal Plains region of the Southeastern United States. All data and descriptions were obtained from published reports, and no new interpretations are included in the report.

Chem-Nuclear Systems, Inc., was licensed to bury waste at the Barnwell site by the South Carolina Department of Health and Environmental Control, Bureau of Radiological Health in May 1971. The licensing agency also has control over all radiological activities at the site, including waste packaging, trench design, trench construction and extensive radiological monitoring.

Approximately 75 percent (by volume) of the radioactive waste buried at the Barnwell site comes from the nuclear power industry. Prior to November 1979, waste shipments to Barnwell were limited to 2.4 milion cubic feet per year. A State executive order issued in November 1979 specified that monthly quotas would gradually decrease from 200,000 to 100,000 cubic feet by October 1981 (Cahill, 1982, p. 7, 10).

GENERAL DESCRIPTION OF BURIAL SITE

The Barnwell low-level radioactive-solid-waste burial site is located approximately 5 miles west of the city of Barnwell, S.C. (figs. 1 and 2). The site occupies an area of about 0.5 square mile near the southeastern edge of the Savannah River Plant (SRP), a U.S. government nuclear facility.

The topography is generally flat to slightly rolling with altitudes ranging from 230 feet to about 260 feet above NGVD (National Geodetic Vertical Datum) of 1929 (Cahill, 1982, p. 4).

Federal facilities, primarily the Savannah River Plant, occupy 34 percent of Barnwell County. Other predominant land uses include forestry (32 percent) and agriculture (24 percent) (Olson and others, 1980, p. 3-31). Major crops include soybeans, corn, wheat, cotton, melons, and pine trees (Cahill, 1982, p. 4). Pine trees are grown primarily for pulp wood on several tracts of land adjacent to the waste disposal site. All surrounding areas are predominantly rural with the exception of the SRP and a nuclear services facility (Chem-Nuclear Systems, Inc., 1980a, p. 3-33).

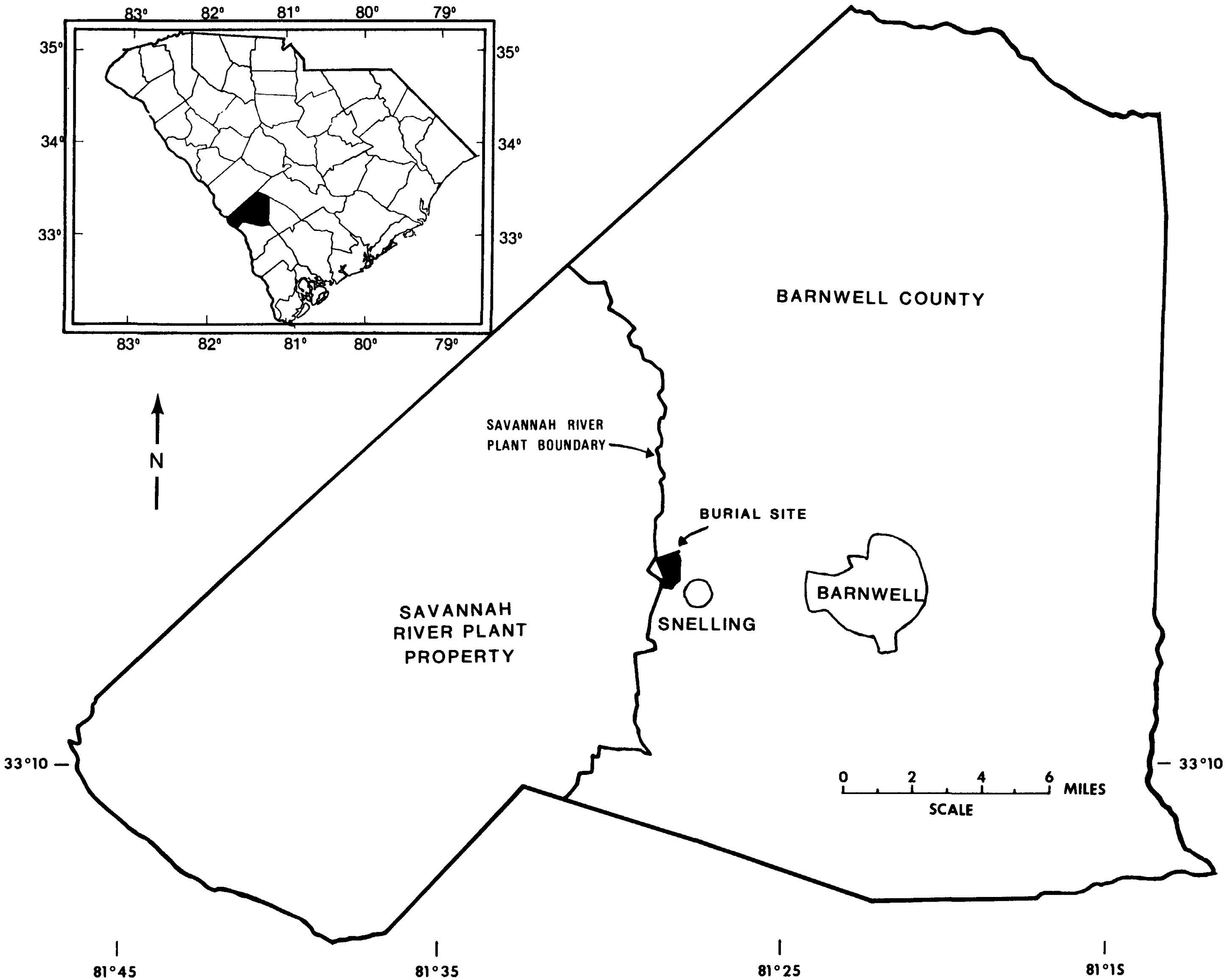

Figure 1.--Location of low-level radioactive waste burial site near Barnwell, S.C. (From Cahill 1982, p. 3)

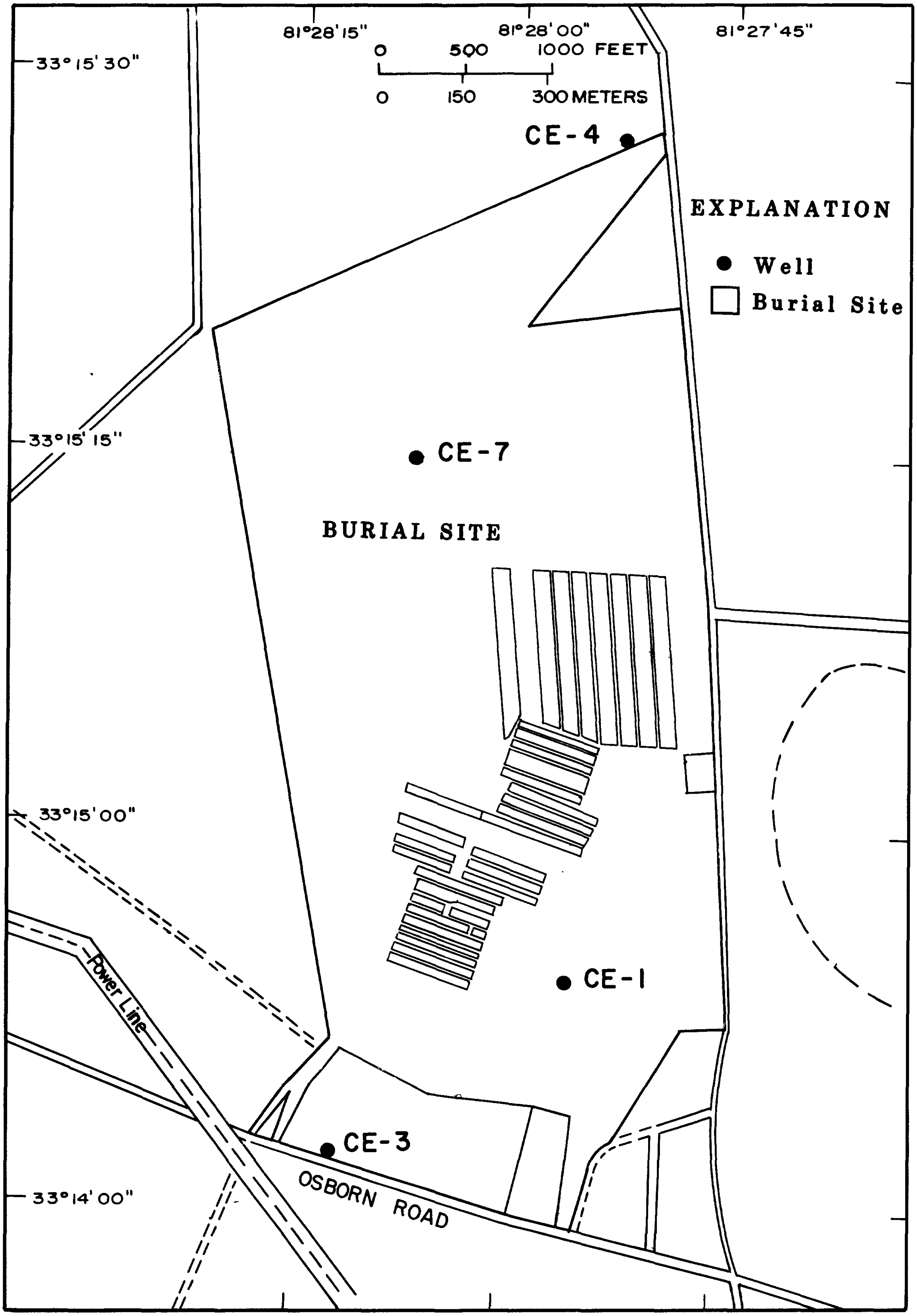

Figure 2.--Location of trenches and wells at the low-level radioactive waste burial site near Barnwell, S. C. (modified from Cahill 1982, p. 11)

CLIMATE

The Barnwell area is characterized by a relatively mild climate; the mean temperature of the coldest month, January, is approximately 48°F, while the mean temperature for the warmest month, July, is approximately 81°F (U.S. Nuclear Regulatory Commission, 1976, p. 2-16).

During the period 1952 through 1978, average annual rainfall at the Barnwell burial site was 46 inches (U.S. Nuclear Regulatory Commission, 1982, p. 3-3). On the average, rainfall is greatest during the summer months. Summer rainfall is about 30 percent of the annual total. Spring rainfall represents 27 percent, winter rainfall represents 25 percent, and fall rainfall represents 18 percent of the average annual rainfall recorded in the Barnwell area (National Oceanic and Atmospheric Administration, 1976). Snowfall does occur, but more than 3 days of sustained snow coverage is very rare. Hail occurs about once every 2 years at any given location (U.S. Nuclear Regulatory Commission, 1982, p. 3-1). Locally intense thunderstorms are the cause of much of the precipitation in the spring and summer, while major weather fronts are the main cause of precipitation during the fall and winter (Cahill, 1982, p. 7).

The average annual temperature at the Savannah River Plant and Laboratory for the 16-year period, 1961-76, was 64°F. The average summer temperature was approximately 81°F and the average winter temperature was 48°F. Less than one-third of the winter days have a minimum temperature below freezing (U.S. Nuclear Regulatory Commission, 1982, p. 3-1, 3-2). Temperature extremes at the Savannah River Plant from 1961 to 1972 ranged from a low of 3°F to a high of 105°F (U.S. Nuclear Regulatory Commission, 1976, p. 2-16).

The average annual relative humidity, from 1964 to 1978, was 66 percent with an average annual minimum of 43 percent and an average annual maximum of 90 percent (U.S. Nuclear Regulatory Commission, 1982, p. 3-2).

Data for 1976 and 1977 collected at a 200-foot off-site television tower located approximately 25 miles northwest of the burial site boundary show that the wind direction was mainly from the west and southwest quadrant. Wind speed for the same period of record is also indicated on figure 3 (E. I. duPont de Nemours and Company, 1980).

Hurricanes in South Carolina most frequently occur in August and September, although the official hurricane season is from June through October. During 272 years of record (1700-1971), 38 hurricanes have caused damage in South Carolina, which is an average occurrence of one hurricane in 7 years. Because the burial site is approximately 75 miles inland and hurricanes tend to diminish as they move over land, hurricanes along the coast rarely produce hurricane force winds at the burial site. The highest wind recorded at the neighboring Savannah River Plant site was 75 miles per hour during Hurricane Gracie in September 1959 (U.S. Nuclear Regulatory Commission, 1976, p. 2-17, 2-19).

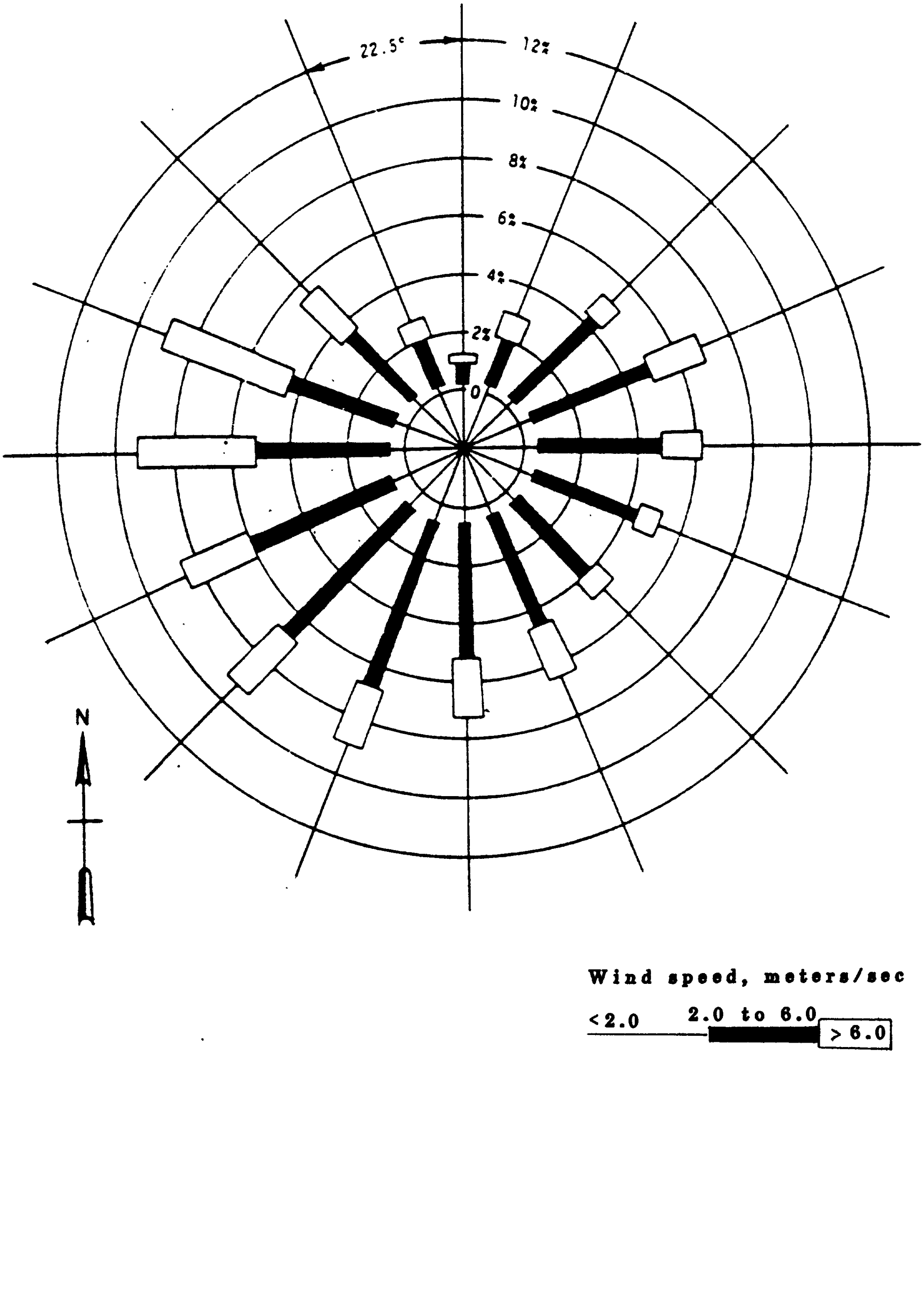

Figure 3.--Wind direction frequency near Barnwell, S. C. (from Environmental Assessment for the Barnwell Low-Level Waste Disposal Facility, 1982, p. 3-7)

Most of the tornadoes in South Carolina occur from March through June; maximum wind speeds can reach 260 miles per hour during these events. Recorded data from 1959 to 1971 show that the State is struck by an average of ten tornadoes per year (Purvis, 1977). Although no facilities have suffered tornado damage, the burial site is in an area where occasional tornadoes are to be expected. Light damage has occurred at the Savannah River Plant on several occasions (U.S. Nuclear Regulatory Commission, 1982, p. 3-3).

GEOLOGY

The Barnwell low-level radioactive solid waste disposal facility is located in the Coastal Plain physiographic province. The Fall Line, which separates the Piedmont and the Coastal Plain provinces, is located approximately 35 miles northwest of the site. The study area is underlain by sediments of the Atlantic Coastal Plain. These sediments are composed of stratified gravel, sand, silt, clay, and limestone, that range in age from Late Cretaceous to Holocene (Cahill, 1982, p. 20). Thickness of the Coastal Plain sediments ranges from a few feet near the Fall Line to more than 4,000 feet along the Atlantic Coast (Siple, 1967).

Logs from a well drilled at the Barnwell Nuclear Fuel Plant, 1-1/2 miles west of the burial site (fig. 5), indicate that the unconsolidated sediments are approximately 1,050 feet deep in the study area. These sediments overlie consolidated rock of Triassic age (Siple, 1967). The electric resistivity, self-potential, lithologic, and stratigraphic logs from this well are shown in figure 4.

Triassic System

During Late Triassic time, extensive normal faulting produced numerous grabens. The rapid accumulation of sediments within the troughs produced the tightly cemented red claystone, siltstone, fine-grained sandstone, breccia, and fanglomerate characteristic of the Newark Group of Late Triassic age (Siple, 1967). Weathering has formed a less consolidated clay, silt, and sand layer at the surface of the system (Marine, 1979).

Cretaceous System

Sediments of the Cretaceous Period include the nonmarine Middendorf Formation and the marine Ellenton Formation. The Middendorf, which consists mainly of fluvial and estuarine deposits of coarse sand and gravel interbedded with diversely colored clay beds or lenses, rests on top of the Triassic rocks. The Middendorf is characterized by highly micaceous and kaolinitic sediments (Cahill, 1982, p. 20-22).

The formational contact between sands of the Middendorf and the basal Ellenton sands can generally be determined by changes in mineral content. Although the two sands are similar, the Ellenton contains an abundance of glauconite, lignite, pyrite, and selenite. A characteristic feature of the

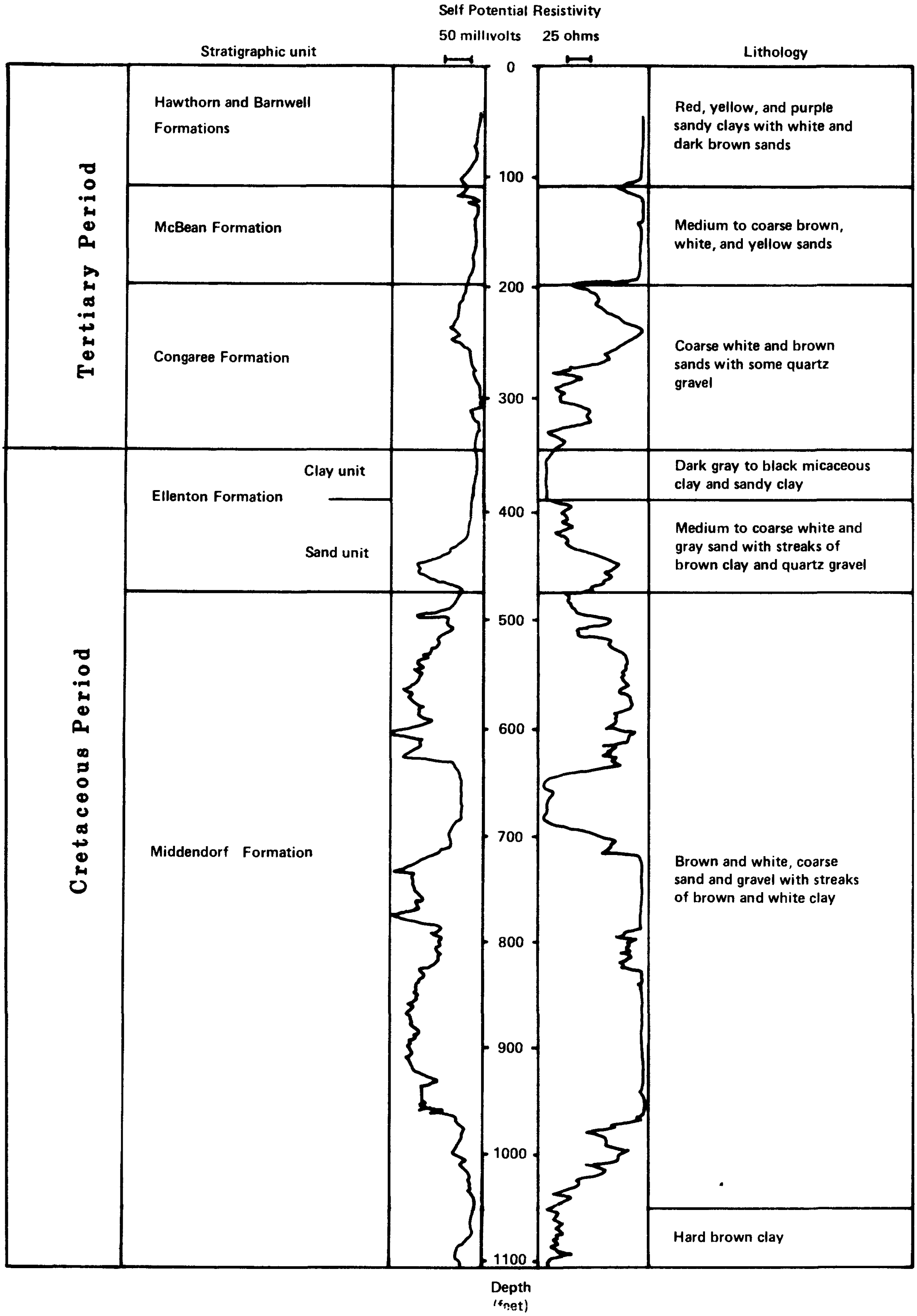

Figure 4.--Stratigraphic interpretation of electric and lithologic logs of well 0-1 at the Allied General Nuclear Services Plant near Barnwell, S. C. (modified from Cahill 1982, p. 21)

Ellenton is the dark gray to black lignitic micaceous silt and clay, normally 40 to 50 feet thick, that occurs in the upper part of the formation. This micaceous silt and clay hydraulically separates the lower sediments from the Tertiary sediments above (Cahill, 1982, p. 21, 22).

Tertiary System

The Tertiary System, composed of marine sand and clay, consists of the Congaree, McBean, and Barnwell Formations of Eocene age and the Hawthorn Formation of Miocene age. Most of the sand zones occur in the Congaree and McBean Formations, whereas the Barnwell and Hawthorn Formations contain more clay (Cahill, 1982, p. 22).

The Congaree Formation, which is the oldest of the Tertiary deposits, is recognizable at the contact by the lithologic contrast between the dark clays of the Ellenton and the sandy gravel of the Congaree.

The McBean Formation consists of white, tan, brown, and yellow clays interbedded with medium to coarse quartz sand. The McBean also contains carbonate material and lenses of silicified limestone. The contact between the McBean and the Congaree occurs approximately 190 feet below land surface, where purple clay lenses are imbedded with the distinct orange to yellow McBean sands.

Above the McBean is the Barnwell Formation. It consists predominantly of brown, maroon, and red clayey sand with a change to yellow sand near the contact with the McBean Formation. The Barnwell sediments usually occur below the water table and contain lenses of sand interbedded with the clays and silts.

Similar lithologic breaks exist between the Barnwell and Hawthorn Formations. The Hawthorn is generally light clayey sand to dark red sandy clay at the base. The upper part of the Hawthorn is normally a tan to reddish color with patches of kaolinitic material and brown pebbles of ferruginous material scattered throughout. This formation also contains numerous clastic dikes (Cahill, 1982, p. 22, 24).

Quaternary System

The Quaternary System consists of wind-blown sands which overlie the Hawthorn Formation. The thickness of these beds ranges from a few inches to as much as several feet (Cahill, 1982, p. 24).

SOILS

The U.S. Department of Agriculture (1977) delineates seven soil mapping units on the waste disposal facility. Table 1 shows the percentage of the Barnwell site covered by each soil type. Blanton sand, Fuquay sand, and Lakeland sand cover approximately 84 percent of the area. These soils, which

Table 1.--Soils of the Barnwell low-level radioactive waste burial site, as percentage of surface area covered by each map unit (U.S. Department of Agriculture, 1977)

Map unit	Percent coverage
Blanton sand	34
Fuquay sand	28
Lakeland sand	22
Plummer loamy sand	1
Lumbee loamy sand	5
Rembert loam	1
Dotham loamy sand	8

occur on level to gently sloping areas, are well drained and susceptible to rapid leaching of plant nutrients. They are severely to moderately limited for agricultural production, but have moderate to high potential for woodland productivity.

Three other soils, Plummer loamy sand, Lumbee loamy sand, and Rembert loam comprise a total of only 7 percent coverage. They all exhibit low permeability leading to water accumulation and conditions such as ponding or high water tables. These soils occur in low, wet, sandy flats, in slight depressions, or in low, flat, oval-shaped bays known as Carolina bays. Due to the high moisture content, these soils are severely limited for agricultural production, but have a high potential for woodland productivity from tree species adapted to wet environments.

The Dothan loamy sand, which covers approximately 8 percent of the area, is deep and well-drained, occurs on uplands, and has moderate available water capacity. It also has a high potential for woodland productivity and moderate limitations for agricultural production (U.S. Department of Agriculture, 1977).

HYDROLOGY

Between 60 and 70 percent of the mean annual precipitation of approximately 46 inches is returned to the atmosphere through evapotranspiration. The remaining 30 to 40 percent (14 to 18 inches), enters the porous sands and recharges the ground-water system. Overland flow is rare, occurring only during intense rainfall and in less permeable areas such as fields or along roadways (Cahill, 1982, p. 24).

Surface Water

Many of the streams on or near the burial site are fed by ground water and originate as springs where confining beds of clayey sand have been eroded (Cahill, 1982, p. 26). Streams that flow to the east discharge to the Salkehatchie River, and those that flow to the south or west discharge to Lower Three Runs (fig. 5). The Salkehatchie River flows to the southeast while Lower Three Runs flows to the south and discharges to the Savannah River.

Marys Branch Creek originates as a spring about 3,000 feet south of the burial site; it flows to the southwest and into Lower Three Runs about 2.5 miles downstream. The principal source of flow in Marys Branch Creek is from the ground-water system, although overland flow is contributed during periods of high rainfall. Based on monthly stream discharge measurements made from August 1976 to December 1978, there is an average discharge of approximately 0.4 ft^3/s at the spring. Measurements 1 mile downstream for the same period of record average 4.7 ft^3/s.

The numerous natural lakes in the area are poorly drained surface depressions known locally as Carolina bays. Direct connection to the underlying saturated zone in some of the bays results in recharge to the saturated zone when water levels in the bays are high and discharge from the saturated zone into the bays when water levels in the bays are low. Because most of these natural lakes are shallow swamps and marshes, the water lost to evapotranspiration is high (Cahill, 1982, p. 26).

Par Pond is the largest man-made lake in the area. An overflow structure at the pond regulates Lower Three Runs. The majority of the runoff from the northwestern section of the study area enters this lake.

Ground Water

Ground water in the study area occurs under water table, semi-confined, and artesian conditions. Under water-table conditions, the water surface is free to rise and fall. Under artesian conditions, the aquifer is overlain by a less permeable layer that confines the water under hydrostatic pressure. The water level in a well developed in a confined aquifer will rise above the base of the confining bed.

Based on water level and hydraulic characteristics of the sediments, Cahill (1982) delineated four major water-bearing zones. The upper 350 feet of saturated sediments, which consist of zones 1, 2, and 3, generally exhibit either water table or semi-confined conditions. Below the 50-foot thick confining clay layer of the Ellenton Formation at a depth of approximately 400 feet, the conditions in zone 4 are confined.

Figure 6 shows the potentiometric surfaces of the four zones on a cross section from well CE-4 at the northeast edge of the burial site to well CE-8 located at Marys Branch Spring about 3,000 feet south of the site. The decrease in elevation of the potentiometric surface in zones 1, 2, and 3 in a

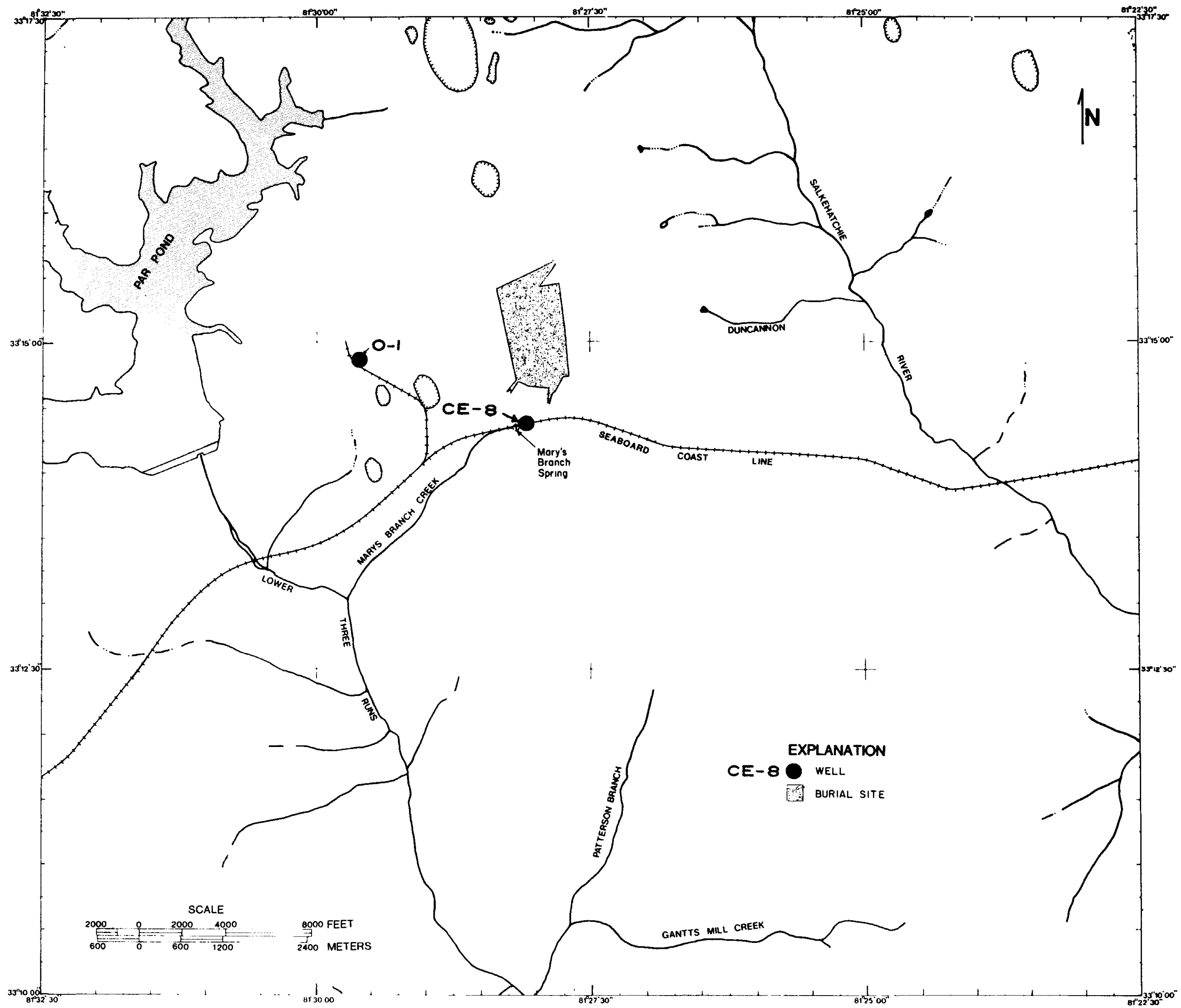

Figure 5.--Location of streams in the vicinity of the low-level radioactive waste burial site near Barnwell, S.C. (modified from Cahill, 1982 p.5)

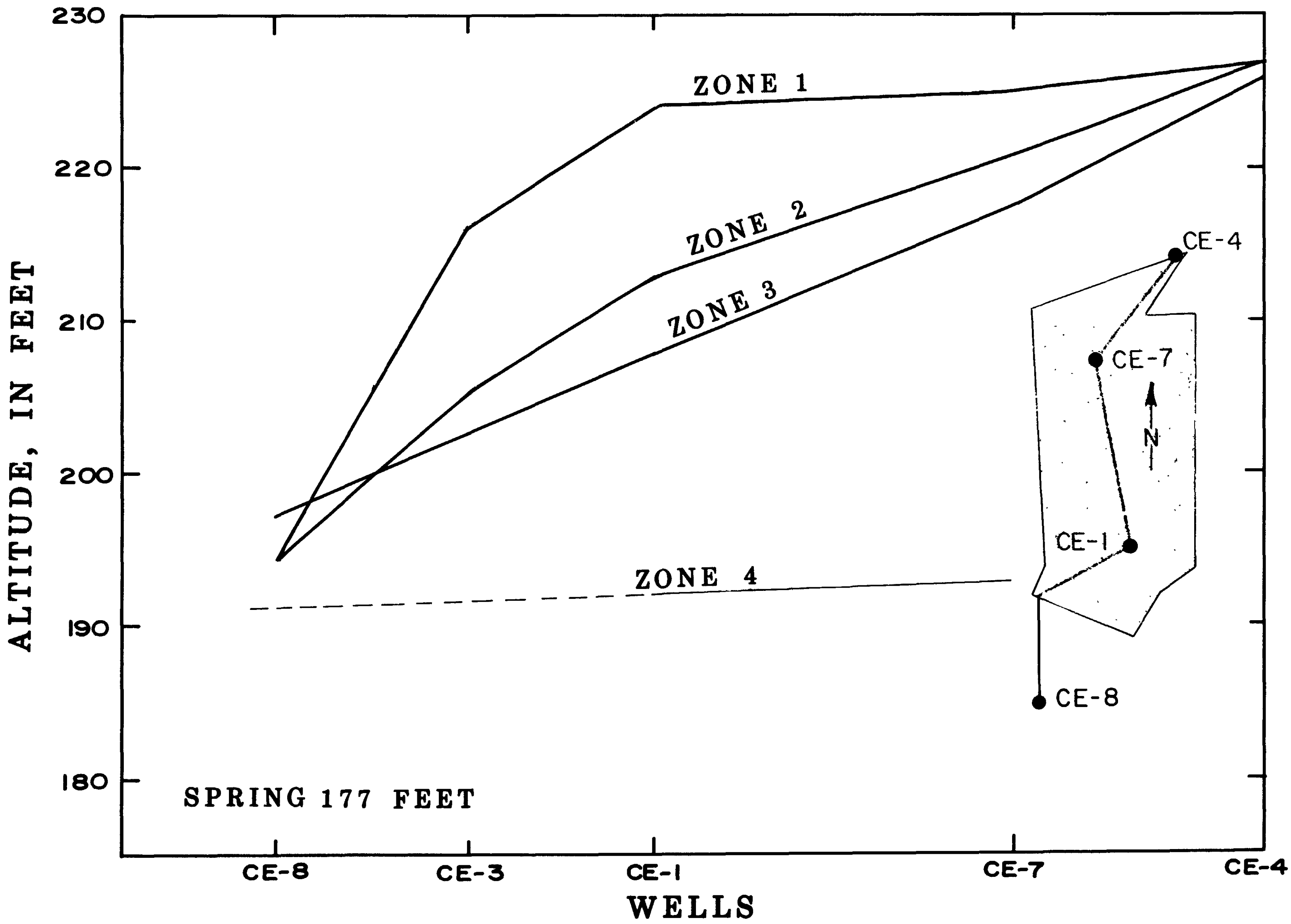

Figure 6.--Potentiometric surface of four water-bearing zones during August 1977 at the low-level radioactive solid waste burial site near Barnwell, S.C. (modified from Cahill, 1982 p.41)

southward direction indicates discharge into the spring at Marys Branch Creek. Figure 7 is a cross section from well CE-4 southwest to well CE-3 showing the thickness of each layer and the potentiometric surfaces during November 1979 (Cahill, 1982, p. 43).

Zone 1 consists of the clayey sands of the lower Hawthorn and upper Barnwell Formations and extends from the water table down to approximately 70 feet beneath the land surface. Ground-water flow in this zone is generally in a southerly direction.

The very fine to medium Eocene sands of the lower part of the Barnwell and upper part of the McBean Formations make up zone 2. Discontinuous clay lenses within this zone range from a few inches to a few feet thick. The thickness of this zone is approximately 100 feet, and the base is identified by silt and clay bedding. The horizontal direction of water movement in zone 2 is similar to zone 1. Therefore, most of the recharge entering this zone at the burial site also discharges into Marys Branch Creek downstream from the spring. Most of the ground-water contribution to Marys Branch Creek is derived from zone 2. Zone 2 is the main source of domestic water in the vicinity of the burial site.

Zone 3 consists mostly of fine to medium subrounded quartz sand in the lower part of the McBean and the upper part of the Congaree Formations. Lenses of interbedded clay are present and in the eastern and southern part of the study area, limestone and consolidated calcareous material also occur within this zone. The top of zone 3 occurs at a depth of about 170 feet below land surface, where silt and clay beds separate this zone from zone 2. The thick silty clay bed of the Ellenton Formation occurs at the bottom of zone 3, approximately 350 feet below land surface. Water levels indicate that in the northern section of the study area, ground-water movement is toward the east, and in the southern section of the area it flows south toward Lower Three Runs. Water for the city of Barnwell is obtained from zone 3. However, the Barnwell city wells are a minimum of 6 miles away from the burial site and are not located in the flow path of ground water from the site.

The 650 feet of sediments that make up the Middendorf Formation define zone 4. The bottom of zone 4 is the top of the Triassic sedimentary rocks, which occur at a depth of about 1,050 feet below land surface. Zone 4 consists of medium to coarse sands and gravel beds intermixed with clay deposits. Data from an aquifer test conducted by Allied General Nuclear Services showed poor hydraulic connection between the Cretaceous sediments of zone 4 and the Tertiary sediments above. Water levels in the wells located in zones 1, 2, and 3 showed no response to pumpage in zone 4. The majority of water in zone 4 discharges into the Savannah River (Cahill, 1982, p. 36-60).

Ground-Water Movement of Radioactive Waste

The mobility of leachate in a soil-water system is difficult to determine. Some radionuclides, such as tritium, move at the same rate as ground water, while the transport of others may be retarded by interaction with the soil. An example from Cahill, 1982, p. 98, represents the most rapid

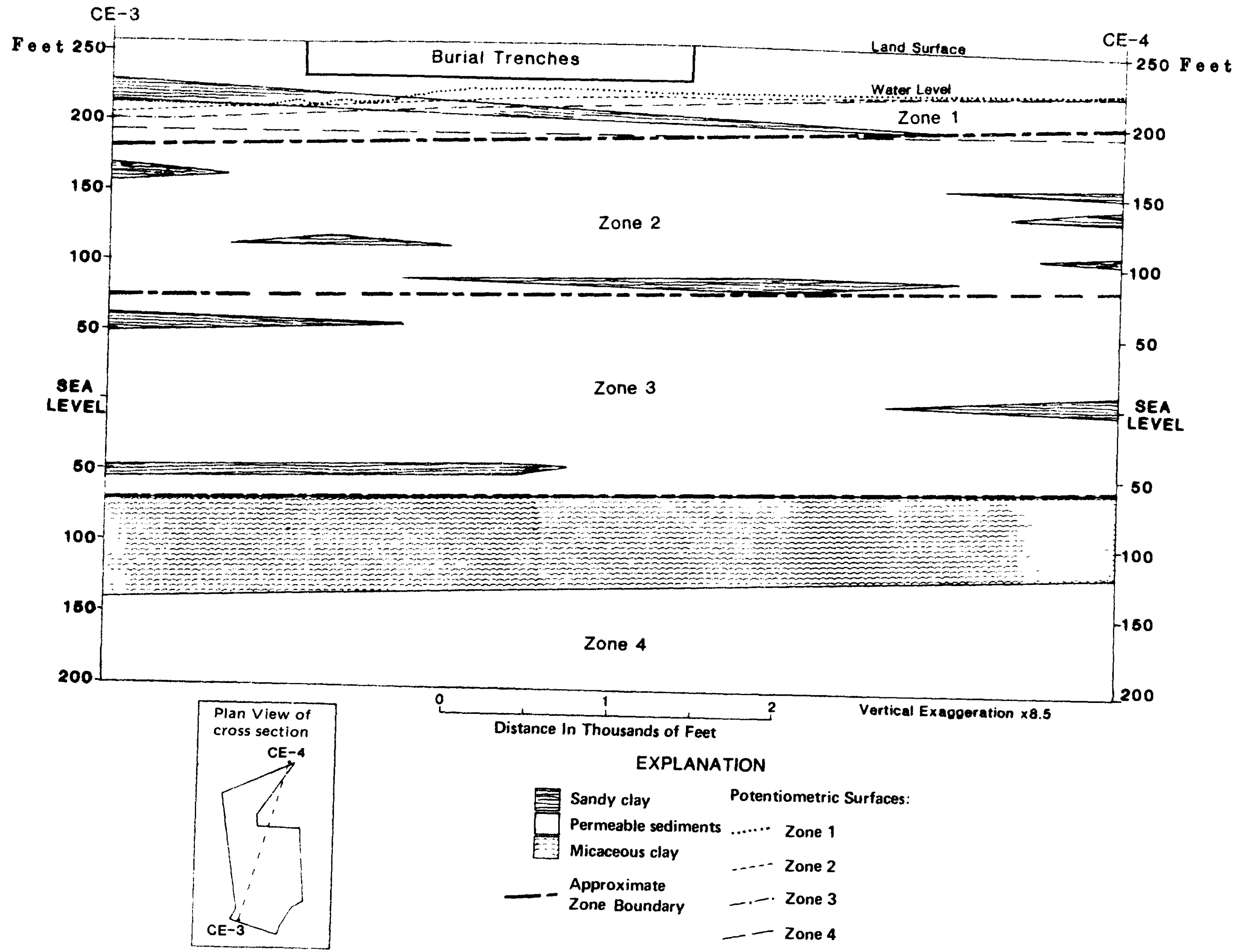

Figure 7.--Cross section through the burial site showing the thickness of the four ground-water bearing zones during November 1982 (from Cahill 1982, p. 42)

migration that can be expected. Because the soil-water potential is less in zone 2 than in zone 1, percolation occurs from zone 1 into zone 2. At an average downward velocity of 0.007 ft/d, water will take about 10 years to descend 25 feet through zone 1 and into zone 2. The higher horizontal water velocity in zone 2 will move the water the 3,600 feet to Marys Branch Creek in a minimum of 40 years. A total travel time of about 50 years is therefore estimated. During this time the radioactivity of the tritiated water will be reduced by 4 half-lives of radioactive decay. The 50-year estimate does not take into consideration factors such as retardation which would increase the time of transport for most radionuclides.

WASTE BURIAL

Nuclear power plants and institutional sources account for the majority of the low-level radioactive waste buried at the Barnwell site. Approximately 75 percent of the waste by volume is shipped to Barnwell from the nuclear industry. Institutional sources such as medical, academic, industrial, and research facilities generate the remaining 25 percent. (U.S. Nuclear Regulatory Commission, 1982, p. 2-1 - 2-4).

Types of Waste

Nonfuel-cycle radioactive waste consists of low specific activity waste such as paper trash, packing material, protective clothing, broken glassware, plastic sheeting and tubing, animal carcasses, obsolete equipment, and building rubble. The principal isotopes in the waste are ^{3}H (tritium) and ^{14}C (carbon 14).

Higher-activity nuclear fuel-cycle waste consists of spent ion-exchange resins, filters, filter sludges, solidified liquids, shielding, piping, control rods, and instruments. Low specific activity waste is also shipped to Barnwell from the nuclear fuel industry. Principal isotopes in the waste include ^{55}Fe, ^{60}Co, ^{63}Ni, ^{134}Cs, and ^{137}Cs (U.S. Nuclear Regulatory Commission, 1982, p. 2-4).

Volume of Waste

Waste shipments to Barnwell were limited to 2.4 million cubic feet per year prior to November 1979. At that time, the State of South Carolina issued an executive order specifying that monthly quotas would decrease gradually from 200,000 to 100,000 cubic feet per month by October 1981. Figure 8 depicts the annual volume of radioactive waste buried at the site from 1971 to 1984 (Heyward Shealy, South Carolina Department of Health and Environmental Control, Written Comm., 1985).

Waste Packaging

The bulk of waste materials are packaged in 210-liter Department of Transportation-approved mild steel drums, and the current practice is to bury the waste materials in the same containers in which they are received. The exception to this practice is waste that requires shipment in an expensive reusable shielded cask. In this case, the waste is packaged in a liner that can be safely removed and placed into the trench. Highly concentrated waste is buried in noncorroding high-integrity containers. Resins and sludges are solidified in approved solidification media. (Chem-Nuclear Systems, Inc., 1980b, p. 145).

Gaseous wastes require special precautions and regulations. These wastes are normally received in small containers which are then placed in a steel can filled with a desiccant and sealed with tar or some similar product. The container is then sealed in concrete in a clay, steel, or concrete pipe and placed in the trench. Gaseous tritium and wastes under pressures of more than 1.5 atmospheres are not accepted at the Barnwell burial site (Chem-Nuclear Systems, Inc., 1980b, p. 147). Receipt of gaseous waste, Kr^{85} (Krypton), has occurred at the Barnwell site on no more than four occasions (Heyward Shealy, South Carolina Department of Health and Environmental Control, Written Comm., 1985).

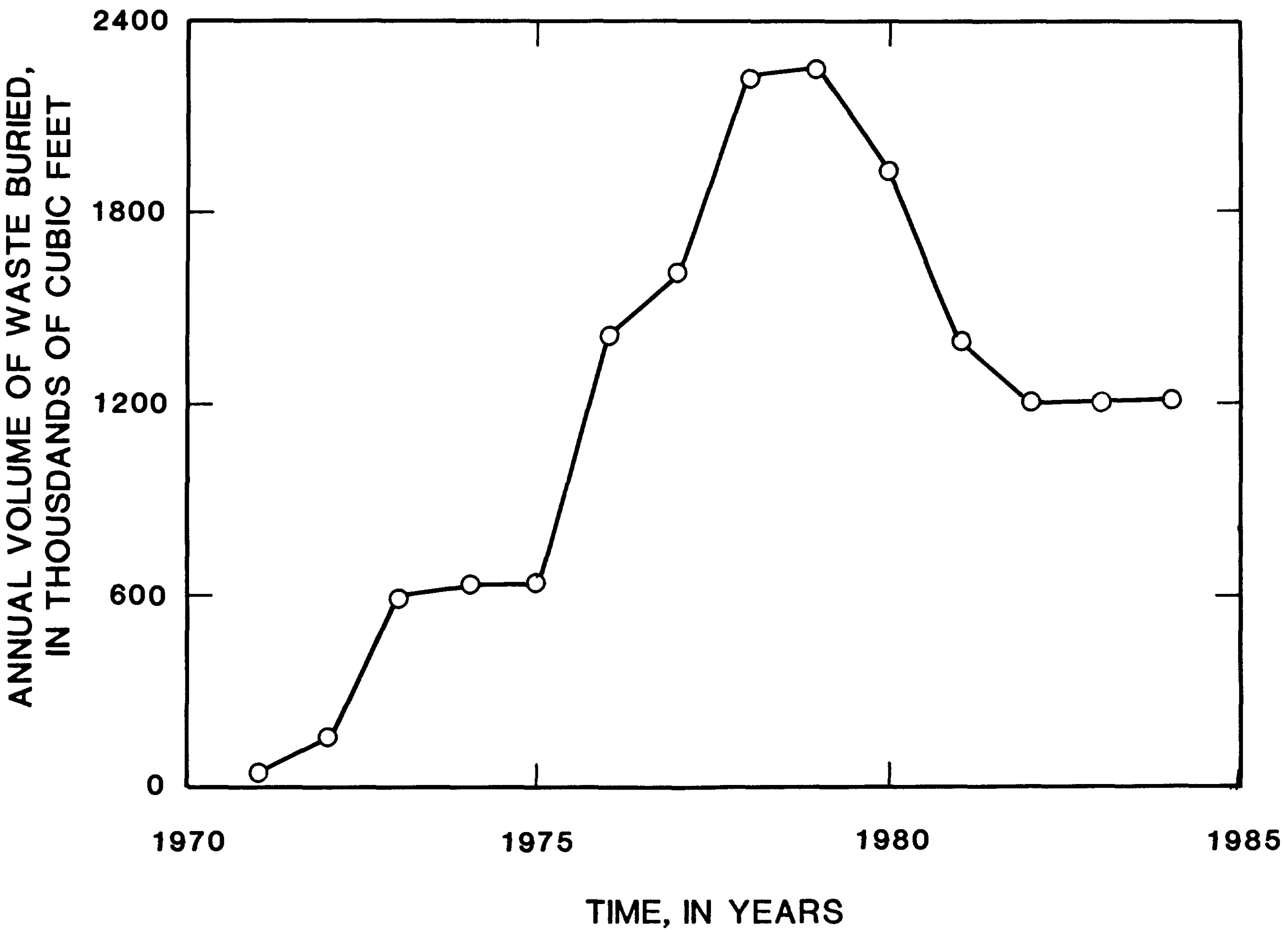

Figure 8.--Annual volume of solid waste buried at the low-level radioactive waste burial site near Barnwell, S.C. during 1971-1984

TRENCH DESCRIPTION

Waste was first buried at Barnwell in May 1971 at the south end of the facility site. At that time the trenches were oriented in a general east-west direction (fig. 2), and the system of numbering the trenches in sequence of excavation began (Cahill, 1982, p. 10).

Trench location is precisely determined using the site's grid system. In order to determine both direction and distance, this grid system utilizes a baseline and reference points. Savannah River Operations (SRO) monuments SRO 123 and SRO 128 are used to form a north-south baseline 10°10' west of magnetic north. Monument SRO 128 is also used as the 0.000, 0.000 reference point and the elevational reference point (U.S. Nuclear Regulatory Commission, 1982, p. 2-15).

Trench Design

The shallow land burial method utilized at the Barnwell site has two basic trench designs: the "regular" and the "slit" trench. Regular trenches are used for low-level waste. Since 1976 the dimensions of these trenches have been 100 feet wide by 1,000 feet long and 22 feet deep. The trench floor slopes to one side (approximately 1.0 percent) and to one end (approximately 0.3 percent) so that if any water does infiltrate the trench cap and percolate through the waste to the trench bottom, it will flow to one corner where it may be collected (Cahill, 1982, p. 10).

Slit trenches are designed for high-curie waste. The narrow width of these trenches (3 feet wide by 500 feet long and 20 feet deep) reduces the "radiation shine" area and, therefore, personnel exposure during offloading is minimized. Barnwell has only one active slit trench (U.S. Nuclear Regulatory Commission, 1982, p. 2-13).

Trench Construction

The initial step during the construction of a new trench is to completely remove the top (sandy) layer of soil from a perimeter around the designated area. Clay is then placed into the excavated area and compacted to high density to construct an upper barrier wall (fig. 9). After shaping the perimeter to facilitate drainage away from the structure, the trench is excavated within this clay area. The compacted clay serves to prevent the upper walls from caving in and to ensure that the trench is surrounded by a relatively impermeable surface barrier (U.S. Nuclear Regulatory Commission, 1982, p. 2-15).

Trench bottoms are excavated so as to maintain at least a 5-foot separation between the trench bottom and the water table (Chem-Nuclear Systems, Inc., 1980b, p. 47). Along the lower side of the trench floor, a 2-foot French drain is constructed and filled with gravel (fig. 10). Monitoring pipes are installed at 100-foot intervals for future sampling capabilities. Two sumps (4 ft x 4 ft) extending 4 feet below the trench floor are placed at 500-foot intervals and filled with gravel to serve as collection points for water. A pipe rising to grade level from the sump allows the removal of any water.

Before the trench is filled with waste, the sandy topsoil previously removed is added to the trench floor in order to provide: (1) a firm and level base for the waste, (2) a porous medium for moisture after trench closure, or rainfall while the trench is open, to move easily to the French drain, and (3) a buffer zone in case of an abnormal rise of the water table (U.S. Nuclear Regulatory Commission, 1982, p. 2-17).

Once the trench has been filled, a minimum of 2 feet of clay is added to the top of the trench and a vibrating compactor is used to accelerate the settling process. An additional 3 feet of soil is added over the clay. The trench cap is contoured for drainage by sloping the adjacent ground away from the structure and establishing a uniform gradient in the longitudinal direction. In order to control erosion, grass is seeded over the trench (Chem-Nuclear Systems, Inc., 1980b, p. 47).

SUMMARY

The Barnwell low-level radioactive solid waste burial site is located in Barnwell County, S.C., 5 miles west of the city of Barnwell. The area is characterized by a relatively mild climate with average monthly temperatures ranging from 48°F to 81°F. Average annual rainfall is approximately 46 inches.

The burial site is located in the Atlantic Coastal Plain Province. Approximately 1,050 feet of stratified gravel, sand, silt, clay, and limestone, ranging in age from Late Cretaceous to Holocene, underlie the burial site.

Seven soil mapping units occur at the waste disposal facility. The three major soil types are all well drained and cover approximately 84 percent of the study area.

Ground water within the study area occurs under water table, semi-confined, and artesian conditions. Four major water-bearing zones were delineated by Cahill (1982). The upper three zones generally exhibit water table to semi-confined conditions, whereas zone 4 is confined. Any overland flow and most precipitation that recharges the ground-water system at the burial site is discharged to Marys Branch Creek through zones 1, 2, or 3. This creek originates as a spring about 3,000 feet south of the burial site and flows to the southwest into Lower Three Runs. Lower Three Runs discharges into the Savannah River.

Nuclear power plants account for the majority of the low-level radioactive waste buried at the Barnwell site. About 75 percent of the waste, by volume, is from the nuclear industry. The remaining waste is contributed by institutions such as universities, hospitals, and research facilities.

The standard trench dimensions at the burial site are 100 feet wide by 1,000 feet long and 22 feet deep. Trench bottoms are a minimum of 5 feet above the water table.

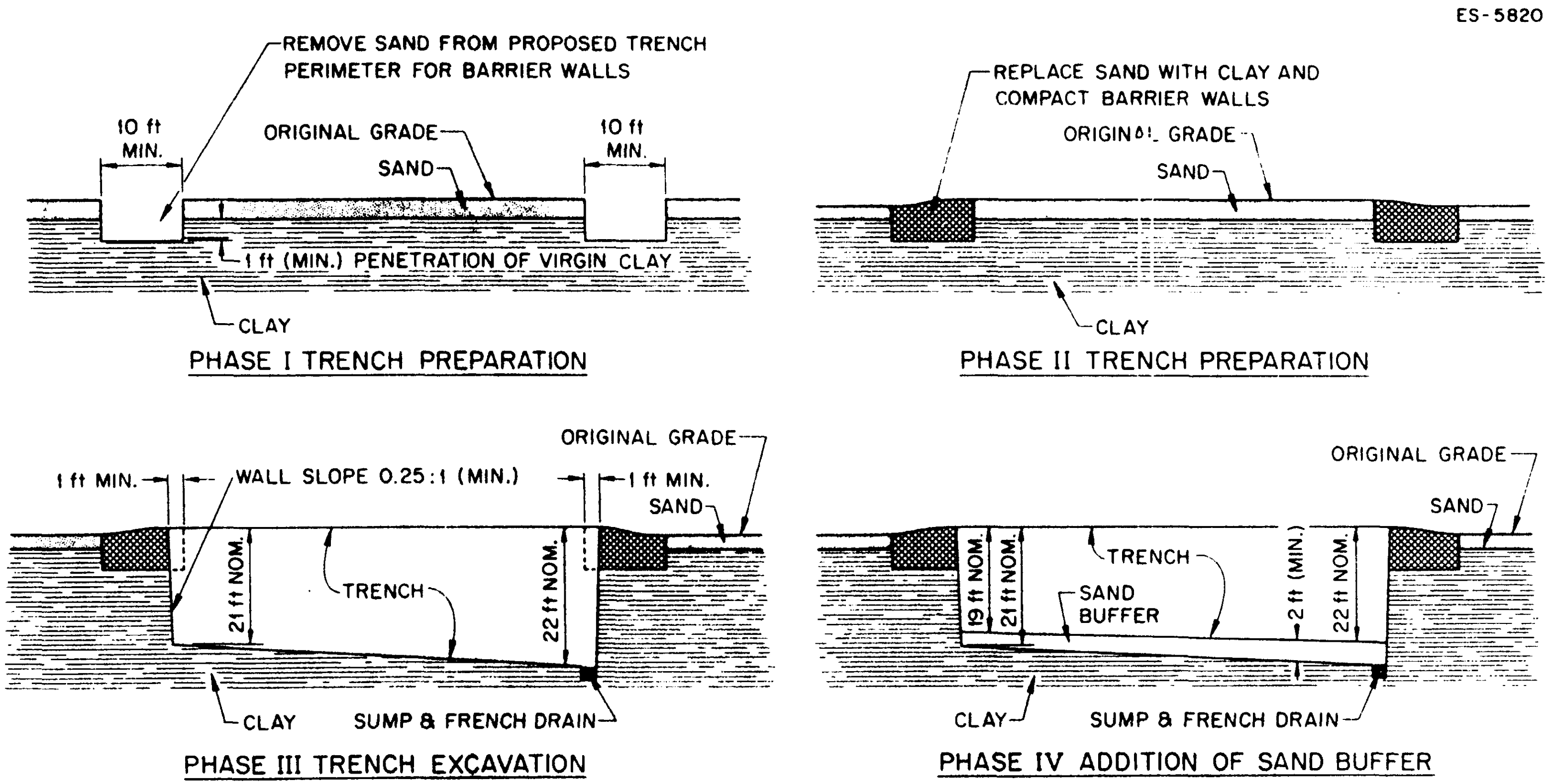

Figure 9.--Trench construction details in four phases. (from Environmental Assessment for the Barnwell Low-Level Waste Disposal Facility, 1982 p.2-16)

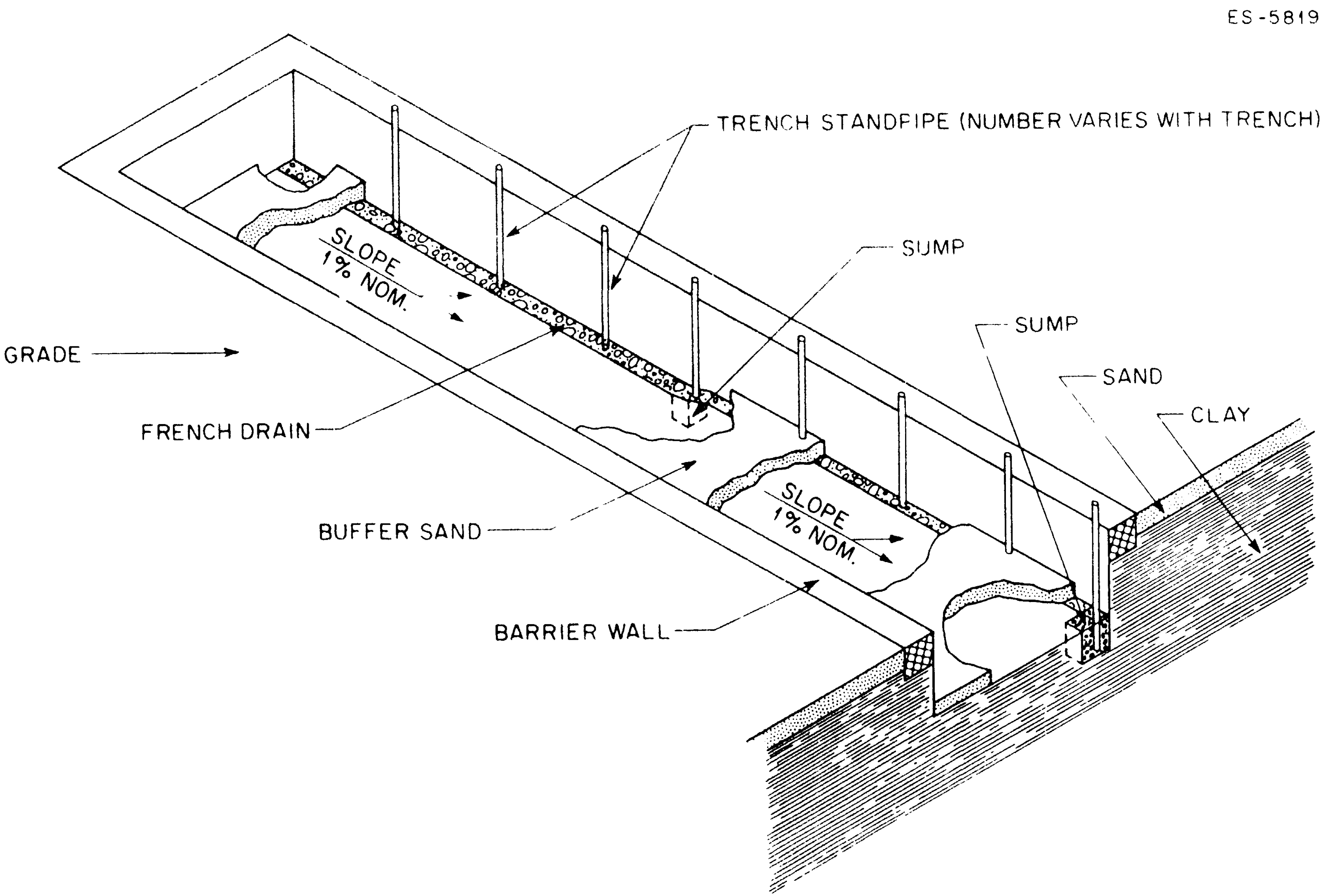

Figure 10.--Typical waste burial trench (from Environmental Assessment for the Barnwell Low-level Waste Disposal Facility, 1982 p. 2-14)

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