Site Hydrogeologic/Geotechnical Characterization Report for Site B New Municipal Solid Waste Landfill

by

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**SITE HYDROGEOLOGIC/GEOTECHNICAL
CHARACTERIZATION REPORT FOR SITE B
NEW MUNICIPAL SOLID WASTE LANDFILL (U)
SAVANNAH RIVER SITE**

APRIL 1991

**Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808**

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT DE-AC09-89SR18035

**SITE HYDROGEOLOGIC/GEOTECHNICAL CHARACTERIZATION REPORT
FOR SITE B NEW MUNICIPAL SOLID WASTE LANDFILL (U)
(WSRC-RP-91-392)
- SAVANNAH RIVER SITE -**

CERTIFICATION OF SITE HYDROGEOLOGIC CHARACTERIZATION REPORT

This report was prepared by Sirrine Environmental Consultants, Inc. under WSRC Subcontracts AX715304 (Task Order No. 42) and AA21060P (Task Order No. 04). Sirrine has performed the work and developed the findings presented in this report in accordance with generally accepted environmental science and engineering practices for municipal landfill siting, and in conformance with the requirements of R.61-68 (Water Classifications and Standards) and R.61-70 (Regulation Requiring Minimum Standards for Sanitary Landfill Design, Construction and Operation) of the South Carolina Code of Laws, as amended, and the "Guidelines for Establishing the Hydrogeologic Acceptability of Proposed Sites for Industrial and Domestic Waste Landfills," (SCDHEC, December 1990).

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SITE HYDROGEOLOGIC/GEOTECHNICAL CHARACTERIZATION REPORT FOR SITE B SAVANNAH RIVER SITE

LIST OF ACRONYMS AND ABBREVIATIONS

A/M Areas	The A and M Areas of the Savannah River Site
ACOE	U.S. Army Corps of Engineers
ASTM	American Society of Testing and Materials
BSB	Site B Soil Boring/Savannah River Site
BTP	Site B Temporary Piezometer/Savannah River Site
BTX	Site B Test Excavation/Savannah River Site
CDR	Conceptual Design Report
CEC	Cation Exchange Capacity
cfs	Cubic Feet Per Second
CLP Standards	Contractor Laboratory Program
cm/sec	Centimeters per Second
CSWE	Construction Services Works Engineering - Westinghouse Savannah River Company
dh	Δh or Head Difference
dl	Δh or Difference Between Potentiometric Pressure Locations
DOE or USDOE	United States Department of Energy
DPSOP	Dupont Standard Operating Procedure
E & PD	Engineering and Projects Division - Westinghouse Savannah River Company
elev.	Elevation
EPA or USEPA	U.S. Environmental Protection Agency
EPD	Environmental Protection Department
1Q91	First Quarter of Calendar Year 1991
1QFY92	First Quarter of Fiscal Year 1992
FDC	Functional Design Criteria
FML	Flexible Membrane Liner
ft	Feet
ft/ft	Ground-Water Gradient
g/cm ³	Grams per Cubic Centimeter
GA/GB	Ground-Water Classifications (SCDHEC)
g	Grams
gpd	Gallons per Day
GSA	General Separations Area
Δh	Hydraulic Head Difference between Two Measuring Points within a Groundwater System
HP	Horse Power
HW/MW	Hazardous Waste/Mixed Waste

**SITE HYDROGEOLOGIC/GEOTECHNICAL
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LIST OF ACRONYMS AND ABBREVIATIONS

I or dh/dl	Hydraulic Gradient
ID	Internal Diameter
IDB	Interim Waste Disposal Site B
in.	Inch(es)
K	Hydraulic Conductivity (Undifferentiated)
Kh	Horizontal Hydraulic Conductivity (Estimated From Slug Test)
Kv or K'	Vertical Hydraulic Conductivity (Estimated From Soil Permeability Test)
Δl	Length of the Flow Path
LL	Liquid Limit
m'	Thickness of the Confining Bed
M-Area	An Operating Area at the Savannah River Site
meq	Milliequivalent
mg/L	Milligrams/Liter
msl	Mean Sea Level
MSWLF	Municipal Solid Waste Landfill
MWD	Mixed Waste Disposal Facility
MWMF	Mixed Waste Management Facility
n	Total Porosity (fraction)
Ne	Effective Porosity (fraction)
OSHA	Occupational Safety and Health Act
pH	Measure of Hydrogen Ion Activity
PI	Plastic Index
PL	Plastic Limit
pcf	Pounds Per Cubic Foot
pci	Picocuries
psi	Pounds Per Square Inch
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RPD	Relative Percent Difference
S-Area	An Operating Area at the Savannah River Site
SCS	Soil Conservation Service (USDA)
SCDHEC	South Carolina Department of Health and Environmental Control
SE	Systems Engineering Department - Westinghouse Savannah River Company
Sirrine or SEC	Sirrine Environmental Consultants, Inc.
SHCR	Site Hydrogeologic Characterization Report

**SITE HYDROGEOLOGIC/GEOTECHNICAL
CHARACTERIZATION REPORT FOR SITE B
SAVANNAH RIVER SITE**

LIST OF ACRONYMS AND ABBREVIATIONS

SRL	Savannah River Laboratory
SS	Split Spoon Sample
SP log	Spontaneous Potential
SPT	Standard Penetration Test
SRP	Savannah River Plant
SRS	Savannah River Site
T	Transmissivity
TOC	Total Organic Carbon
TOH or TOX	Total Organic Halogens
TOX	Total Organic Halogens
ug/L	Micrograms per Liter
USBR	United States Bureau of Reclamation
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture
UTRC	Upper Three Runs Creek
V	Flow Velocity
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compounds
w	Water Content Reported in Weight Percent
WMP	Waste Management Projects
WSRC	Westinghouse Savannah River Company
yr	Year
Z-Area	An Operating Area at the Savannah River Site

1.0 EXECUTIVE SUMMARY

This "Site Hydrogeologic/Geotechnical Characterization Report" (SHCR) presents the results of a comprehensive study conducted on a proposed solid waste landfill site, identified herein as Site B, at the Savannah River Site (SRS). This report is intended to satisfy all requirements of the South Carolina Department of Health and Environmental Control (SCDHEC) with regard to landfill siting requirements and ground water and environmental protection. In addition, this report provides substantial geotechnical data pertinent to the landfill design process.

Site B was selected through a rigorous screening and scoring program that evaluated six candidate sites. These sites were screened with respect to several criteria: Ground Water, Geology, Topography/Soils, Geotechnical Considerations, Surface Waters, Environmentally Sensitive Areas, and Other Technical and Engineering Considerations. Based on this review process, Site B, located in the central portion of the SRS, was selected for detailed characterization in support of the landfill permitting and design process.

Site B is somewhat rectangular in shape and consists of a total of 366 acres. The proposed landfill area is to be situated on a 69 acre portion of Site B. Site B drains to Tinker Creek via Mill Creek, McQueen Branch and other unnamed creeks and tributaries. Surface drainage renders Site B relatively isolated from the operational areas of the SRS. No wetland areas exist in the proposed design area, although two small wetlands have been identified adjacent to the larger Site B.

The new landfill will be designed for a 20-year capacity and will be a combination above and below grade facility. The conceptual design for the new landfill employs state-of-the-art composite liner technology as well as leachate collection, gas management, and capping/closure systems. The proposed facility will be designed to meet or exceed all applicable SCDHEC and U.S. Environmental Protection Agency (USEPA) regulatory standards.

Several previous investigations have been performed at Site B, including ground-water studies. Hydrogeologic data obtained during these previous investigations was utilized in this study where it yielded valuable insight into site conditions. This study of Site B consisted of both a geotechnical and hydrogeologic characterization of subsurface conditions. A total of 41 borings were drilled and 16 test pits were excavated as part of the geotechnical characterization study. Laboratory geotechnical testing was conducted on bulk and undisturbed samples to enable characterization of physical properties and to verify soil classification. The hydrogeologic characterization consisted of drilling 13 test holes and sampling a total of 34 monitoring wells and piezometers. Aquifer hydraulic properties were also characterized by water-level measurements, pneumatic slug tests and laboratory hydraulic conductivity analyses.

The results of the geotechnical investigation indicate limited volumes of soil materials suitable for liner and cap materials. However, the use of these materials may be impractical due to site management constraints. An off site source is probably the best alternative for these materials.

The hydrogeologic investigation confirmed that two major confining beds, the Green Clay and the Williamsburg/Rhems, are continuous throughout the site. The Green Clay is a regionally significant silt and clay deposit, of low permeability material, and functions as a highly effective confining zone. Similarly, relatively thick, low permeability lithologies are present within the Williamsburg/Rhems confining bed. As a result of these hydrogeologic conditions, a head reversal is present across this confining bed, indicating the potential for ground-water flow from the deeper, prolific Cretaceous aquifers into the shallower Congaree Aquifer, which is confined below the Green Clay. The water table aquifer occurs above the Green Clay with an unsaturated zone greater than 50 ft thick throughout nearly all of Site B. These conditions collectively provide protection from contamination to the major aquifers, which are commonly used for industrial and water supply purposes.

The findings of this characterization study indicate that with proper engineering design, a landfill facility can be constructed and operated at site B with minimal risk to the environment. In addition, ground water flow rates and directions and the relationships between hydrogeologic units at the site, are well understood and will facilitate the implementation of an effective ground-water monitoring program. Finally, in the unlikely event that ground-water contamination occurs as a result of landfilling operations, an effective corrective action program can be developed and implemented.

2.0 INTRODUCTION

A new municipal solid waste landfill is to be constructed at the Savannah River Site (SRS), South Carolina. Sirrine Environmental Consultants, Inc. (Sirrine) was contracted by Westinghouse Savannah River Company (WSRC) to conduct a systematic screening of six candidate sites. This review resulted in the selection of Site B as the best-suited site. Sirrine subsequently was charged with conducting a hydrogeologic/geotechnical characterization of Site B in support of WSRC's landfill permitting and design process. This project is under the direction of the Systems Engineering Department (SE), Engineering and Projects Division (E&PD) and is authorized as Sirrine's Task Order No. 04, under WSRC Subcontract AA21060P. Parts of the work performed under this project scope were authorized as Sirrine's Task Order No. 42, under WSRC Subcontract AX715304.

2.1 Background and Objectives

The existing sanitary landfill at SRS is estimated to achieve design capacity by 1QFY92 (WSRC, 1990). A proposal for landfill expansion was submitted to the South Carolina Department of Health and Environmental Control (SCDHEC). However, because of an apparent ground-water impact as a result of current landfilling operations, the Department recommended construction of a new sanitary landfill at another site. As a result, six sites were identified by E&PD as candidates for a new municipal solid waste landfill. A technical screening of each of the six sites (referred to as Sites B, C, D, H, N, and O) was performed by Sirrine as directed by E&PD. Site screening criteria were developed and grouped into the primary areas of Geology, Ground Water, Topography/Soils, Geotechnical, Surface Waters, Environmentally Sensitive Areas, and Other Technical/Engineering Considerations. The screening criteria were based upon: 1) draft technical guidance provided to the U.S. Department of Energy (DOE) by SCDHEC (letter from Van Keisler, SCDHEC, to S.R. Wright, DOE, dated October 09, 1989); 2) proposed revisions to the Resource Conservation and Recovery Act (RCRA) Subtitle D; and 3) current standards of practice (Robinson, 1986).

The site screening study identified Site B as the best location for a new municipal solid waste landfill (see "Site Screening Report", WSRC-RP-90-1286, Sirrine, 1990b). The location of Site B is shown in Figures 2-1 and 2-2.

A field investigation designed to provide a comprehensive hydrogeologic/geotechnical characterization of Site B was conducted by Sirrine during the late summer and fall of 1990. Field activities included soil sampling, geotechnical analyses, piezometer installation, hydraulic testing, and ground-water sampling. The primary objectives of the site hydrogeologic/geotechnical characterization included:

- 1) Characterization of site hydrogeologic conditions and selected aquifer properties;
- 2) identification, description and characterization of site geology, with special emphasis on confining units and permeable zones;
- 3) sampling, characterization and geotechnical analysis of potential liner and cap materials, and confining units;
- 4) sampling and analysis of ground water; and
- 5) identification of site recharge/discharge areas and related hydrologic features.

2.2 Comparison of This Report With SCDHEC Landfill Siting Guidelines

The siting of industrial and domestic waste landfills in South Carolina is regulated by SCDHEC (Superfund and Solid Waste Section) under the State's Water Classification and Standards Regulations (R.61-68.D) and Standards for Landfill Design, Operation, and Construction Regulations (R.61-70). The most recent guidance governing these landfills is "Guidelines for Establishing the Hydrogeologic Acceptability of Proposed Sites for Industrial and Domestic Waste Landfills - December 1990 Interim Final". This guidance identifies an investigatory and review process that, for promising sites, culminates in submittal of a "Final Site Hydrogeologic Characterization Report" (SHCR). These guidelines also identify technical requirements for the SHCR.

SIRRINE
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 Greenville, South Carolina

FIGURE 2-1
PROPOSED NEW MUNICIPAL
SOLID WASTE LANDFILL
SITE B
SAVANNAH RIVER SITE

SIRRINE JN G035A.00

This report for Site B) is intended to satisfy all requirements of SCDHEC's SHCR criteria. The SCDHEC landfill siting guidance identifies seventeen (17) "suggested hydrogeologic considerations" as well as numerous detailed technical "hydrogeologic issues". Table 2-1 is provided to facilitate review and reconciliation of this report against the SCDHEC hydrogeologic issues and considerations. This table identifies the locations in this report where each SCDHEC issue or consideration is discussed. Note that this report goes substantially beyond the basic requirements of the SCDHEC guidance in that comprehensive geotechnical and ground-water quality characterizations are also presented.

2.3 Proposed Landfill Facility Description

The area designated for landfill construction is located in the northwestern portion of Site B and is approximately 69 acres in area as identified in "Conceptual Design Report (CDR) for New Sanitary Landfill (Draft)", (WSRC, 1990), and "Functional Design Criteria (FDC): New Sanitary Landfill", (WSRC, 1990b). The location of the proposed landfill site is presented in Figure 2-3 and Appendix A. The new landfill will be designed for a 20-year capacity. This facility will be a combination above/below grade landfill with a minimum depth of 20 feet (ft) below natural grade and an above grade height consistent with SCDHEC policies and guidelines.

The conceptual components of the proposed landfill were outlined in a comparison report "Design Technology Selection Review for the New Municipal Solid Waste Landfill (U)", (Sirrinc, 1990a). These features are outlined in Figure 2-4. A more detailed description of the facility's design concept is presented in the Draft CDR (WSRC, 1990). A composite liner system will be constructed of a flexible membrane liner in contact with a low-permeability compacted soil or equivalent self-sealing liner. A leachate collection system consisting of a porous collection layer inlaid with perforated pipes will channel leachate to a containment system for storage prior to treatment and disposal. A passive gas collection system will be constructed for the safe collection and venting of decomposition gases. The final cover system of the landfill is to be constructed of a vegetated top cover, a middle drainage layer, and a low-permeability bottom layer composite of synthetic flexible membrane and compacted soil.

Table 2-1
Guide to Discussion of SCDHEC "Hydrogeologic Issues" in this Report
Site B Site Hydrogeologic Characterization Report

Hydrogeologic Issues	Discussed in Section	See Also		
		Figures	Tables	Appendices
Location/Topography				
State/County	2.1	2-1	-	-
Tax Map	2.1, 3.2	2-1	-	-
USGS Topographic Map	2.1, 3.2	2-2, 2-3	-	A
Site Topography	2.1, 3.2	2-2, 2-3	-	A
Land Use	2.1, 3.2	2-1, 2-2, 2-3	-	A
100-Year Floodplain	3.2	3-1	-	-
Wetlands	3.2	2-3, 3-1	-	A
Local/Regional				
Geologic Units	3.1, 3.3, 5.1, 5.2	5-10, 6-1, 6-11	5-1	-
Seismic Activity and Faults	5.2	-	-	-
Ground-Water Movement	6.1, 6.2	2-1, 2-2, 6-1, 6-11	-	-
Potentiometric Gradients/Flow Rates	6.1, 6.2	2-1, 2-2, 6-1, 6-11	-	-
Ground-Water Quality	6.1, 6.2, 7.1, 7.2	-	6-2	-
Recharge/Discharge Areas	6.1, 6.2	2-1, 2-2, 6-1, 6-11	6-2	A
100-Year Floodplain	3.2	3-1	-	-
Wetlands	3.2	2-3, 3-1	-	-
Site Hydrogeology				
Relation to Regional/Local Conditions	6.1, 6.2	5-1 thru 5-10, 6-1 thru 6-11	5-1, 6-1, 6-2	B,C,D,E,H,I
Geologic Units	5.2, 6.1, 6.2	5-1 thru 5-10	5-1, 6-1, 6-2	B,C,D,E,H,I
Thickness/Distribution of Units	5.2, 6.1, 6.2	5-1 thru 5-10	5-1	B,C,D,E,H,I
Structural Attitude of Units	5.2, 6.2	5-1 thru 5-10	5-1	B,C,D,E
Hydraulic Properties of Units	6.2	5-6 thru 5-10, 6-1 thru 6-11	-	B,C,D,E,G
Geochemical Properties of Units	6.2, 7.1, 7.2	5-6 thru 5-9	7-1 thru 7-3	K,L
Lateral Ground-Water Movement	6.2	5-6 thru 5-9, 6-1 thru 6-11	6-1	B,C,D,E,G
Vertical Ground-Water Movement	6.2	5-6 thru 5-9, 6-1 thru 6-11	6-1, 8-1	B,C,D,E,G,I,L
Ground-Water Flow Rates	6.2	5-6 thru 5-9, 6-4, 6-5, 6-7, 6-8	-	B,C,D,E,G
Depth to Ground-Water	6.2, 8.2	5-6 thru 5-9, 6-6, 6-9	6-1	B,C,D,E
Temporal Fluctuation	6.2	-	6-1	-
Ground-Water Quality	6.2, 7.1, 7.2	-	7-1 thru 7-3	K
Discharge Points	6.1, 6.2	2-2, 6-2	-	-
7Q10 of Receiving Stream	3.2	2-1, 2-2, 3-1	-	-
100-Year Floodplain	3.2	3-1	-	-
Wetlands	3.2	2-3, 3-1	-	A

(Continued p. 1 of 2)

Table 2-1
Guide to Discussion of SCDHEC "Hydrogeologic Issues" in this Report
Site B Site Hydrogeologic Characterization Report

Suggested Hydrogeologic Criteria	Discussed in Section	See Also		
		Figures	Tables	Appendices
Cap Material	8.1, 8.2, 8.3, 9.2	5-6 thru 5-9	8.1, 8-2, 8-3	B,C,D,E,I
Complex Hydrogeology	6.1, 6.2, 9.1	5-6 thru 5-9, 6-1 thru 6-11	-	B,C,D,E
Confining Unit	5.2, 6.2, 9.1	-	-	B,C,D,E
Corrective Action Demonstration	6.2, 9.1	5-10	5-1	-
Bedrock	5.2, 6.2, 9.1	5-6 thru 5-9, 6-6, 6-9	-	-
Depth to Ground Water	6.2, 9.1	3-1	-	B,C,D,E
100-Year Floodplain	3.2, 9.1	3-1	-	-
Ground-Water Flow Rate	6.2, 9.1	5-6 thru 5-9, 6-4 thru 6-8	-	B,C,D,E,G
Ground-Water Use	6.2, 9.1	-	6-2	-
Highly Transmissive	6.2, 9.1	5-6 thru 5-9	-	B,C,D,E,G
Karst Features	5.2, 6.2, 9.1	5-6 thru 5-9	-	B,C,D,E
Liner Unit	8.1, 8.2, 8.3, 9.2	5-6 thru 5-9	8-1, 8-2, 8-3	L
Recharge Areas	3.2, 6.2, 9.1	2-2, 5-6 thru 5-9, 6-1, 6-11	-	A,B,C,D, E
Special Ground-Water Areas	6.2, 9.1	-	-	-
Surface Water	3.2, 6.2, 9.1	-	-	-
Unmonitorable Areas	6.2, 9.1	2-1, 2-2, 3-1	-	-
Wetlands	3.2, 9.1	-	-	A

(p. 2 of 2)

FIGURE 2-3
TOPOGRAPHIC MAP WITH
WITH MONITORING WELL,
PIEZOMETER, SOIL BORING
AND TEST PIT LOCATIONS
SITE B SHCR
-SAVANNAH RIVER SITE-

- = 100 & MWL WELL SERIES
- ▲ = BSB LANDFILL BORING
- = BTP PIEZOMETERS
- = BTX LANDFILL TEST PIT
- = INVESTIGATIVE SITE BOUNDARY
- = PROPOSED LANDFILL LOCATION
- W = WETLAND AREAS

NOTE: ALL ELEVATIONS ARE IN FEET

PLANT
NORTH

SIRRINE
ENVIRONMENTAL
CONSULTANTS

Greenville, South Carolina

10/10/90 00:00:00

10/10/90 00:00:00

*Reference to specification values for illustration only.

SIRRINE
ENVIRONMENTAL
CONSULTANTS

Greenville, South Carolina

FIGURE 2-4

RECOMMENDED
LANDFILL COMPONENTS*
(TYPICAL SECTION)

SIRRINE JN 00358.00

3.0 SITE LOCATION AND PHYSIOGRAPHIC SETTING

3.1 Physiography

The Savannah River Site occupies an approximately 300-square mile area within the Upper Atlantic Coastal Plain and is located roughly 30 miles southeast of the Fall Line, which marks the northeast-southwest trending boundary between the crystalline rocks of the Piedmont and the sediments of the Atlantic Coastal Plain. The Atlantic Coastal Plain sediments form a wedge of unconsolidated to semiconsolidated sediments which increase in thickness from zero at the Fall Line to more than 4,000 ft near the coast of South Carolina. The sediments range in age from Late Cretaceous to Holocene and dip gently to the southeast toward the sea (Savannah River Laboratory, (SRL), 1988).

The Atlantic Coastal Plain in South Carolina is divided into three physiographic zones: the Upper, Middle, and Lower Coastal Plains. These zones trend approximately parallel to the coast and the Fall Line. The surface of the Upper Coastal Plain, which is characterized by predominantly fluvial erosion, slopes from 650 ft mean sea level (msl) at the Fall Line to approximately 250 ft msl at the southeastern boundary. The Middle Coastal Plain is characterized by fluvial erosion which has generally obscured the primary depositional topography. The Lower Coastal Plain is characterized by a primary depositional topography (SRL, 1988).

The Upper Atlantic Coastal Plain in South Carolina is separated into two major physiographic divisions: the Aiken Plateau, in the south-central part of the state, and the Congaree Sand Hills, located in the central and north-central portion of South Carolina. The SRS facility lies on the Aiken Plateau, which is bounded by the Savannah River to the southwest and the Congaree River to the north-northeast. The Aiken Plateau is highly dissected by streams and is characterized by broad interfluvial areas with narrow steep-

sided valleys. Ground surface elevations at SRS range from approximately 100 ft msl in the stream and river valleys to 400 ft msl at the topographically highest locations on the plateau at the site.

The Savannah River forms the southwestern boundary of the SRS. The five main streams on the site are tributaries of the Savannah River. These include Upper Three Runs Creek, Four Mile Creek, Pen Branch, Steel Creek, and Lower Three Runs Creek (see Figure 2-1).

3.2 Site Description

The site selected for the new municipal solid waste landfill, referred to as Site B, is located in the north central part of the SRS approximately two miles northeast of H-Area (Figures 2-1 and 2-2). Access to Site B is by SRS Road E-2 (gravel) which intersects with SRS Road E (paved) approximately 14,400 ft east of the intersection of SRS Road 4 and Road E at H-area. Road E-2 transects the width of the southeastern portion of Site B.

Based upon SRS coordinates provided by Waste Management Projects (WMP-WSRC), Site B is approximately 366 acres in area. This site is roughly rectangular in shape, with the long axis oriented northwest/southeast. (Note all references to compass direction in this report refer to true north, and not "Plant North". References to grid coordinates refer to the Plant grid coordinate system.) Ground surface elevations at Site B range from 280 to 326 ft msl. The site drains to Tinker Creek, approximately 4000 ft to the northwest, via Mill Creek to the east and northeast, McQueen Branch to the southwest and west, and other unnamed drainages and tributaries to the north and northwest. Tinker Creek flows southwesterly to converge with Upper Three Runs Creek, and ultimately the Savannah River.

The average slope across the site is approximately 0.036 ft/ft. Site B conditions are depicted in Figure 2-3. An expanded scale (1" = 200') base map of Site B is provided as Appendix A, and illustrates topographic conditions, site features, and locations of investigative activities.

No stream gauging stations exist on Tinker Creek in the immediate area of Site B. The nearest gauging station is on Upper Three Runs Creek, approximately five miles north of the site (Bloxham, 1976). The standard statistical expression of low flow conditions, i.e. the 7Q10 value, for Upper Three Runs Creek at that location is 0.72 cfs/mi².

Based on similar soils and geology, but a somewhat smaller drainage basin, the 7Q10 value for Tinker Creek just downstream of Site B is expected to be similar or slightly larger, i.e. in the range of 0.75-0.85 cfs/mi².

The 100-year floodplain for both Tinker Creek to the northwest and Mill Creek to the northeast is approximately 4800 ft from Site B (Figure 3-1). The highest elevation of the 100-year floodplain in this area is 200 ft above mean sea level (NUS Corporation, 1984).

Possible wetland areas on Site B were evaluated by the U.S. Army Corps of Engineers and WSRC (letter from Pete Nowacki to Sirrine, dated April 01, 1991). Two areas were confirmed as wetlands based on USACOE criteria for surface hydrology, vegetation and hydric soils. These areas are identified on Figure 2-3. The only wetland area near the proposed landfill location is a small pocket, approximately one acre or less in area, at N76,200 - E74,400. The other area is centered about N71,500 - E75,600, along SRS Road E-2, and is approximately 10 acres.

This second wetland area is a "Carolina Bay"-like feature. This site is not currently on the SRS inventory of Carolina Bays but has been confirmed by SRS soil scientists to have

hydric soils (letter from B. McGee to P. Nowacki, dated November 13, 1990). This depressional feature trends northeast - southwest and is approximately 1200 ft long and 480 ft wide.

The nearest other cataloged wetland areas are located approximately 900 ft from the northeastern boundary of Site B (Figure 3-1). This wetland includes Mill Creek and its associated tributaries and is classified as bottomland hardwoods (NUS Corporation, 1984).

A soil survey of the SRS (Soil Conservation Service (SCS-USDA), June 1990) indicates that the predominant soil series at Site B include the Fuquay, Blanton, and Dothan series. These soils have generally sandy profiles with sandy loam to sandy clay loam (USDA) argillic (subsoil) horizons. The Fuquay and Dothan series also have plinthitic horizons or sub-stratums. The site also includes small areas of the Troup, Lakeland, and Vaucluse series. All of these soils are typically excessively-well drained to well-drained with low organic matter content. The "Carolina Bay"-like feature in the southeastern portion of Site B has Ogeechee soils. This series is poorly drained with moderate organic matter content. These soils are mainly found in topographic surface depressions and are ponded during wet periods.

Nearly all of Site B is currently managed as forestland. Most of the site has mature commercial stands of southern pine species including loblolly pine, longleaf pine and slash pine. Some areas of the site have been clear-cut within the past 10-15 years and have been replanted to plantation pine culture or have regenerated to natural pine stands. Small portions of the site, such as the wetland area in the southeastern portion of the site, are dominated by hardwood stands.

No archaeological resources or endangered species were identified at Site B through the Site Use/Site Clearance permitting process (Sirrinc, 1990b).

3.3 Previous Investigations

Several geotechnical and hydrogeological investigations have previously been conducted on different portions of Site B in support of various SRS initiatives, including some waste facility siting efforts. Between 1982 and 1988, numerous monitoring wells, piezometers, and soil borings were completed at the site during several different investigations. Aquifer testing and geotechnical analyses of soils were also performed during each investigation to characterize aquifer properties and lithologic conditions. The results of each of these investigations, as they relate to the suitability of Site B for the proposed landfill, are discussed in Section 6 of this report.

A brief description of the existing wells (prior to this investigation) at the site is provided in Section 4. The locations of all existing monitoring wells proximal to Site B are depicted on Figure 2-3 and Appendix A.

Three piezometers were installed at Site B by Dames and Moore in 1982. Piezometers BH-1A, BH-2A, and BH-3A were installed to depths of 60 to 65 ft below ground surface (Dames and Moore, 1984).

Well cluster P-14 at Site B is composed of 7 wells which screen different zones in both the Tertiary and Cretaceous aquifers. Wells P-14C, P-14TC, P-14TB, and P-14TA were installed in 1984 (Geraghty & Miller, 1984). Wells IDB-1A, IDB-1B and IDB-1C, which are included in well cluster P-14, were installed at an earlier date.

Eleven ground-water monitoring wells were installed from late 1987 through early 1988, (Sirrine Environmental Consultants, 1989). These wells include IDB-2A, IDB-2B, IDB-2C, and IDB-3 through IDB-10. An additional 15 monitoring wells were installed by Sirrine in the spring and summer of 1988 and include cluster wells MWD-1A through 1D, MWD-2A, MWD-

2C, MWD-2D, MWD-3A, MWD-5A, MWD-5C, MWD-5D, MWD-8, MWD-9, MWD-10, and MWD-11 (C.T. Main, 1988). Wells in the IDB and MWD series screen different ground-water zones within the Tertiary-age sediments.

The program of borings, test pits, and piezometer installations carried out during the course of this study is described in Section 4.

4.0 DATA COLLECTION METHODS AND PROCEDURES

4.1 Field Operations and Data Collection

The approach and methodology for this hydrogeologic and geotechnical effort was presented in the "Hydrogeologic Investigation Program Plan for the Proposed New Landfill Site B" (Sirrinc, 1990c) approved by the SRS Site Ground-Water Coordinator in July, 1990. A summary of this program plan outlining the borings and piezometers installed as a part of this study is presented in Table 4-1.

4.1.1 *Drilling and Soil and Sediment Sampling*

All drilling and soil and sediment sampling activities were conducted between July 01 and December 31, 1990. Three drilling techniques were employed during this project: hollow stem auger, mud rotary, and wire-line coring. The borings were located throughout the area of Site B and north of Road E-2. The drilling method was dictated by the type of investigation planned. Table 4-1 summarizes the program plan and field investigation approach. Figure 2-3 and Appendix A present the base map for Site B and identify the locations of all field investigation activities, as well as the locations of pertinent pre-existing monitoring wells.

4.1.1.1 Deep Coring

The three deep core holes, BSB-38 to BSB-40, were drilled first to provide stratigraphic control for the remainder of the field work. These coreholes were designed to determine the thickness, extent, and hydraulic conductivity of the principal confining layers separating the aquifers beneath the site. Each of these borings was continuously cored and completed in a sand unit underlying the Williamsburg/Rhems confining unit (See Section 5

Table 4-1
Planned Field Investigation Activities, Methods and Objectives
Proposed Landfill Site B, Savannah River Site

<u>Field Activity</u>	<u>Activity Nomenclature</u>	<u>Exploration Method</u>	<u>Activity Objective</u>	<u>Depth Range Explored</u>
Shallow Geotechnical Borings	BSB-1 and BSB-4 through BSB-37	Hollow Stem Auger/ Split Spoon Sampler	<ul style="list-style-type: none"> • Standard Penetration Test • Sample Shallow Soils • Geotechnical Analysis 	50-ft
	BSB-2 and BSB-3	Hollow Stem Auger/ Split Spoon Sampler	<ul style="list-style-type: none"> • Standard Penetration Test • Sample Shallow Soils • Geotechnical Analysis 	100-ft
Deep Geologic Borings	BSB-38 through BSB-40	Wire Line Coring	<ul style="list-style-type: none"> • Establish Stratigraphic Control • Sample Deep Sediment • Collect Geophysical Data 	0-360 ft
	BSB-41	Mud Rotary Boring	<ul style="list-style-type: none"> • Establish Stratigraphic Control • Sample Deep Sediment • Collect Geophysical Data 	
Temporary Piezometers	BTP-1 through BTP-4	Hollow Stem Auger/ Split Spoon Sampler	<ul style="list-style-type: none"> • Sample Shallow Soils • Install Water Table Piezometer • Conduct Slug Tests • Collect Ground water Samples • Collect Piezometer Data 	0-85 ft
	BTP-5 through BTP-12 and IDB-2CC	Mud Rotary Boring with Shelby Tube, Pitcher Barrel and Wire Line Core Sampling	<ul style="list-style-type: none"> • Sample Deep Sediment • Install Temporary Piezometer Clusters • Conduct Slug Tests • Collect Ground water Samples • Collect Piezometer Data • Collect Geophysical Data 	0-360 ft
Test Pits	BTX-1 through BTX-16	Tracked Excavator	<ul style="list-style-type: none"> • Explore Shallow Subsurface • Observe Excavation Stability • Sample Near-Surface Soils for Geotechnical Analyses • Investigate Perched Water • Investigate Shallow Offset and Displacement 	0-30 ft

for discussion of regional stratigraphy and lithology). Geophysical logging of each corehole was then performed (See Section 4.1.3). Each deep core hole was subsequently grouted to the surface.

Lithologic samples were obtained using a 5-ft long, 2-3/4-inch diameter core barrel lowered through the outer drill casing by wireline. The core was extruded on site into a PVC trough. Detailed geologic logs, summaries of which are contained in Appendix H, were prepared by a Sirmine hydrogeologist. After the field logs had been prepared, the cores were wrapped in plastic sheeting and stored in plastic boxes supplied by WSRC.

Several methods were used to enhance core recovery. In general, bentonite-based drilling fluids (Quick Gel™) were used throughout the coring program. Other methods included varying the length of the core barrel shoes, shortening the core run, and altering the rotational speed of the bit.

4.1.1.2 Deep (Mud-Rotary) Drilling

The ten mud-rotary holes, BSB-41, BTP-5 to BTP-12, and IDB-2CC, were advanced into the Williamsburg/Rhems confining bed, with total depths ranging from 225 to 310 ft. Cuttings were sampled every five ft and used to develop geologic descriptions in the field. Upon completion of the drilling, the holes were geophysically logged. The holes were then back-filled into the upper Congaree Formation for later construction of a piezometer. (See Section 5 for discussion of regional stratigraphy and lithology).

4.1.1.3 Shallow Geotechnical (Hollow-Stem) Drilling and Sample Description

Geotechnical characteristics of near-surface soils at the site were investigated by means of 37 auger borings. The soil borings were drilled during the period beginning August 27, 1990 and ending September 19, 1990 by Environmental Monitor Testing Corporation with

technical oversight provided by Sirrine. An all-terrain Mobile B-57 Auger Rig was used to advance 7-1/2-inch hollow-stem augers. Of the 37 hollow-stem auger borings, 35 were drilled to a depth of 50 ft. Borings BSB-2 and BSB-3, however, were continued to 100 and 105 ft, respectively. Upon completion each of these borings was grouted to the surface.

Samples were collected at 5-ft intervals with a split-spoon sampler in accordance with ASTM D 1588-84, Standard Method for Penetration Test and Split-Barrel Sampling of Soils. This procedure provides a disturbed sample of the soil for laboratory analysis, and also provides an indicator of the driving resistance or relative density of the soil formations penetrated by the sampler. The split-spoon sampler consists of a section of pipe that splits into two pieces along the axis of the pipe. A driving shoe and waste barrel are screwed to the ends to hold the split section together during driving. The standard split-spoon sampler has an outside diameter of 2.0 inches and an inside diameter of 1.375 inches, and is driven 18 - 24 inches into the soil with a 140-pound hammer free-falling a distance of 30 inches. The number of blows required to advance the sampler is recorded in 6-inch increments, and the "blow count" for the Standard Penetration Test (SPT) is the sum of the blows for the second and third increments. Engineering correlations to SPT blow counts may be found in many soil mechanics text books, but, due to the many factors that can cause variations in blow counts, they are most useful in qualitative comparisons.

In addition to recording SPT blow counts, and collecting samples for laboratory analysis, the geotechnical oversight person recorded visual observations or descriptions of the soil at the time of sampling according to ASTM D 2488-87, Standard Practice for Description and Identification of Soils (Visual-Manual Procedures). This system is the conventional soil classification system for geotechnical borings. The logs also include a description of color according to the MunsellTM color chart, texture, and structure or layering of the soil that might not be evident after the soil has been "blended" for transport to the laboratory. Soil geotechnical boring logs are presented in Appendix I. These include field descriptions of the soil encountered, SPT values or blow counts, and relevant laboratory data.

4.1.1.4 Collection of Low Permeability Soil/Sediment Samples

Fine-grained (low permeability) soil/sediment samples were obtained for permeability testing. These samples were obtained in three ways: Shelby tubes, pitcher barrels and sections of core. When the material to be sampled was sufficiently soft and cohesive, an undisturbed samples was collected using a Shelby tube. In cases where the material to be sampled was dense or indurated, an attempt was made to collect a sample using a pitcher barrel sampler (a spring-loaded, stationary tube sampler with a rotating outer barrel and bit). If both of these preferred methods (Shelby tube and pitcher barrel) failed, a section of core was removed and packaged for physical analysis. In the mud rotary borings, core retrieval accomplished by coring the targeted interval using the 94 mm coring system. Consequently, many of the mud rotary borings had some discrete intervals that were cored.

Samples were taken from the dark gray clay at the top of the Williamsburg/Rhems and Green Clay confining units (See Section 5.0 for discussion). Table 4-2 lists the method employed to collect undisturbed soil samples for each boring.

4.1.1.5 Description of Geologic Samples

Detailed geologic logs were prepared in the field (Appendix H). Grain size classification was made by visual comparison to charts according to the modified Wentworth system in accordance with "SRS Hydrogeological Data Collection Procedures" DPSOP 254. Note that this system is different from the ASTM system used for shallow geotechnical borings (Section 4.1.1.3). The Wentworth system is the standard at SRS for characterization and correlation of lithology. The Wentworth grain size classification used is as follows:

Table 4-2
Fine-Grained Soil and Sediment Sample Locations and Depths By Sample Type
Proposed Landfill Site B, Savannah River Site

Boring No.	Sample Technique Employed								
	Shelby Tube			Pitcher Barrel			Core		
	Sample No.	Depth Range (ft)	Recovery (ft)	Sample No.	Depth Range (ft)	Recovery (ft)	Sample No.	Depth Range (ft)	Recovery (ft)
BTP - 5	—	—	—	1 2 3 4	246.5 - 249.0 251.0 - 253.3 266.0 - 268.5 268.5 - 270.5	0.25 0.60 2.45 0.65	—	—	—
BTP-6C	2 3	270.0 - 270.4 272.0 - 272.3	0 0	1	272.4 - 274.5	1.70	—	—	—
BTP-7C	—	—	—	—	—	—	—	262.3 - 263.6 263.6 - 265.9	1.30 2.30
BTP-8C	No Sample - Lost Circulation			—	—	—	—	—	—
BTP-9C	1	260.0 - 260.6	0.80	1	260.6 - 262.6 285.0 - 287.5	0.60 1.10	—	—	—
BTP-10C	1	300.0 - 302.0	1.80	—	—	—	—	250.0 - 251.1 251.4 - 252.4	1.10 1.00
BTP-11C	1	280.0 - 282.5	2.50	—	—	—	—	276.6 - 279.5 283.0 - 285.0	2.90 2.00
BTP-12C	—	—	—	2	181.5 - 183.7	0.80	—	177.0 - 178.5 300.65 - 301.4 302.0 - 303.5	1.50 0.35 1.50

“—” indicates no sample collected or category not applicable.

(continued, p.1 of 2)

Table 4-2
Fine-Grained Soil and Sediment Sample Locations and Depths By Sample Type
Proposed Landfill Site B, Savannah River Site

Boring No.	Sample Technique Employed								
	Shelby Tube			Pitcher Barrel			Core		
	Sample No.	Depth Range (ft)	Recovery (ft)	Sample No.	Depth Range (ft)	Recovery (ft)	Sample No.	Depth Range (ft)	Recovery (ft)
IDB-2CC	1	149.0 - 151.5	1.10	—	—	—	—	163.5 - 164.1	0.60
BSB-2	1	60.0 - 62.0	2.00	—	—	—	—	—	—
BSB-38	—	—	—	—	—	—	—	285.0 - 286.5	1.50
BSB-39	—	—	—	—	—	—	— ?	288.0 - 290.0 290.0 - 291.8	2.00 1.80
BSB-40	—	—	—	—	—	—	—	282.0 - 282.5	0.50
BSB-41	1	160.0 - 160.5	0.50	1 2	160.5 - 162.5 162.5 - 165.0	2.00 1.90	— — — — — —	228.0 - 228.9 243.0 - 244.5 244.8 - 246.2 276.9 - 277.7 284.8 - 286.4 286.4 - 287.7	0.90 1.50 1.40 0.80 0.60 1.30

— indicates no sample collected or category not applicable.

(p.2 of 2)

<u>Classification</u>	<u>Size (mm)</u>
Small Cobbles	64
Very Coarse Pebbles	32 - 64
Coarse Pebbles	16 - 32
Medium Pebbles	8 - 16
Fine Pebbles	4 - 8
Granules (very fine pebbles)	2 - 4
Very Coarse Sand	1 - 2
Coarse Sand	1/2 - 1
Medium Sand	1/4 - 1/2
Fine Sand	1/8 - 1/4
Very Fine Sand	1/16 - 1/8
Silt	1/256 - 1/16
Clay	<1/256

Color was described according to the Munsell™ color chart. Texture, roundness, sedimentary structures, carbonates, fossils and accessory minerals were also noted on the field logs where appropriate. Classification of the fine grained material was made by utilizing the smear and thread test to determine clay and silt content. In the absence of blow-counts, relative terms were utilized to characterize the cohesiveness of the sediments in accordance with DPSOP 254.

4.1.2 Geophysical Logging

Upon completion, each of the coreholes (See Section 4.1.1.1) and the mud-rotary borings (See Section 4.1.1.2) was conditioned for geophysical logging by circulating clean drilling fluid until the sand content in the returning fluid was at a minimum. Geophysical logs were run slowly from the bottom of the borehole upwards. Single point resistivity, long and short

normal electric logs, natural gamma, spontaneous potential and caliper logs were obtained from the deep coreholes and mud rotary holes. The geophysical logger was equipped with digital capture capability to minimize the need for relogging and to provide the ability to adjust parameters, if needed at later dates. The geophysical logs were used in conjunction with the geologic logs for stratigraphic interpretation and piezometer screen interval selection.

4.1.3 Test Pits

Sixteen test pits were excavated at selected representative locations throughout Site B in accordance with the Site B Program Plan. The excavation was carried out by CSWE personnel and equipment (Koehring 1066 Trackhoe) during the period 30 November to 05 December 1990. The test pits were approximately 4 ft by 20 ft by 30 ft deep. The sides of the test pits were photographed and logged from the surface. Bulk soil samples (approximately 50 pounds) were collected from selected soil horizons from the bucket of the excavator. Personnel were not permitted to enter the test pits after the depth exceeded 4 ft, in accordance with SRS and OSHA safety rules. Test pits were backfilled immediately upon completion of sampling and logging. Test pit logs are included in Appendix J of this report.

4.1.4 Piezometer Design Concepts

4.1.4.1 Ground-Water Monitoring Concept

Three configurations of ground-water monitoring piezometers were employed during this hydrogeologic program: a single piezometer per borehole for the "C" piezometer, and two piezometers side by side in a single borehole for the "D"/"DD" clusters. The strategy and procedures for the construction and use of these monitoring devices are included in the project hydrogeologic program plan, and as presented in Table 4-1 (Sirrine, 1990c).

The "D"/"DD" piezometer clusters were comprised of a one-inch "DD" piezometer bracketing the water table and a two-inch "D" piezometer located 10-15 ft below the water table. The purpose of these two piezometers was to enable monitoring of the water table ("DD") and to allow determination of estimated hydraulic conductivity ("D") by the pneumatic method (See Section 4.1.4.3 and Appendix G). These two devices were installed into the same boring. The "D"/"DD" clusters were constructed within 10-15 ft of each "C" piezometer and screen placement was determined based on cuttings descriptions and the geophysical logs from the "C" piezometer boring.

4.1.4.2 Deep (Congaree) Piezometers

The "C" piezometers were set in accordance with DPSOP 254 with the exception of using 2-inch diameter PVC (polyvinyl chloride) casing with centralizers spaced at about 20 ft intervals rather than 40 ft. Figure 4-1 presents the typical construction details of the "C" piezometers. Nine "C" piezometers were constructed. A summary of the construction details for all "C" piezometers is presented in Table 4-3. The design and construction details for each piezometer is provided in Appendix F.

For purposes of comparison and analysis, the construction details of all pertinent "existing" wells proximal to the site are summarized in Table 4-4. This summary covers the IDB, MWD and P-series wells.

4.1.4.3 Water Table Cluster Piezometers

Eleven borings were drilled for water table piezometers during the project, in accordance with the Site B hydrogeologic program plan. Two piezometers were installed in each of these eleven borings. First, a two-inch piezometer ("D") was installed with a ten-ft. screen submerged 10-15 ft below the water table surface. These piezometers were constructed specifically to enable estimation of hydraulic conductivity of the water table aquifer by

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FIGURE 4-1

**TYPICAL CONSTRUCTION-SITE B
 PIEZOMETER TYPE "C"
 (CONGAREE PIEZOMETER)**

SIRRINE JN G-0358.00

Table 4-3
Summary of Piezometer Construction Details-This Study (1)
Proposed Landfill Site B, Savannah River Site

Well Number	SRS Grid Coordinates (2)	Date of Installation	Date Constructed	Depth Drilled (ft)	Top of Casing Elevation (2) (ft msl)	Ground Surface or Pad Elevation (2) (ft msl)	Depth of Screened Interval (ft below ground surface)	Elevation of Screened Interval (ft msl)	Screen Length (ft)	Aquifer Screened
BTP-1D	N74583.50 E75186.67	9/6/90	10/9/90	72.00	296.90	294.00	58.50-68.52	235.50-225.48	10.02	Water Table
BTP-1DD	N74583.50 E75186.67	9/6/90	10/9/90	72.00	296.85	294.00	40.50-50.53	253.50-243.47	10.03	Water Table
BTP-2D	N73421.71 E74770.68	9/18/90	10/8/90	93.00	319.74	317.00	75.50-85.60	241.50-231.49	10.01	Water Table
BTP-2DD	N73421.71 E74770.68	9/18/90	10/8/90	93.00	319.13	317.00	57.50-67.54	259.50-249.46	10.04	Water Table
BTP-3D	N73399.72 E75613.70	9/19/90	10/4/90	76.00	301.93	298.20	62.50-72.52	235.70-225.68	10.02	Water Table
BTP-3DD	N73399.72 E75613.70	9/19/90	10/4/90	76.00	301.94	298.20	44.50-54.53	253.70-243.67	10.03	Water Table
BTP-4D	N72201.16 E76003.97	9/19/90	10/2/90	85.00	302.52	299.90	71.50-81.53	228.40-218.37	10.03	Water Table
BTP-4DD	N72201.16 E76003.97	9/19/90	10/2/90	85.00	302.47	299.90	53.50-63.53	246.40-236.37	10.03	Water Table
BTP-5C	N77091.73 E74098.78	10/2-10/5/90	10/22/90	270.50	305.06	305.10	180.00-190.02	125.10-115.08	10.02	Congaree
BTP-6C	N76596.86 E74402.40	9/10-9/17/90	9/20/90	274.30	308.87	306.80	185.00-195.03	121.80-111.77	10.03	Congaree
BTP-6D	N76610.60 E74409.27	9/10-9/17/90	9/24/90	87.00	309.43	307.10	76.00-86.01	231.10-271.09	10.01	Water Table

- (1) See piezometer construction details (Appendix A).
(2) All horizontal and vertical survey data provided by WSRC.
(3) Pad elevation except where footnote indicates ground surface elevation.

(continued, p.1 of 3)

Table 4-3
Summary of Piezometer Construction Details-This Study (1)
Proposed Landfill Site B, Savannah River Site

Well Number	SRS Grid Coordinates (2)	Date of Installation	Date Constructed	Depth Drilled (ft)	Top of Casing Elevation (2) (ft msl)	Ground Surface or Pad Elevation (2) (ft msl)	Depth of Screened Interval (ft below ground surface)	Elevation of Screened Interval (ft msl)	Screen Length (ft)	Aquifer Screened
BTP-6DD	N76610.60 E74409.27	9/10-9/17/90	9/24/90	87.00	309.42	307.10	55.00-65.07	252.10-242.03	10.07	Water Table
BTP-7C	N76595.14 E75714.42	11/13-11/16/90	11/20/90	310.00	316.36	(3) 313.50	212.00-222.00	101.50-91.50	10.00	Congaree
BTP-7D	N76580.51 E75712.77	11/13-11/16/90	11/26/90	105.00	317.18	(3) 313.60	85.00-95.02	228.60-218.58	10.02	Water Table
BTP-7DD	N76580.51 E75712.77	11/13-11/16/90	11/26/90	105.00	316.73	(3) 313.60	67.00-77.07	246.60-236.53	10.07	Water Table
BTP-8C	N75796.58 E75202.16	8/15-8/23/90	8/24/90	225.00	324.19	322.10	204.94-215.00	117.06-107.10	10.06	Congaree
BTP-8D	N75813.69 E75226.58	8/15-8/23/90	8/28/90	102.00	324.87	322.70	90.00-100.03	232.70-222.67	10.03	Water Table
BTP-8DD	N75813.69 E75226.58	8/15-8/23/90	8/28/90	102.00	324.25	322.70	72.00-82.04	250.70-240.66	10.04	Water Table
BTP-9C	N74794.48 E76202.95	9/26-9/27/90	10/1/90	287.50	295.05	292.90	183.00-193.01	109.90-99.89	10.01	Congaree
BTP-9D	N74805.27 E76213.76	9/26-9/27/90	10/2/90	77.00	294.86	292.80	65.00-75.01	227.80-217.79	10.01	Water Table
BTP-9DD	N74805.27 E76213.76	9/26-9/27/90	10/2/90	77.00	293.92	292.80	47.00-57.07	245.80-235.73	10.07	Water Table
BTP-10C	N74641.88 E74504.29	8/29-8/30/90	9/4/90	300.00	292.92	290.70	166.50-176.52	124.20-114.18	10.02	Congaree

- (1) See piezometer construction details (Appendix A).
(2) All horizontal and vertical survey data provided by WSRC.
(3) Pad elevation except where footnote indicates ground surface elevation.

(continued, p.2 of 3)

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Table 4-3
Summary of Piezometer Construction Details-This Study (1)
Proposed Landfill Site B, Savannah River Site

Well Number	SRS Grid Coordinates (2)	Date of Installation	Date Constructed	Depth Drilled (ft)	Top of Casing Elevation (2) (ft msl)	Ground Surface or Pad Elevation (2) (ft msl)	Depth of Screened Interval (ft below ground surface)	Elevation of Screened Interval (ft msl)	Screen Length (ft)	Aquifer Screened
BTP-10D	N74627.06 E74504.08	8/29-8/30/90	9/6/90	68.00	292.73	290.50	55.00-65.00	235.50-225.50	10.00	Water Table
BTP-10DD	N74627.06 E74504.08	8/29-8/30/90	9/6/90	68.00	292.72	290.50	35.00-45.01	255.50-245.49	10.01	Water Table
BTP-11C	N72992.73 E76499.89	10/29-11/2/90	11/7/90	300.00	293.42	291.30	190.00-200.00	101.30-91.30	10.00	Congaree
BTP-11D	N72983.61 E76488.61	10/29-11/2/90	11/8/90	78.00	293.39	291.10	66.00-76.02	225.10-215.08	10.02	Water Table
BTP-11DD	N72983.61 E76488.61	10/29-11/2/90	11/8/90	78.00	292.57	291.10	48.00-58.06	243.10-233.04	10.06	Water Table
BTP-12C	N72289.15 E74900.85	12/14-12/19/90	12/31/90	310.00	311.15	(3) 308.90	190.00-200.00	118.90-108.90	10.00	Congaree
BTP-12D	N72281.11 E74888.54	12/14-12/19/90	1/3/91	81.00	310.37	(3) 307.60	66.00-76.01	241.60-231.59	10.01	Water Table
BTP-12DD	N72281.11 E74888.54	12/14-12/19/90	1/3/91	81.00	310.08	(3) 307.60	48.00-58.07	259.60-249.53	10.07	Water Table
IDB-2CC	N77223.99 E75394.85	12/09-12/10/90	12/12/90	241.00	307.61	(3) 304.80	228.00-238.01	76.80-66.79	10.01	Congaree

- (1) See piezometer construction details (Appendix A).
(2) All horizontal and vertical survey data provided by WSRC.
(3) Pad elevation except where footnote indicates ground surface elevation.

Table 4-4
Summary of Existing Monitoring Well Construction Details-Previous Installations (1)
Proposed Landfill Site B, Savannah River Site

Well Number	SRS Grid Coordinates	Date of Installation	Depth Drilled (ft)	Top of Casing Elevation (ft msl)	Ground Surface or Pad Elevation (ft msl)	Depth of Screened Interval (ft below ground surface)	Elevation of Screened Interval (ft msl)	Screen Length (ft)	Casing Type	Screen Type	Aquifer Screened
IDB-2A	N77284.38 E75391.13	1/19/88	402.50	304.29	301.78	324.88-330.26	(-23.10)-(-28.48)	5.38	4-in Carbon Steel	0.015-in Slot Stainless Steel	Pee Dee
IDB-2B	N77284.08 E75392.16	1/29/88	200.00	305.69	303.15	182.00-187.02	121.50-116.13	5.02	4-in Sch. 40 PVC	0.015-in Slot PVC	Congaree
IDB-2C	N77243.98 E75393.58	2/2/88	108.00	308.43	304.03	95.53-100.55	208.48-203.48	5.02	4-in Sch. 40 PVC	0.015-in Slot PVC	Lower Water Table
IDB-3	N77008.45 E75022.09	12/1/87	98.00	324.87	322.37	89.00-94.03	233.37-228.34	5.03	4-in Sch. 40 PVC	0.015-in Slot PVC	Water Table
IDB-4	N78134.69 E74922.90	12/4/87	84.00	316.61	314.11	55.21-75.20	258.90-238.91	19.99	4-in Sch. 40 PVC	0.015-in Slot PVC	Water Table
IDB-5	N75570.59 E75488.78	12/7/87	93.00	321.94	319.44	65.00-85.00	254.44-234.44	20.00	4-in Sch. 40 PVC	0.015-in Slot PVC	Water Table
IDB-6	N72691.32 E75264.61	12/10/87	87.30	318.97	316.47	56.25-76.29	260.22-240.18	20.04	4-in Sch. 40 PVC	0.015-in Slot PVC	Water Table
IDB-7	N73511.92 E74450.09	12/16/87	85.00	313.38	310.88	50.10-70.09	260.78-240.79	19.99	4-in Sch. 40 PVC	0.015-in Slot PVC	Water Table
IDB-8	N72016.69 E77061.99	12/17/87	78.00	293.13	290.63	42.00-61.98	248.63-228.65	19.98	4-in Sch. 40 PVC	0.015-in Slot PVC	Water Table
IDB-9	N78124.45 E76398.06	2/5/88	95.70	288.34	285.84	80.40-85.41	205.44-200.43	5.01	4-in Sch. 40 PVC	0.015-in Slot PVC	Water Table
IDB-10	N74955.50 E74405.07	2/8/88	89.00	295.76	293.26	73.00-77.99	220.26-215.27	4.99	4-in Sch. 40 PVC	0.015-in Slot PVC	Water Table

(continued, p. 1 of 3)

Table 4-4
Summary of Existing Monitoring Well Construction Details-Previous Installations (1)
Proposed Landfill Site B, Savannah River Site

Well Number	SRS Grid Coordinates	Date of Installation	Depth Drilled (ft)	Top of Casing Elevation (ft msl)	Ground Surface or Pad Elevation (ft msl)	Depth of Screened Interval (ft below ground surface)	Elevation of Screened Interval (ft msl)	Screen Length (ft)	Casing Type	Screen Type	Aquifer Screened
MWD-1A	N69592.80 E75121.90	5/26/88	275.50	329.49	327.50	205.00-270.10	122.50-57.4	65.10	4-in Sch. 40 PVC	0.015-in Slot PVC	Congaree
MWD-1B	N69611.80 E75114.10	5/18/88	196.00	329.61	327.40	193.60-195.70	133.80-131.17	2.10	4-in Sch. 40 PVC	0.015-in Slot PVC	Green Clay
MWD-1C	N69607.60 E75127.80	4/11/88	181.00	328.61	327.00	119.00-155.00	208.00-172.00	36.00	4-in Sch. 40 PVC	0.015-in Slot PVC	Lower Water Table/McBean
						160.00-170.00	167.00-157.00	10.00	4-in Sch. 40 PVC	0.015-in Slot PVC	Lower Water Table/McBean
MWD-1D	N69598.70 E75108.10	4/6/88	105.00	330.00	327.90	55.00-100.10	272.90-227.80	45.10	4-in Sch. 40 PVC	0.015-in Slot PVC	Water Table
MWD-2A	N69768.80 E75241.10	4/26/88	275.00	324.41	322.70	200.00-265.10	122.70-57.60	65.10	4-in Sch. 40 PVC	0.015-in Slot PVC	Congaree
MWD-2C	N69771.50 E75255.50	4/14/88	181.70	324.28	322.50	120.00-170.10	202.50-152.40	50.10	4-in Sch. 40 PVC	0.015-in Slot PVC	Lower Water Table/McBean
MWD-2D	N69761.40 E75266.60	5/9/88	81.00	324.60	322.50	55.00-75.00	267.50-247.50	20.00	4-in Sch. 40 PVC	0.015-in Slot PVC	Water Table
MWD-3A	N69839.40 E74755.50	5/10/88	284.00	330.84	328.70	205.00-225.00	123.70-103.70	20.00	4-in Sch. 40 PVC	0.015-in Slot PVC	Congaree
MWD-5A	N69234.70 E75490.80	5/6/88	271.90	324.59	322.60	200.60-265.70	122.00-56.90	65.10	4-in Sch. 40 PVC	0.015-in Slot PVC	Congaree
MWD-5C	N69226.80 E75500.20	4/25/88	180.00	325.05	322.80	120.20-170.30	202.60-152.50	50.10	4-in Sch. 40 PVC	0.015-in Slot PVC	Lower Water Table/McBean
MWD-5D	N69220.30 E75486.60	4/1/88	80.00	324.87	323.00	53.50-73.50	269.50-249.50	20.00	4-in Sch. 40 PVC	0.015-in Slot PVC	Water Table

(continued, p. 2 of 3)

Table 4-4
Summary of Existing Monitoring Well Construction Details-Previous Installations (1)
Proposed Landfill Site B, Savannah River Site

Well Number	SRS Grid Coordinates	Date of Installation	Depth Drilled (ft)	Top of Casing Elevation (ft msl)	Ground Surface or Pad Elevation (ft msl)	Depth of Screened Interval (ft below ground surface)	Elevation of Screened Interval (ft msl)	Screen Length (ft)	Casing Type	Screen Type	Aquifer Screened
MWD-8	N70074.00 E75101.60	3/30/88	78.00	325.77	323.70	50.00-70.00	273.70-253.70	20.00	4-in Sch. 40 PVC	0.015-in Slot PVC	Water Table
MWD-9	N68948.90 E75201.00	3/31/88	88.00	322.53	320.60	60.00-80.00	260.60-240.60	20.00	4-in Sch. 40 PVC	0.015-in Slot PVC	Water Table
MWD-10	N69508.70 N75085.60	6/3/88	175.00	330.85	328.90	123.70-169.10	205.20-159.80	45.40	6-in Sch. 40 PVC	0.030-in and 0.015-in Slot PVC	Lower Water Table/McBean
MWD-11	N69475.50 E75067.90	6/17/88	268.00	330.84	328.90	204.50-265.00	124.40-63.90	60.50	6-in Sch. 40 PVC	0.030-in and 0.015-in Slot PVC	Congaree
P-14C	N72420.00 E76424.60	NA	186.41	295.03	293.78	145.00-155.00	148.78-138.78	10.00	4-in Sch. 80 PVC	0.018-in Slot PVC	Lower Water Table/McBean
P-14TC	N72432.50 E76432.10	N/A	507.00	295.91	293.49	490.00-500.00	(-196.51)-(-206.51)	10.00	4-in Carbon Steel	0.018-in Slot Stainless Steel	Pee Dee
P-14TB	N72453.90 E76425.70	N/A	572.00	295.81	293.56	555.00-565.00	(-261.44)-(-271.44)	10.00	4-in Carbon Steel	0.018-in Slot Stainless Steel	Black Creek
P-14TA	N72444.90 E76439.60	N/A	850.00	295.73	293.44	816.83-840.00	(-523.93)-(-548.56)	23.17	4-in Carbon Steel	0.018-in Slot Stainless Steel	Middendorf

(1) IDB well information compiled from "Site Characterization Studies for the Proposed Waste Management Facilities at the Savannah River Plant, Aiken, South Carolina", Simine Environmental Consultants (Job No. F-1385), Greenville, South Carolina, July 1989.

MWD well information compiled from "Savannah River Plant 600-G Area, Hazardous/Mixed Waste Disposal Facility, Hydrogeologic Characterization, Phase One Summary and Recommendations," Chas. T. Main, Inc., Charlotte, North Carolina, October 1988. Also compiled from "Environmental Protection Well Inventory (U)", Environmental Protection Department Environmental Monitoring Section, Westinghouse Savannah River Company, Savannah River Site, Aiken, South Carolina, March 1990.

P well information compiled from "Installation of Deep Observation Well Clusters p. 13, p. 14, and p. 15, Savannah River Plant, Aiken, South Carolina", Geraghty & Miller, Inc., Aiken, South Carolina, August, 1984.

pneumatic slug testing technique (See Section 4.1.6). A requirement for pneumatic slug testing is a totally submerged piezometer intake. These submerged piezometers are designated with a "D" label, e.g. BTP-1D.

In the same boring, a one-inch piezometer ("D") was installed with screen placement bracketing the water table. The shallow (bracketing) piezometers are designated with a "DD" label, e.g. BTP-1DD.

A bentonite seal between the base of the upper piezometer and the intake of the lower piezometer was constructed to hydraulically separate the two piezometers within the confines of the borehole. A filter pack was installed around each screen and the borehole annulus was grouted to ground surface above the bentonite seal for the or upper piezometer. A detailed diagram of the construction of the water table piezometers is included as Figure 4-2. Table 4-3 summarizes piezometer construction details for the "D"/"DD" series. Design and construction details for each piezometer is provided in Appendix F.

4.1.5 Piezometer Development

The development of all piezometers constructed as a part of this study was carried out under the direction of the Groundwater Monitoring Group of WSRC-EPD. Piezometer development was carried out by WSRC subcontract drillers according to WSRC standard methods. Each of the piezometers was developed with compressed air using a reverse flow method. As employed by WSRC-EPD, this method utilizes filtered, oil-free air, which is pumped and surged in the screened area of the piezometer for 8 to 12 hours. This development activity was continued until the water from each piezometer became visibly free of turbidity and indicator parameters stabilized. Water samples were taken before initiating the development procedure and at the end of the process. These water samples

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FIGURE 4-2

TYPICAL CONSTRUCTION-SITE B
PIEZOMETER TYPES "D" AND "DD"
(WATER TABLE PIEZOMETERS)

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were tested for pH, specific conductivity, and temperature by the WSRC-EPD Ground Water Monitoring Group. Well development records are on file at SRS Building 772-7B (Contact Janelle Janssen (803)952-7648).

4.1.6 Characterization of Aquifer Hydraulic Properties

Hydraulic conductivity tests were conducted by the pneumatic slug test method in each of the "C" and "D" series piezometers. The scope at this project did not allow for pump tests or aquifer tests. The scope of this project did not allow for pump tests or aquifer tests. Also, the small diameter of the 2-inch piezometers, the extended distances between them, and the small available drawdown in the water table piezometers precluded multiple well aquifer tests.

The pneumatic method of McLane et al., (1990) was used for slug testing of the "C" and "D" piezometers. The concept and methodology employed in this procedure is described in detail in Appendix G.

Equipment required for the pneumatic slug test method included:

1. A pneumatic well head assembly capable of providing an air-tight seal with a pressure/vacuum port, a quick release valve, and the capacity to accommodate a transducer cable and water level indicator tapes;
2. An oil-free air compressor capable of supplying positive or negative pressure;
3. An In-Situ, Inc. Hermit 1000 electronic data logger with transducer. (Note: The published procedure for the pneumatic slug test calls for two water level indicators. However, the capabilities of the Hermit data logger eliminate the need for a second indicator, thus simplifying the hardware requirements).

4. All slug testing equipment in contact with the piezometers and ground water was decontaminated between measurements according to DPSOP-254 protocols (See Section 4.1.7).

4.1.7 Ground-Water Sampling

Ground-water samples were collected from selected wells and piezometers on and around the proposed landfill site. The objective of this sampling was to define the geochemistry of the aquifer and to screen the ground water for existing contamination. To assure that analytical results meet SRS standards, sampling, preservation, shipping, and analytical procedures were performed in accordance with requirements of the "SRS Hydrogeological Data Collection Procedures", (DPSOP-254).

The field sampling program was designed to collect samples from selected wells and temporary piezometers in the area under consideration for use as a landfill (west of E-2 Road). The sampling plan called for sampling the P-14 and IDB series wells, and the BTP-C and BTP-D series temporary piezometers.

All decontamination procedures were conducted in accordance with DPSOP-254 protocols. Standard submersible pump sampling procedures were followed for purging and sampling of the IDB and P series wells. When sampling the BTP series piezometers and IDB-2CC, standard bailer sampling protocol was followed. Appropriate sampling and equipment decontamination protocols were employed to minimize any possibility of cross-contamination. Before each bailing and sampling activity, new vinyl gloves were donned, bailers were decontaminated, and a new poly-rope was attached to the bailer. A sheet of plastic was laid on the ground around each temporary piezometer to ensure that the rope and bailer did not come into contact with the ground. All wells and piezometers were purged of stagnant water prior to sampling. For wells in the P-14 series and IDB series, purging was accomplished with dedicated submersible pumps. The temporary piezometers

(BTP series) were purged and sampled with a bailer. Wells and temporary piezometers were purged until pH, temperature and conductivity stabilized. All wells and temporary piezometers were sampled within 24 hours of completion of purging.

Standard sampling order was followed with the volatile organic (VOA) samples collected first. The well sampling activities and field data were recorded on Field Data Information Logs for Ground-Water Sampling Forms.

Prior to sampling, all wells were developed to the standards of the SRS Groundwater Monitoring Program (DPSOP-254). As is often encountered in sampling of wells a water produced during purging sampling was turbid. During the purging and sampling process, ground water removed from the wells (discharge water) cleaned up significantly or completely, except at BTP 4D, where ground water remained turbid. A review of the geologic log for BTP-4D reveals that the piezometer is open to a stiff sandy clay unit. This is a reasonable explanation for the turbidity in the sample water. The turbidity had no apparent impact on the analytical results.

All ground-water sample containers were filled directly from the bailer, then properly sealed, packed, and preserved on ice in pre-chilled coolers in the field. All sample handling, preservation, shipping and control was carried out in accordance with DPSOP-254, SW-846 (USEPA, 1982), and other appropriate parameter-specific protocols as identified in Appendix K. Strict adherence to these procedures is documented by chain-of-custody forms (Appendix K).

Each container was pre-prepared with preservatives appropriate to the parameters to be analyzed. Next, the appropriate chain-of-custody record and request for analysis forms were completed and enclosed in the appropriate coolers. After clearance through WSRC, the ground-water samples were shipped to IT Corporation Laboratory in Earth City, Missouri.

Quality Assurance/Quality Control samples included replicate (duplicate) samples and various blanks. While sampling at BTP-6C a field blank and rinsate sample were taken. A trip blank also accompanied these samples. In addition, eight replicate samples were taken, four from "C" wells and four from "D" wells. Of these wells, 11-C and 12-D are upgradient of the site.

In addition to collection of samples for laboratory analyses, water levels, and several physical/chemical parameters were measured in the field. Field measured parameters included temperature, pH, specific conductance and turbidity. All field and analytical results are presented in Section 7.

During the course of field work, operational variances were encountered on some of the existing wells which prevented collection of all information desired for this study. These variances included inability to obtain a water contact in the water level drop pipe (for wells equipped with pumps), and/or pumps which were inoperable or had discharge rates inadequate to purge the well. These variances were reported to SED for corrective action. As a result of these operational problems, no samples were collected from wells IDB-3, IDB-4, IDB-6, IDB-8, IDB-1A, IDB-1B, and P14C.

4.2 Ground-Water Analyses

4.2.1 Ground-Water Quality Analytical Program

The analytical program was designed to address the two primary goals, to characterize aquifer geochemistry and to screen the ground water for any potential contamination. The precedent for this analytical program for the proposed landfill site is the program already used at the existing SRS sanitary landfill. Table 4-5 presents the ground-water parameters analyzed for Site B.

Table 4-5
Parameters for the Site B Ground-Water Chemistry Characterization Program
Proposed Landfill, Savannah River Site

SRS Analytical Group	Parameter	Category
Group I	Arsenic Barium Cadmium Chromium Lead Mercury Selenium Silver Fluoride Nitrate Gross Alpha Gross Beta Total Radium 2,4-Dichlorophenoxyacetic Acid Endrin Lindane Methoxychlor Silvex Toxaphene	Metal Metal Metal Metal Metal Metal Metal Metal Inorganic Inorganic Radiological Radiological Radiological Pesticide/Herbicide Pesticide/Herbicide Pesticide/Herbicide Pesticide/Herbicide Pesticide/Herbicide Pesticide/Herbicide
Group II	Chlorine Iron Magnesium Phenols Sodium Sulfate	Inorganic Metal Metal Organic Metal Inorganic
Group III	pH Conductivity Total Organic Carbon Total Organic Halogens	Indicator Indicator Organic Organic
Other Analyses	Calcium Copper Nickel Ammonia Total Phosphate Tritium Volatiles	Metal Metal Metal Inorganic Inorganic Radiological Organic

(1) Pesticides/Herbicides

For aquifer geochemical characterization, analysis of the major ions typically found in ground water was specified. Major cation analyses in the program included calcium, sodium, silica, magnesium and iron. Major anions include chloride, sulfate, nitrate, and total phosphates. These geochemical parameters were complemented by a group of water quality parameters of regulatory concern as presented in Groups I and II in Table 4-5. Some overlap exists between the first two groups as some naturally-occurring species (major ions) impact water quality if present in large concentrations. The third analyte group shown in Table 4-5 is the contaminant indicator parameters. Typically, baseline values for these parameters are set during the characterization phase of a potential waste management site. These analyses are continued after operation begins to screen for waste site impacts to ground water. Finally, the "other analyses" listed in Table 4-5 are indicator parameters and other contaminant parameters analyzed to screen for impacts that could be related to prior agricultural land use or introduction of other man-made constituents, for example, phosphate and pesticides/herbicides.

4.2.2 Analytical Procedures

The SRS subcontractor laboratory analyses are performed according to the standards of EPA Test Methods for Evaluating Solid Waste (SW-846), unless more extensive standards (e.g., CLP) are warranted. Analyses for this project were performed by International Technologies (IT) Laboratories (formerly Metatrace), according to DPSOP-254 and SW-846 standards. The specific method used for each analysis is identified in Appendix K-2. Examples of the chain-of-custody records are included in Appendix K-6 and of the request for analysis forms are include in Appendix K-7. Official copies of all chain-of-custody and analytical processing forms for this project are in the files of the WSRC site custodian.

4.2.3 Quality Assurance/Quality Control

A program of quality control and validation was developed for utilization throughout the ground-water characterization program. In addition to performing sampling, collection, preservation, and custody documentation of samples as described above, various samples were collected during the investigation to provide quality control to support interpretation of the chemical data. These samples included field duplicates, field blanks, and rinsate blanks.

Duplicate samples provide information on precision of the analytical process. Duplicates were selected at random by the on-site coordinator and submitted as blind samples to the laboratory for analyses. Seven duplicate samples were collected in this investigation and analyzed for selected parameters identical to the primary samples.

Field blanks are samples of deionized or analyte-free water that are poured into a sample container and handled in the same manner as the unknown sample. The purpose of these samples is to identify possible sources of contamination during collection, preservation, shipping, or handling.

Rinsate blanks are defined as samples which are obtained by rinsing the sample collection equipment (bailer, pump, auger, etc.) with analyte-free deionized water after decontamination, and placing the rinsate water in appropriate sample containers for analysis. These samples are used to determine if decontamination procedures have been effective to standards. Two rinsate blanks were collected and analyzed for total cyanide and metals in accordance with the site hydrogeologic program plan.

The results of the Quality Assurance program are reported in Section 7.1.1.

4.3 Geotechnical Laboratory Analyses

A variety of baseline soil classification analyses and geotechnical measurements were conducted on soil and sediment samples collected from Site B. As presented in Table 4-2, undisturbed samples were collected by several methods as well as bulk and split-spoon samples. Samples of all three types were tested for particle-size distribution (sieve and hydrometer) and Atterberg Limits.

These basic tests were employed to confirm the field classification of the soils according to ASTM Method D-2487 (Unified Soil Classification System or USCS), and to provide more detailed characterization data on soil physical properties. The methods for these tests are described in detail in Appendix L-5.

Selected low-permeability samples representative of fine-grained soils at Site B were also tested for permeability. Samples of the bulk soils were selected for determination of Standard Proctor Density.

A description of all geotechnical analytical methods employed in this study is provided in Appendix L-5. Other tests run on selected representative samples included Specific Gravity, Initial Moisture Content, Cation Exchange Capacity and Organic Matter Content. The results of all soil geotechnical testing is presented in Section 8.

5.0 REGIONAL AND SITE GEOLOGY

5.1 Regional Geology

The sediments of the Atlantic Coastal Plain in South Carolina are stratified sand, clay, limestone and gravel that dip gently seaward and range in age from Late Cretaceous to Recent. The sediments form a seaward thickening wedge that is essentially zero ft thick at the fall line to more than 4,000 ft thick at the coast.

Members of twelve geologic formations within the Upper Coastal Plain sediments are recognized in the subsurface in the central portion of the Savannah River Site (DWPF-SAR, 1990). These formations are listed below from deepest to shallowest and a very brief summary of the typical lithologies is presented.

- Cape Fear - poorly sorted, silty to clayey quartz sands and interbedded clays.
- Middendorf - mostly medium to coarse quartz sand with pebbly zones common.
- Black Creek - quartz sands, silts and clays, more micaceous and lignitic than other Cretaceous units.
- Pee Dee - light colored sands and highly colored clays.
- Rhems - gray, poorly sorted micaceous, lignitic, silty and clayey quartz sands interbedded with gray clays.
- Williamsburg - silty, medium to coarse grained quartz sand interbedded with clay.
- Congaree - yellow, orange, tan, gray and greenish gray, well sorted, fine to coarse quartz sands.
- Santee - carbonates, calcareous quartz sands, quartz sands, glauconitic sands and clays.
- Clinchfield - quartz sand.
- Dry Branch - a carbonate member and a quartz sand member.

- Tobacco Road - moderately to poorly sorted red, brown, tan, purple and orange quartz sands.
- Upland Unit - poorly sorted, clayey to silty sands with lenses and layers of conglomerates, pebbly sands and clays.

5.2 Site B Geology

Correlation to recognized geologic units was done for this study only to the extent necessary to support the regional continuity of identified aquifers and aquitards.

5.2.1 Units Encountered

Geologic data were collected at Site B using 41 shallow borings and 13 deeper borings. Three borings were continuously cored from ground surface to depths ranging from 340 to 359 ft below ground surface. Previous investigations included a boring located at the northern end of the site that was drilled into the Upper Cretaceous age sediments (IDB-2A), and a boring located in the southeastern portion of the site that was drilled into the Cape Fear Formation (P-14TA), both of which were cored continuously. In addition, several continuously sampled borings were drilled in the extreme southern portion of the site (MWD series). Geologic cross sections were constructed using these data to evaluate the subsurface conditions at the site.

During this study, 41 shallow (to a depth of 50 ft or less) geotechnical borings (BSB 1-37 and BTP 1-4) were drilled across the site and sixteen test pits (BTX 1-16) were excavated. The information from these borings and excavations was also used in constructing the geologic sections. The cross sections are included as Figures 5-6 through 5-9, discussed later in this Section. Recognized stratigraphic units encountered at Site B, during this and previous investigations, are described in the following paragraphs, from deepest to shallowest. Table 5-1 summarizes the major geologic units important to this study and their approximate elevations at the Site.

Table 5-1
Elevations and Significant Confining Units
Proposed Landfill Site B, Savannah River Site

Boring Number	Green Clay (ft msl)	Williamsburg/Rhems (ft msl)
BSB 38	147.2 to 132.0	65.7 to 16.0
BSB 39	149.9 to 135.9	74.9 to -3.0
BSB 40	142.0 to 123.0	41.0 to -2.0
BSB 41	147.0 to 130.0	70.0 to 5.0
BTP 5C	154.0 to 138.0	87.0 to 33.5 (BOE) (1)
BTP 6C	152.0 to 134.0	80.0 to 32.4 (BOE)
BTP 7C	145.0 to 132.0	53.5 to 27.5
BTP 8C	150.8 to 131.8	--- (2)
BTP 9C	153 to 139	71 to 5.4
BTP 10C	151.7 to 130.7	71 to -11
BTP 11C	141.0 to 124.0	70.0 to -0.0
BTP 12C	139.4 to 120.0	52.0 to -1.1 (BOE)
IDB 2A	161.0 to 138.0	60.3 to 30.0
MWD 2A	138.2 to 127.0	52.2 to 47.2 (BOE)
MWD 5A	140.0 to 128.0	51.0 to 2.8 (BOE)
P 14TA	137.0 to 121.0	70. to -3.0

(1) BOE denotes bottom of exploration.

(2) Unit not reached.

At well P-14TA, drilled in 1984, the Cape Fear, Middendorf, Black Creek and Pee Dee Formations were encountered. The Cape Fear consists primarily of medium to dark gray, fine grained sand with dark gray clay. The top of the Cape Fear Formation was encountered at a depth of 842 ft below land surface. The P-14TA boring was terminated eight ft into it.

Overlying the Cape Fear, is the Middendorf Formation which was encountered at a depth of 640 ft. It is 202 ft thick (-350 to -550 ft msl) at this location. This unit consists primarily of thick, variegated, brown, gray, red, and tan clay with gray to brown, silty fine to very coarse sands with zones of granules and pebbles (G&M, 1984). Several distinct clay layers occur within the Middendorf, with the thickest at the top of the unit from 640 to 660 ft below ground surface (-350 to -370 ft msl).

The top of the Black Creek Formation, which overlies the Middendorf, was encountered at P-14TA at a depth of 515 ft below ground (-220 ft msl). The unit is 125 ft thick extending to a depth of 640 ft, (-350 ft msl), and consists of gray to dark gray, medium to coarse quartz sands interbedded with medium to dark gray, micaceous clays up to eleven ft thick (G&M, 1984).

Above the Black Creek is the Pee Dee Formation. The Pee Dee was encountered in P-14TA (1984) and in IDB-2A (1989), at the southern and northern ends of Site B, respectively. At P-14TA, the Pee Dee is 198 ft thick, extending from 317 to 515 ft below ground (25 to -220 ft msl). It is described as light to dark gray, medium to very coarse, quartz sand with white to light gray kaolinitic clays. At IDB-2A the top of the Pee Dee was encountered at a depth of 322 ft (-20 ft msl). The unit is at least 80 ft thick extending to a depth of 402 ft (-100 ft msl) where the boring was terminated. It was described as a light to medium gray, fine to medium grained quartz sand, with minor amounts of clay and silt, interbedded with light to dark gray, micaceous clays.

Overlying the Pee Dee Formation at Site B, is a sequence of interbedded sands and clays. The sediments are generally light to dark gray in color, micaceous and lignitic. The clays are plastic and of low permeability. This sequence of sands and clays was identified as the Williamsburg and Ellenton Formations (Bledsoe, 1984) and as the Ellenton Formation (Sirrione, 1989). After review of recently published documents related to the geology of the SRS, it was concluded that this geologic sequence of dark gray clays and sands is probably correlatable to the Williamsburg and Rhems Formations as described in DPSTA-200-10, SUP 20, "Safety Analysis Report, Defense Waste Processing Facility", 1990.

Delineation of the tops and bottoms of the Williamsburg and Rhems Formations focused on the sequence as a confining unit. The profile of this confining unit consists of an upper clay and lower clay of varying thickness with sand layers sandwiched in between. No attempt was made to pick the contact between the formations. The unit is referred to in the remainder of this report as the Williamsburg/Rhems confining unit, although the top may not correlate precisely with the top of the Williamsburg stratigraphic unit nor the bottom with the base of the Rhems stratigraphic unit. Figure 5-1 portrays the surface configuration of the Williamsburg/Rhems confining unit as observed at Site B. Figure 5-2 presents isopach data for this unit.

During the Site B field investigation, twelve borings were drilled into or through the Williamsburg/Rhems confining unit. The top of the unit occurs at depths ranging from about 215 to 235 ft (elev. 87.0 to 44.0 ft msl) and the base from 290 to 320 ft (elev. 27.5 to -9.1 ft msl). The thickness ranges from about 26 to 84 ft and averages about 55 ft.

The Congaree Formation overlies the Williamsburg/Rhems unit at the site and has been extensively investigated during this and previous studies. The full thickness of the Congaree Formation was sampled in three borings (BSB 38, 39 and 40) during the recent exploration program. The Congaree consists of a green to orange, moderately well sorted, fine to coarse-grained sand, with minor amounts of silt and clay. The top of the Congaree

FIGURE 5-1
SURFACE CONFIGURATION
OF THE WILLIAMSBURG/
RHEMS CONFINING UNIT
SITE B SHCR
-SAVANNAH RIVER SITE-
CONTOUR INTERVAL = 10 FT

- HDB & MWD WELL SERIES
- ▲ BSB LANDFILL BORINGS
- BTP PIEZOMETERS
- BIX LANDFILL TEST PITS
- INVESTIGATIVE SITE BOUNDARIES
- - - PROPOSED LANDFILL LOCATION
- NOTE: ALL ELEVATIONS MSL DATUM

PLANT
NORTH

TRUE
NORTH

0 100 200

SIRRINE
ENVIRONMENTAL
CONSULTANTS

Greenville, South Carolina

was encountered at depths ranging from 165 to 175 ft (elev. 149.8 to 121 ft msl) and the base of the Congaree was found at depths between 215 to 235 ft below ground (elevations 175.5 and 190.7 ft msl). The average thickness of the Congaree is about 70 ft. The Congaree Formation at Site B dips to the southeast at approximately 22 ft/mile.

Above the Congaree Formation, lies the Santee Formation. The basal member of the Santee is a tight, sandy clay layer, 8 to 20 ft thick. This sandy clay is the Caw Caw member (DWPF-SAR, 1990), and has been called the Green Clay in many previous reports and will be referred to by that name in this report. The top of the Green Clay was encountered at depths ranging from 160 ft msl (elev. 160 ft msl) under the northwestern end of the site to 180 ft (elev. 140 ft msl) under the southeastern end of the site. Figure 5-3 presents the surface configuration of the Green Clay as observed at Site B. Figure 5-4 provides isopach data for this unit.

The remaining portion of the Santee Formation overlying the Green Clay is a fine to medium grained, white to pale green sand with some shell fragments. This sandy unit occurs between 130 and 190 ft (185 - 136 ft msl) and ranges in thickness from 24 to 49 ft.

Overlying the Santee Formation is the Dry Branch Formation. The unit consists of fine to medium grained, yellowish orange sand with frequent spots of manganese oxide and occasional thin clay lenses. The formation is about 38 to 48 feet thick and occurs from 92 - 113 ft (217 to 210 ft msl).

Above the Dry Branch, the Tobacco Road Formation was encountered. A thin bed of flat, quartz pebbles was noted in several borings at Site B between 90 and 110 ft below ground surface (elev. 210 to 220 msl). This pebble bed is believed to mark the base of the Tobacco Road Formation (Huddleston and Hetrick, 1986). The unit consists predominantly of red to purple, fine to medium sands and sandy clays interbedded with purple and red clays. A thick, 10 to 20 ft sandy clay occurs near the top of the unit.

The top of the Tobacco Road Formation was identified in only one boring, BSB 39, in this study. It is characterized by a cobble layer that also marks the base of the Upland unit. This cobble layer was noted at a depth of 30 ft (279 ft msl). Based on the regional dip, the top of the Tobacco Road Formation probably ranges from about 290 to 260 ft msl which would be about 10 to 60 ft deep.

The Upland Unit at BSB-39 is described as a very fine to medium grained, clayey sand. It probably occurs at or just below the surface down to 30 to 40 ft. The unit is overlain by one or more soil horizons and it is typically difficult to distinguish the contact between the Upland unit and the overlying soils. The stratigraphic and lithologic conditions observed at Site B are portrayed in four geologic cross-sections (Figures 5-6 to 5-9). The locations of these geologic cross-sections are shown in Figure 5-5. Large scale presentations of these four cross-sections are provided in Appendices B, C, D and E.

5.2.2 Structural Geology

Field data from the Site B investigation and other recent investigations were reviewed extensively to determine if there were any evidence of faulting in the post Cretaceous sediments. Structure contour maps of the top of the Green Clay and Williamsburg/Rhems confining units, included in this report, indicate that these units follow the regional dip and no unusual features were noted, (Figures 5-1 and 5-3). Additionally, no obvious evidence of offset or displacement is evident in the four geologic cross sections (Figures 5-6 through 5-9).

5.2.3 Calcareous Units

Calcareous material was encountered in two previously drilled borings at Site B, IDB-2A and P-14TA. In IDB-2A, from 90 to 132 ft below ground (elev. 212 to 170 ft msl) a zone was encountered that was described as five ft of cemented, fragmented shells overlying

H

G

F

E

D

C

B

A

A

APPROX. N64°W

H

G

F

E

D

C

B

A

B

APPROX. N38°W

A

APPROX. S41°W

calcareous clayey sand. At P-14TA, the carbonate zone was encountered from 146-156 ft below ground (elev. 157 to 137 ft msl) and was described as fossiliferous limestone with sand and clay.

During the recent Site B field operations, limey sand and shell fragments and calcite cemented sandstone were encountered in BTP-9C from 115 to 135 ft below ground (elev. 177 to 157 ft msl). At BTP-10C, shell fragments and calcite cemented sandstone were encountered from 115 to 135 ft below ground (elev. 175 to 155 ft msl). Circulation loss was not encountered at either of these two borings.

At BTP-8C, circulation was lost at 125 ft below ground surface (elev. 197 ft msl) and never regained. The borehole was completed to a total depth of 225 ft. The position of this zone correlates with the carbonate material encountered in the other borings mentioned.

There are several conclusions that can be drawn about this carbonate zone. First, the zone is variable, lithologically and in terms of permeability. Secondly, the unit is an interfingering sequence rather than a thick, consistent, planar bed. Lastly, and most importantly, the carbonate section is deeper than 50 ft, throughout site B. The significance of the final conclusion, is that the proposed regulatory guidance advises against limestone exhibiting secondary permeability, within 50 ft of the base of the proposed landfill.

5.2.4 Depth to Bedrock

Bedrock has not been encountered in any boring drilled at Site B. The deepest well drilled during all of the studies was P-14TA, which was drilled to a total depth of 850 ft below land surface, into the Cape Fear Formation. A regional map depicting the surface of the basement rock under the entire Savannah River Site is included as Figure 5-10. Based on the regional contours, the top of bedrock is estimated to occur at depths ranging from 1,000 to 1,100 ft. (-800 to -700 ft msl).

6.0 REGIONAL AND SITE HYDROGEOLOGY

6.1 Regional Hydrogeology

The Coastal Plain sediments constitute a multilayered hydrologic system consisting of both aquifers and confining beds. Ground-water flow paths and flow velocities are governed by the aquifer hydraulic properties, geometry, and the locations of recharge and discharge areas. In general, the aquifers are composed of predominantly sandy material whereas aquitards are the clay and silt-rich beds. Locally discontinuous aquitards frequently occur within aquifers.

The geologic formations described in Section 5.0 are discussed in terms of their water bearing characteristics and their significance as sources of water supply in the following paragraphs.

The Cape Fear Formation consists primarily of relatively low permeability clay and therefore acts hydraulically as a confining bed. The Cape Fear Formation is not used as a source of water. The Middendorf, overlying the Cape Fear, is a regionally significant aquifer throughout the Upper Coastal Plain. Wells screened in the Middendorf are reported to produce as much as 3,000 gpm (Logan and Euler, 1989). At the SRS, ground water in the Middendorf aquifer generally flows from north to south and southwest toward the Savannah River, which is a discharge area for the aquifer.

Overlying the Middendorf aquifer is the Black Creek aquifer. Like the Middendorf, the Black Creek is a regionally significant aquifer and provides drinking water to a large geographic area. The hydraulic conductivity of the Black Creek in the SRS vicinity has been reported at 90 ft/day (Logan and Euler, 1989). Wells screened in the aquifer at the SRS are capable

of producing 500-600 gpm. Ground water in the Black Creek Formation at the SRS, flows from north to south/southwest toward the Savannah River, which is a discharge area for the aquifer.

The Pee Dee Formation overlies the Black Creek in the Upper Coastal Plain. The Pee Dee is commonly hydraulically connected to the Black Creek and overlying sediments and is not considered a single aquifer. No water supply wells are reported to be screened solely in the Pee Dee Formation in the vicinity of the SRS.

Overlying the Pee Dee Formation are the Williamsburg and Rhems Formations. As described in Section 5.0, these two formations consist of mostly clay with some sand interbeds and are usually considered to be aquitards. Clay beds within these formations have low reported permeabilities. For example, vertical hydraulic conductivities of 6.30×10^{-8} cm/sec (monitoring well P-27TB) and 1.4×10^{-8} cm/sec (monitoring well P-19) have been reported on-site. Additionally, hydraulic heads in the aquifers underlying these formations are frequently higher than the hydraulic heads in the overlying Congaree aquifer. This upward hydraulic gradient along with the low permeability, indicate that the Williamsburg and Rhems Formations act as a significant confining bed.

The Congaree aquifer, which overlies the Williamsburg/Rhems confining bed, yields significant quantities of water and at the SRS is a relatively prolific aquifer. Well yields as high as 660 gpm with 50 ft of drawdown have been obtained near the center of SRS (Siple, 1967). Municipal wells screened in the Congaree aquifer at Barnwell yield as much as 400 gpm (Logan and Euler, 1989).

The only drinking water supply wells screened in the Congaree aquifer at the SRS are at the Site perimeter patrol barricades. Throughout the central portion of the SRS, the Congaree aquifer flows toward either Upper Three Runs Creek or the Savannah River, which are discharge areas.

Above the Congaree aquifer is a laterally extensive confining bed referred to as the Green Clay. This clay layer is continuous over at least the southeastern two-thirds of the SRS (Logan and Euler, 1989).

Vertical head differences across the Green Clay have been observed to be as much as 80 ft. Many undisturbed samples have been collected from the Green Clay at the SRS for characterization. Vertical hydraulic conductivity for these materials is commonly reported in the range of 10^{-8} to 10^{-10} cm/sec.

Above the Green Clay, ground water occurs in the Santee, Dry Branch and Tobacco Road Formations. Ground water in these formations commonly occurs under water table conditions and there is generally hydraulic connection between them. Discontinuous, low permeability, clay layers are common throughout the water table aquifer and they can serve to confine the ground water occurring beneath them, on a local basis. The Tan Clay, recognized in the central SRS, is the most extensive of these locally significant clay layers and head changes of eight to ten ft have been reported between the saturated units above and below it.

Where the Tan Clay is continuous enough to provide hydraulic separation, the aquifer beneath it has been referred to as the McBean. The McBean aquifer is typically comprised of the Santee and Dry Branch Formations. Hydraulic conductivity estimates of between 0.13 and 136.0 ft/day have been reported for the McBean in the General Separations Area of the SRS, (WSRC, 1990). A pumping test conducted in the McBean aquifer at Site B yielded an average hydraulic conductivity of 1.64 ft/day and average transmissivity of 858 gpd/ft² (C.T. Main, 1988). This wide range of values is indicative of the variable lithologies encountered in the aquifer.

In cases where the Tan Clay is discontinuous or non-existent, ground water in the Santee, Dry Branch and Tobacco Road Formations occurs as a water table aquifer. Hydraulic conductivity values between 0.05 and 45.5 ft/day have been reported for the Water Table aquifer in the General Separations Area (WSRC, 1990). As for the McBean, this wide range of values is indicative of the variable lithologies encountered in the aquifer.

At the SRS, no water supply wells are known to be screened in the water table aquifer or the McBean aquifer. Outside of the boundaries of the SRS, rural domestic and light industrial wells are screened in these aquifers (Logan and Euler, 1988).

6.2 Site B Hydrogeology

6.2.1 *Identification of Hydrologic Units*

6.2.1.1 Pee Dee Aquifer

Two monitoring wells are screened in the Pee Dee aquifer at Site B, IDB-1A and IDB-2A. Horizontal hydraulic conductivity of the unit was estimated to be 7.6×10^{-3} cm/sec from a slug test at IDB-2A. Head measurements made at these two wells on 2/19/91 were 188.21 ft msl at IDB-1A and 187.71 ft msl at IDB-2A. The generalized configuration of the Pee Dee potentiometric surface is presented in Figure 6-1.

6.2.1.2 Williamsburg/Rhems Confining Unit

The Williamsburg/Rhems confining unit averages 55 ft in thickness under Site B. Undisturbed samples of the confining unit were collected during recent field operations and sent to a geotechnical laboratory for analysis of physical and chemical properties. Properties tested for were cation exchange capacity, organic content, vertical hydraulic conductivity, grain size distribution and natural moisture content. Results indicate that the

confining unit has a high cation exchange capacity (approximately 50 meq/100 grams), a high organic content (approximately 9.8%), and a low hydraulic conductivity (7.98×10^{-10} to 2.27×10^{-8} cm/sec). Table 4-2 presents information on the sample depths and laboratory tests conducted. Test results are included in Table 8-1. The character and extent of the Williamsburg/Rhems unit is graphically depicted in Figures 5-6 through 5-9, the geologic cross sections.

Two samples collected at BTP-9C and one sample collected at BTP-10C of the intervening sandy layers within the confining unit, yielded vertical hydraulic conductivities from 1.29×10^{-7} to 1.19×10^{-6} mc/sec. Vertical hydraulic conductivity estimates (Kv) are presented on the cross sections.

6.2.1.3 Congaree Aquifer

The Congaree aquifer at Site B occurs under confined conditions. The potentiometric surface of the Congaree ranges in elevation from 190 to 178 ft msl and ground water within the aquifer flows to the northwest toward Tinker Creek. Geologic data collected at Site B indicate that the confining layer above the Congaree (Green Clay) is incised by Tinker Creek which would cause the aquifer to discharge, at least in part, into the creek (Figure 6-2).

Eight of the BTP piezometers, installed during the recent field investigation, are screened in the Congaree aquifer. At one location on Site B, there is a piezometer cluster that has a piezometer screened at the base of the Congaree aquifer (IDB-2CC) and a piezometer screened in the upper part of the aquifer, (IDB-2B). Potentiometric data from this piezometer cluster, indicate that the vertical gradient within the Congaree is about 0.009 ft/ft and is in the upward direction. This apparent upward hydraulic gradient may be the result of a local discharge area created by nearby Tinker Creek (Figure 6-2).

The potentiometric surface of the Congaree aquifer, based on data collected in this study, is presented in Figure 6-3. The horizontal gradient within the Congaree, calculated using data from all of the Congaree piezometers (Figure 6-3), is 0.0019 ft/ft.

Hydraulic conductivity estimates from recently conducted slug tests in the Congaree aquifer range from 1.2×10^{-4} cm/sec to 2.5×10^{-3} cm/sec, or 0.35 to 7.19 ft/day with an average of 2.36 ft/day (Figure 6-4). These values of hydraulic conductivity are in agreement with an estimate from a slug test conducted at monitoring well IDB-2B, of 0.39 ft/day. A constant discharge pumping test conducted at MWD-5A in May 1989 yielded an estimate of hydraulic conductivity around 30 ft/day (WSRC, 1991).

A review of the lithologies encountered in the Congaree aquifer beneath Site B, help to explain the large difference in hydraulic conductivity measured from the southern to the northern end of the site. At the southern end of the site (MWD wells), the Congaree was noted to be a medium to coarse, relatively clean sand. Moving north and west, the Congaree was described as a fine to medium to a medium to coarse sand at P-14TA.

Further toward the interior of the site, at BSB40, the unit was described as a fine to medium sand and in the northwestern end of the site at BSB38 and BSB39, it is described as a very fine to medium grained sand with up to 20% fines. This apparent fining of the Congaree from south to north, agrees with the lessening hydraulic conductivity observed along the same path.

Using the hydraulic conductivity estimates from the BTP slug tests, the flow velocity over a given flow path can be calculated for the Congaree aquifer. The velocity formula is based upon Darcy's Law and is:

$$V = (K/n) \times (dh/dl), \text{ where,}$$

FIGURE 6-3
CONGAREE
POTENTIOMETRIC
SURFACE ON 02/19/91
SITE B SHCR
-SAVANNAH RIVER SITE-

CONTOUR INTERVAL = 2 FT

- = IDB & MWD WELL SERIES
- ▲ = IDB LANDFILL BORINGS
- = BTP PIEZOMETERS
- = IDB LANDFILL TEST PITS
- = INVESTIGATIVE SITE BOUNDARY
- - - = PROPOSED LANDFILL LOCATION
- NOTE: ALL ELEVATIONS MSL DATUM

PLANT
NORTH

TRUE
NORTH

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- v = flow velocity (ft/day)
- K_h = hydraulic conductivity (horizontal), estimated from slug tests and pumping tests (ft/day)
- n = porosity, assumed to be 0.20
- dh = the change in head over the length of the flow path (ft)
- dl = the length of the flow path (ft)

To accurately represent the flow velocities within the Congaree aquifer at Site B, the estimates from previous studies should be averaged with the estimates from the current study to account for the variation in lithology discussed earlier. This adjustment yields an average K_h of 5.2 ft/day. The calculated gradient along a particular flow path (Figure 6-5) was .00145. Substituting these values into the velocity equation yields a flow rate of 0.038 ft/day or 13.8 ft/yr. Flow rates and flow directions in the Congaree as observed in this study are presented in Figure 6-5.

6.2.1.4 Green Clay Confining Unit

Overlying the Congaree aquifer is the Green Clay confining unit. The Green Clay is 6 to 20 ft thick and laterally continuous from the southern to the northern boundaries of Site B. Vertical hydraulic conductivity values determined from laboratory testing of undisturbed samples, ranged from 7.62×10^{-9} cm/sec at IDB 2CC to 8.76×10^{-9} cm/sec at BTP 12C. (Methods for determining vertical hydraulic conductivity (K_v) of undisturbed soil samples are discussed in Section 4.3 and Appendix L-5).

The Green Clay supports a difference in head of 62.77 ft at the MWD-5 cluster and 57.22 ft at the IDB-2 cluster (data from 2/19/91). This head differential is further evidence of the unit's lateral continuity. Lithologically, the unit varies from a silty, fine sand (MWD-5) to a hard, micaceous clay (P14 TA), to a firm to hard, sandy clay (BSB-39).

Travel time through the Green Clay can be simplistically estimated using the velocity equation described previously. The vertical gradient is 60 ft of head change over 15.2 ft of thickness or 3.9 ft/ft. The average vertical hydraulic conductivity (K_v) is 8.19×10^{-9} cm/sec (2.32×10^{-5} ft/day) and the assumed porosity is 0.10. Substituting these values into the flow equation yields a velocity of 9.05×10^{-4} ft/day or 3.30×10^{-1} ft/yr. Dividing the average thickness (15.2 ft) by the velocity yields a travel time through the Green Clay of 46 years.

In a similar fashion, gross leakage through the Green Clay can be estimated per unit area of the clay. The equation is:

$$Q_c = (K'/m') \Delta h A_c \text{ (Walton, 1962)}$$

Where:

- K' = hydraulic conductivity of the confining unit (ft/day);
- m' = thickness of the confining unit (ft);
- Δh = change in hydraulic head across the confining unit (ft);
- A_c = area across which leakage occurs (ft²)

Using the same parameters as for the travel time estimate, yields a volume of 9.16×10^{-5} ft³/day per square foot of area. This translates to 1.46×10^3 ft³/day across the 366 acre site.

6.2.1.5 Unconfined Aquifer

The unconfined or water table aquifer at Site B includes saturated sediment of the Santee, Dry Branch and Tobacco Road Formations. The top of the water table ranges in elevation from 260 ft msl in the extreme southern end of Site B, to 240 ft msl in the northern end of Site B. The water table surface as observed on February 19, 1991, is presented in Figure 6-6. The base of the unconfined aquifer is the Green Clay and the thickness of the saturated unit therefore ranges from 85 to 105 ft. As described in Section 6.1, the water table aquifer resides in a lithology that is characterized by numerous lenses and

discontinuous layers of clay, silt, and sandy/silty clay. These lenses would be expected to affect flow relationships within the unit.

At the extreme southern end of Site B, a shallow clay layer was observed in the MWD borings that was correlated to the Tan Clay of the General Separations Area. Wells finished above and below this clay layer display head differences of as much as ten ft (Main, 1988) (Table 6-1). During the current investigation, this clay layer was determined not to be continuous under the entire B site. For the majority of Site B, therefore, the section from the water table surface down to the top of the Green Clay is considered to be unconfined.

Piezometers screened in the water table aquifer at Site B are screened both across the water table surface and from five to twenty five ft below the water table surface. Based on water level elevations measured at these piezometers, the vertical gradient within the water table aquifer, appears to be quite variable.

At five of eleven BTP piezometer clusters, a difference in head of greater than two ft was observed between the DD and the D piezometer. At three locations, BTP 1D, 1DD, BTP 6D, 6DD and BTP 12D, 12DD there is geologic evidence that a perched water table exists that is being measured by the DD piezometers. At BTP 3D, 3DD, and BTP 10D, 10DD, geologic evidence does not suggest obvious perched water conditions. If one assumes that the measured heads at these two points are correct, then the vertical gradient within the upper portion of the unconfined aquifer at BTP 3 and BTP 10 is 0.43 ft/ft and 0.13 ft/ft, respectively, which appears to be anomalously high compared to the other paired water table piezometers.

The remaining six piezometer clusters (BTP 2D, 4D, 7D, 8D, 9D, 11D) display head differences between the DD and D piezometers of between 0.05 and 0.95 ft. Estimating the length of the flow path as the distance from the water table surface to the top of the "D" piezometer screen, yields a range of vertical gradients of 0.008 ft/ft to 0.083 ft/ft.

Table 6-1
Summary of Water Level Elevations Site B Area Wells - This Study (1)
Proposed Landfill Site B, Savannah River Site

Water Table Well Number	11/16/90		1/14/91		1/23/91		2/19/91	
	Depth to Water	Water Elevation	Depth to Water	Water Elevation	Depth to Water	Water Elevation	Depth to Water	Water Elevation
BTP 1D	— (2)	—	47.80	249.10	48.12	248.78	47.34	249.56
BTP 2D	61.75 (3)	255.23	64.22	255.52	64.15	255.59	63.44	256.30
BTP 3D	54.13 (3)	244.84	56.30	245.63	55.90	246.03	55.28	246.65
BTP 4D	57.65 (3)	241.91	—	—	59.88	242.64	59.31	243.21
BTP 6D	73.87 (3)	232.99	75.45	233.98	75.35	234.08	75.07	234.36
BTP 7D	—	—	75.95	241.23	75.62	241.56	75.19	241.99
BTP 8D	77.37 (3)	244.59	79.65	245.22	79.40	245.47	78.82	246.05
BTP 9D	51.02 (3)	241.83	52.05	242.81	51.90	242.96	51.65	243.21
BTP 10D	40.91 (3)	249.49	41.64	251.09	41.45	251.28	40.46	252.27
BTP 11D	—	—	52.65	240.74	52.65	240.74	52.20	241.19
BTP 12D	—	—	55.40	254.97	56.06	254.31	52.26	258.11
1 DD	—	—	43.88	252.97	43.50	253.35	42.31	254.54
2 DD	61.75 (3)	255.26	63.46	255.67	63.50	255.63	63.03	256.10
3 DD	48.84 (3)	250.13	50.85	251.09	51.20	250.74	49.94	252.00
4 DD	56.64 (3)	242.92	—	—	64.85	237.62	58.31	244.16
6 DD	56.31 (3)	250.55	55.16	254.26	55.15	254.27	55.12	254.30
7 DD	—	—	75.25	241.48	75.15	241.58	74.68	242.05
8 DD	77.63 (3)	244.33	78.98	245.27	78.70	245.55	78.13	246.12
9 DD	51.14	241.71	51.02	242.90	50.95	242.97	50.65	243.27
10 DD	39.54	250.86	40.36	252.36	40.05	252.67	38.34	254.38
11 DD	—	—	51.66	240.91	51.70	240.87	51.33	241.24
12 DD	—	—	46.26	263.82	48.65	261.43	48.26	261.84
IDB 3	—	—	Dry	Dry	91.15	233.72	90.82	234.05
IDB 4	—	—	Dry	Dry	Dry	Dry	69.19	247.42
IDB 5	—	—	77.60	244.34	77.50	244.44	76.78	245.16
IDB 6	—	—	Dry	Dry	65.45	253.52	64.38	254.59
IDB 7	—	—	57.35	256.03	57.35	256.03	56.40	256.98
IDB 8	—	—	Dry	Dry	Dry	Dry	54.56	238.57
IDB 9	—	—	50.95	237.39	50.95	237.39	50.59	237.75
IDB 1C	—	—	57.30	239.90	74.01	223.17	56.81	240.37
IDB 2C	73.54	232.86	72.90	233.50	72.85	233.55	72.58	233.85
MWD 1D	—	—	69.25	260.75	69.25	260.75	68.09	261.91
MWD 2D	—	—	63.98	260.62	63.90	260.70	63.02	261.58
MWD 5D	—	—	64.12	257.13	64.10	260.69	63.45	261.77
MWD 8	—	—	68.64	257.13	—	—	63.10	262.67
MWD 9	—	—	60.93	261.60	—	—	60.16	262.37

- (1) All depths relative to top of casing unless otherwise noted.
(2) "—" denotes "No Data available"
(3) Depth refers to ground surface.

(continued, p.1 of 2)

Table 6-1
Summary of Water Level Elevations Site B Area Wells - This Study (1)
Proposed Landfill Site B, Savannah River Site

Lower Water Table/McBean Well Number	11/16/90		1/14/91		1/23/91		2/19/91	
	Depth to Water	Water Elevation	Depth to Water	Water Elevation	Depth to Water	Water Elevation	Depth to Water	Water Elevation
P 14C	—	—	57.10	237.93	57.10	237.93	—	—
MWD 1C	—	—	74.15	254.46	74.01	254.60	73.22	255.39
MWD 2C	—	—	67.79	256.47	69.70	254.56	68.83	255.43
MWD 5C	—	—	70.89	254.16	73.45	251.60	72.52	252.53
MWD 10	—	—	74.89	255.96	74.80	256.05	73.89	—
Congaree Well Number	11/5/90		1/14/91		1/23/91		2/19/91	
	Depth to Water	Water Elevation	Depth to Water	Water Elevation	Depth to Water	Water Elevation	Depth to Water	Water Elevation
BTP 5C	—	—	128.65	176.41	128.40	176.66	128.08	176.98
BTP 6C	128.87 (3)	177.45	131.25	177.62	131.35	177.52	131.05	177.82
BTP 7C	—	—	138.35	178.01	138.45	177.91	138.16	178.20
BTP 8C	142.81 (3)	179.01	145.00	179.19	145.05	179.14	144.78	179.41
BTP 9C	—	—	114.45	180.60	114.50	180.55	114.23	180.82
BTP 10C	109.67	180.71	112.07	180.85	112.12	180.80	111.84	181.08
BTP 11C	—	—	109.35	184.07	109.35	184.07	109.06	184.36
BTP 12C	—	—	121.20	189.95	126.05	185.10	125.75	185.40
IDB 1B	—	—	113.25	184.05	—	—	112.93	184.37
IDB 2B	—	—	129.20	176.49	129.35	176.34	129.06	176.63
IDB 2CC	—	—	130.70	176.91	130.70	176.91	130.54	177.07
MWD 1A	—	—	140.65	188.84	140.62	188.87	140.33	189.16
MWD 2A	—	—	135.70	188.71	135.65	188.76	135.36	189.05
MWD 3A	—	—	142.58	188.26	142.56	188.28	142.25	188.59
MWD 5A	—	—	135.20	189.39	135.10	189.49	134.83	189.76
MWD 11	—	—	140.07	190.77	139.95	190.89	139.49	191.35
Pee Dee Well Number	11/5/90		1/14/91		1/23/91		2/19/91	
	Depth to Water	Water Elevation	Depth to Water	Water Elevation	Depth to Water	Water Elevation	Depth to Water	Water Elevation
IDB 1A	—	—	108.82	187.96	—	—	108.57	188.21
IDB 2A	116.68	187.62	116.90	187.39	117.10	187.19	116.58	187.71

- (1) All depths relative to top of casing unless otherwise noted.
(2) "—" denotes "No Data available"
(3) Depth refers to ground surface.

(p. 2 of 2)

At the P-14 well cluster in the southern end of Site B there is a well screened in the top of the unconfined aquifer (IDB-1C) and another well screened in the lowermost part of the same aquifer (P-14C). The ground-water elevation in IDB-1C on January 14, 1991 was 239.9 ft msl and the ground water elevation in P-14C on 1/23/91 was 237.93 ft msl. These data indicate a downward change in head of 1.97 ft. The vertical distance from the top of the screen in IDB-1C to the top of the screen in P-14C is 60 ft. Dividing the change in head by the vertical distance between the two measuring points yields a vertical gradient within the unconfined water table unit of 0.033 ft/ft.

Using data collected on February 02, 1991, the average horizontal gradient in the unconfined aquifer was calculated to be 0.013 ft/ft. This reveals that the vertical gradient within the aquifer is almost three times greater than the horizontal gradient and with no further information, would imply that the propensity is for downward flow. In fact, the unconfined aquifer resides in a highly stratified unit (as can be seen in Figures 5-6 through 5-9) and the ratio of horizontal to vertical hydraulic conductivity is likely 10:1 or higher. The influence of a much greater horizontal hydraulic conductivity is that the dominant component of flow is probably horizontal rather than vertical, within the unconfined aquifer.

Hydraulic conductivity estimates based upon slug tests at the BTP piezometers ranged from 0.08 to 5.90 ft/day with an average of 1.7 ft/day (Figures 6-7 and 6-8). Using the procedure described in section 6.2.1.3, the ground water flow rates were estimated. Flow rates range from 1.5 ft/yr to 108 ft/yr, using the minimum and maximum hydraulic conductivity estimates.

Ground water flow in the unconfined aquifer is to the north toward Tinker Creek and to the northeast toward Mill Creek, a tributary of Tinker Creek (Figure 6-6). Tinker Creek is the closest likely outcrop of the unconfined aquifer and is 4000 ft from the northern boundary of the site. Using the maximum estimated flow rate of 108 ft/yr, the travel time from Site B to Tinker Creek is estimated to be 37 years. This estimate is considered simplistic because it does not take into consideration travel time through the unsaturated zone, vertical flow or heterogeneity of the aquifer.

6.2.1.6 Unsaturated Zone

The unsaturated zone is that portion of the subsurface between the land surface and the water table. At Site B it ranges from 40 to 80 ft thick, as depicted in Figure 6-9 and in Figures 5-6 through 5-9.

Evidence of perched ground water was observed at piezometer locations BTP 1, BTP 6, and BTP 12. There may also be perched ground water at piezometer locations BTP 3 and BTP 10.

The presence of a shallow and areally extensive zone of perched water could present problems for a landfilling operation. All of the observed cases of perched water at Site B, show the perched water zone to be thin, discontinuous and only a few feet above the actual water table. Table 6-1 summarizes water elevations at all BTP piezometers.

Figure 6-9 depicts the depth to ground water at Site B based on recent measurements (02/19/91). No attempt was made to differentiate between perched ground water and the true water table, in generating the map. This figure indicates that the shallowest depth to ground water (the thinnest unsaturated zone) is approximately 40 ft. The shallowest measured depth to ground water during this study was 39.41 ft, at BTP 10D, on February 02, 1991. Following unusually high and prolonged precipitation periods the water table would be expected to be potentially several ft higher, resulting in substantially lower unsaturated zone thickness. This response is a function of several key factors including aquifer characteristics, discharge locations/proximity and the nature of the precipitation events.

Based on the present minimum depth to groundwater of 40 ft, it is reasonable to conclude that even the largest possible rise in the water table would still leave adequate unsaturated zone thickness to allow for a buffer of 5 ft or more between the base of the landfill and the water table surface.

FIGURE 6-7
AREAL DISTRIBUTION OF
HYDRAULIC CONDUCTIVITY
(FT/DAY) IN THE WATER
TABLE AQUIFER
SITE B SHCR
-SAVANNAH RIVER SITE-

- (BTP) VALUE INDICATES K_h AT DESIGNATED WELL
 • = IDB & MWD WELL SERIES
 ▲ = BSB LANDFILL BORINGS
 ● = BTP PIEZOMETERS
 ■ = BIX LANDFILL TEST PITS
 — = INVESTIGATIVE SITE BOUNDARY
 --- = PROPOSED LANDFILL LOCATION
 NOTE: ALL ELEVATIONS MSL EARTH

PLANT
NORTH

0 200 400

SIDPINE

6.2.2 Ground-Water Use

According to the information listed in the SRP Production Wells Inventory, (supplied to Sirrine by G.B. O'Berry on 8/8/90), the nearest public supply well, 905-2S, is 10,827 ft WSW of the proposed landfill site. This well, though not operational, has a rated pumping capacity of 1,000 gallons per minute, see Table 6-2. It is screened in the highly permeable portions of the Black Creek and Middendorf Formations as are 14 of the 15 wells listed in Table 6-2. These 15 wells are within 12,300 ft of the landfill but only seven are operational with two not having been brought on line yet. The others have been abandoned. All of the potentially operational wells are west of the landfill site, in H or S areas. The wells are screened in the Pee Dee, Black Creek or Middendorf Formations. These wells are over 1-1/2 miles from the landfill site and are withdrawing water from formations separated from the landfill by both the Green Clay and the Williamsburg/Rhems aquitards. Additionally, these wells are generally located in the side-gradient direction to the landfill and thus, should have no threat posed to them by the proposed landfill.

6.2.3 Head Reversal

Two monitoring wells adjacent to Site B are screened in the regionally significant Upper Cretaceous Pee Dee aquifer, IDB-1A and IDB-2A. These wells are also paired with nearby monitoring devices screened in the overlying Congaree aquifer. Based on observations of water levels in these devices during this study, the head levels in the deeper Pee Dee aquifer are roughly 5 to 11 ft higher than in the overlying Congaree aquifer. This head difference is presented in Figure 6-10. This upward vertical gradient, or "head reversal" has been commonly observed throughout this portion of the site, as depicted in Figure 6-11. The significance of this head reversal phenomenon with respect to the proposed landfill is that it imports a natural physical barrier to potential contamination of the deep regional aquifer systems.

Table 6-2
Public Supply Well Locations Relevant to Site B
Proposed Landfill Site B, Savannah River Site

Well Number	SRS Grid Coordinates		Distance From Site B Centroid (ft)	Depth Below Grade (ft)	Pumping Rate (gpm)	Status (1)	Screened Interval (Below Grade ft)
	Distance N (ft)	Distance E (ft)					
905-16R	17110	100	18,209	655	500	ABD	100-105, 600-650
905-35H	2500	12160	13,639	865	1000	ABD	460-465, 685-855
905-43H	2900	11750	13,314	864	1000	ABD	653-705, 748-851
905-44H	3800	11850	13,756	834	1000	ABD	478-488, 568-823
905-45H	4100	11250	13,315	882	1000	ABD	557-572, 582-876
905-48H	3500	11375	13,205	876	1000	ABD	496-501, 721-866
905-56G	28537	0	29,712 (SW)	215	5	ABD	200-210
905-66H	25805	12148	13,651 (SW)	860	1000	OPR	667-737, 750-845
905-80H	30360	11709	13,365 (SW)	862	1000	OPR	695-700, 719-850
905-87H	39250	12122	14,055 (SW)	820	1000	OPR	530-590, 750-800
905-88H	32950	11190	12,770 (SW)	875	1000	OPR	535-540, 780-870
905-108H	41480	11161	13,858 (SW)	860	1000	OPR	540-590, 750-840
905-S	270	10860	11,923 (SW)	417	350	OPR	360-410
905-1S	490	10337	11,434 (WSW)	835	1000	NOP	495-550, 630-830
905-2S	14290	9535	10,827 (WSW)	807	1000	NOP	510-520, 520-795
905-119H	25790	11969	13,577 (WSW)	849	1000	OPR	669-679, 696-752

1) Status denoted by: ABD = Abandoned; OPR = Operational; NOP = Not Operational.

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FIGURE 6-11
 HEAD DIFFERENCE FROM
 UPPER CRETACEOUS
 SEDIMENTS AQUIFER (PEE
 DEE) TO CONGAREE FORMATION
 AQUIFER AT
 SAVANNAH RIVER SITE

SIRRINE JN G0358.00

7.0 GROUND-WATER QUALITY RESULTS

7.1 Field Analytical Results

Prior to sampling, each well and piezometer was purged as described in Section 4.1.7. The volumes removed are reported in Table 7-1. During the sampling activity, field measurements of pH, specific conductance, and water temperature were made on samples from all wells and piezometers. Observations of relative turbidity were also recorded for all samples. The results of these observations are presented in Table 7-1.

Several wells and piezometers indicated significantly elevated pH values. Values of pH greater than approximately 8.0 may indicate grout contamination associated with well construction. Examination of the specific conductance, pH and turbidity observations did not indicate any trends or deviations from the typical range of values expected with respect to the aquifers sampled.

7.2 Laboratory Analytical Results

7.2.1 *Data Quality*

To put analytical results in context of normally expected analytical variations and resultant concentration ranges, the results of quality assurance samples will be discussed first. In some cases, statistical evaluation of the data is appropriate and results are listed accordingly. Refer to Section 4.2.3 for descriptions and purposes of these samples.

7.2.1.1 Laboratory Handling Variances

The analytical methods employed for each parameter analyzed are presented in Appendix K-2. Variances with the analytical protocol identified in Sections 4.1.7 and 7.2.1 were identified in the laboratory data transmittal letter, included as Appendix K-1 of this report. These variances were related in all cases to laboratory exceedances of holding times for

Table 7-1
Summary of Field Analytical Results - Ground Water Samples (1)
Proposed Landfill Site B, Savannah River Site

Piezometer /1 Well	Volume Purged (gal)	Date	pH	Specific Conductance (μmhos/cm)	Water Temperature (°C)	Turbidity (2) (subjective)
BTP 1D	6.0	01/23/91	5.39	30.00	17.00	2
BTP 2D	40.0	01/23/91	5.72	120.00	18.00	2
BTP 3D	14.0	01/22/91	5.74	20.00	18.00	3
BTP 4D	5.0	01/23/91	5.40	40.00	18.00	3
BTP 5C	12.0	01/22/91	11.18	80.00	17.60	1
BTP 6C	5.0	01/22/91	7.84	40.00	18.00	1
BTP 6D	3.0	01/17/91	8.29	122.90	17.00	4
BTP 7C	6.0	01/17/91	7.10	0.27	16.00	3
BTP 7D	4.0	01/17/91	7.48	66.80	16.60	2
BTP 8C	12.0	01/16/91	6.92	0.22	18.00	1
BTP 8D	3.0	01/16/91	7.15	16.74	18.20	2
BTP 9C	12.0	01/16/91	12.09	1.96	18.00	2
BTP 9D	3.0	01/16/91	7.34	45.00	18.40	2
BTP 10C	8.0	01/15/91	5.80	156.10	18.10	2
BTP 10D	6.0	01/15/91	5.60	47.80	17.50	4
BTP 11C	20.0	01/15/91	8.15	196.30	18.10	2
BTP 11D	6.0	01/14/91	6.30	15.10	17.00	3
BTP 12C	18.0	01/23/91	5.49	150.00	18.00	2
BTP 12D	17.0	01/28/91	5.97	41.70	16.00	4
IDB 4	7.2	01/18/91	10.50	27.70	16.90	2
IDB 5	(3) —	—	9.90	37.70	18.50	—
IDB 6	4.7	01/18/91	9.90	17.60	17.70	2
IDB 7	33.2	01/18/91	9.50	33.00	18.30	1
IDB 8	5.6	01/18/91	9.60	17.10	17.00	2
IDB 9	89.6	01/18/91	10.60	210.00	12.50	1
IDB 10	85.6	01/18/91	10.10	104.80	15.20	1
IDB 1C	112.0	01/23/91	7.90	17.40	17.10	1
IDB 2A	—	01/18/91	—	—	—	—
IDB 2B	—	01/18/91	—	—	—	—
IDB 2C	—	01/18/91	—	—	—	—
IDB 2CC	18.0	01/24/91	7.78	240.00	16.50	2
P14TA	1904.0	—	5.85	36.30	19.60	1
P14TB	—	01/24/91	—	—	—	—
P14TC	1018.0	—	5.50	37.50	18.50	1

(1) See Appendix K-1 for detailed field sampling data forms for each piezometer/well.

(2) Relative turbidity: 4-highly turbid, 1-clear.

(3) "—" Data Incomplete.

selected parameters and selected samples. This variance affected all samples for Total Organic Halides.

Some samples were also affected for Ammonia, Sulfates, Phenols, Herbicides, and Volatiles. These variances are highlighted in the summary data tables, discussed in Section 7.2.2. As no regulations exist for standards for site characterizations, exceedence of holding times constitutes an informal Quality Assurance issue. Regardless, these particular analytical results are suspect. As an independent check on these issues, these comparisons between various measurements related to the VOA group were made. As discussed in 7.2.2.1. conclusions regarding impacts to groundwater by organic species were verified independent of the samples with variances.

7.2.1.2 Field Duplicates

One field duplicate was collected for each of seven (7) wells and analyzed for phenols, total organic carbon (TOC), and total organic halogens (TOX). The results of the primary and duplicate analyses are commonly compared by computing a relative percent difference [RPD] (EPA, 1987).

The RPD is calculated by the following equation:

$$\text{RPD} = \frac{(A - B)}{(A + B)} * 200$$

Where: A = primary samples results

B = duplicate sample results

200 = a factor to convert to percent and also including a 2 previously expressed by calculating the average of A and B (i.e., (A+B)/2)

The analytical results for the field duplicates and the corresponding RPDs for each sample pair are listed in Appendix K-3. The RPDs for the sample pairs range from 0 to 104 percent. The greater RPDs generally correspond to samples where holding times were

exceeded for that constituent. Consequently, use of the data from these samples is used with caution (see Section 7.2.2.1).

7.2.1.3 Field Blanks

Two field blanks (BTP 8D and BTP 6C) were collected. The former was analyzed for an extensive suite of volatiles organic compounds, whereas, the other was analyzed for the organic indicators TOC and TOX and also for phenols. The results of these analyses are presented in Appendix K-4. The analytes were generally not within practical quantitation limits (i.e. lower than matrix-related variations). These findings indicate proper sampling technique and that contamination was not introduced during sampling.

Methylene chloride and phenol were detected at extremely low concentrations of 2.0 and 7.7 ug/L, respectively. Detection of these minute quantities is not considered remarkable because (1) methylene chloride is a common lab artifact, and (2) phenols were barely above detection.

7.2.1.4 Rinsate Blank

One rinsate sample (BTP 6C) was collected and analyzed for phenol, TOC, and TOX. The results of these analyses, listed in Appendix K-4, indicate that all analytes were below the practical quantitation limit and that decontamination procedures were effective. That is, decontaminated equipment yielded clean rinsate.

Based on all field quality control sample results, the field procedures were in control. The quality assurance data indicates that the data are of good quality.

7.2.2 *Interpretation of Results*

To facilitate interpretation of analytical results, analytical data listed in Appendix K-5 have been compiled into two summary tables. Table 7-2 summarizes the organic analyses and Table 7-3 summarizes the metals, radionuclide, and inorganic results.

7.2.2.1 Organic Analytes

The analytical data summary shown on Table 7-2 indicates that, with the exception of a few marginal exceedences, concentrations of an extensive suite of organics were below detection levels. Of the 37 parameters analyzed, detectable concentrations were present only for three, TOC, TOX (both indicator parameters), and phenols. For both TOC and phenols, concentrations were only marginally above the detection limit. For phenols the exceedence was well within the relative percent difference (RPD) observed in duplicates (i.e., is within analytical error limits). TOC concentrations exceeded the detection limit by more than the RPD observed in duplicates. However, TOC is a gross indicator of organic carbon which can reflect compounds such as natural organic acids and organic matter which can be introduced into the borehole during drilling. In any case, the absence of the specific compounds in the volatiles group (which includes the primary solvents used at SRS) indicates that ground water has not been impacted by industrial activities. These results indicate that, due to the absence of these constituents, any impacts the proposed facility might have would be readily detected by routine monitoring. Specifically, no discrimination between pre- and post-landfilling impacts would be required.

Measurements for the TOX parameter was significantly above quantitation limits for several samples, but in each of these cases the sample had exceeded holding times. This parameter is a gross indicator of total halogenated organic compounds. The specific organics listed include those which could reasonably be expected to occur based on knowledge of SRS processes. The absence of the specific compounds coupled with the exceedence of holding time on the TOX analyses would indicate that the TOX values are misleading and that organic halogens have not impacted ground water beneath Site B.

Table 7-2
Summary of Analytical Results - Organics
Ground Water Samples
Proposed Landfill Site B, Savannah River Site

Parameter	Sample ID	BTP 1D	BTP 2D	BTP 3D	BTP 4D	BTP 5C	BTP 6C	BTP 6D	BTP 7C	BTP 7D	BTP 8C	BTP 8D
Total Organic Carbon	mg/l	LT (1)	1	LT	1	(2) 2.56	LT	1	LT	1	LT	1
Total Organic Halogens	µg/l	LT (3)	5	LT	5	LT	5	LT	5	LT	5	LT
Volatiles												
1,1,1-Trichloroethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
1,1,2,2-Tetrachloroethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
1,1,2-Trichloroethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
1,1-Dichloroethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
1,1-Dichloroethylene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
1,2-Dichloroethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
1,2-Dichloropropane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
2-Chloroethylvinyl Ether	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Benzene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Bromodichloromethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Bromoform	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Bromomethane	µg/l	LT	10	LT	10	LT	10	LT	10	LT	10	LT
Carbon Tetrachloride	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Chlorobenzene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Chloroethane	µg/l	LT	10	LT	10	LT	10	LT	10	LT	10	LT
Chloroform	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Chloromethane	µg/l	LT	10	LT	10	LT	10	LT	10	LT	10	LT
cis-1,3-Dichloropropene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Dibromochloromethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Ethylbenzene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Methylene Chloride	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Tetrachloroethylene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Toluene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
trans-1,2-Dichloroethene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
trans-1,3-Dichloropropene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Trichloroethylene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Trichlorofluoromethane	µg/l	LT	10	LT	10	LT	10	LT	10	LT	10	LT
Chloroethene	µg/l	LT	10	LT	10	LT	10	LT	10	LT	10	LT
Phenol												
Phenol	µg/l		5.18	LT	5	LT	5	LT	5	LT	5	LT
Pesticides/ Herbicides												
2,4-Dichlorophenoxyacetic Acid	µg/l	LT	0.10	LT	0.10	LT	0.10	LT	0.10	LT	0.10	LT
Endrin	µg/l	LT	0.02	LT	0.02	LT	0.02	LT	0.02	LT	0.02	LT
Lindane	µg/l	LT	0.01	LT	0.01	LT	0.01	LT	0.01	LT	0.01	LT
Methoxychlor	µg/l	LT	0.50	LT	0.50	LT	0.50	LT	0.50	LT	0.50	LT
Silvex	µg/l	LT	0.02	LT	0.02	LT	0.02	LT	0.02	LT	0.02	LT
Toxaphene	µg/l	LT	0.50	LT	0.50	LT	0.50	LT	0.50	LT	0.50	LT

(1) "LT" indicates sample concentration below the quantitation limit.

(2) Bold value indicates a "detect" above the quantitation limit.

(3) Shading indicates sample was analyzed beyond method specified holding time for that constituent/analysis.

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Table 7-2
Summary of Analytical Results - Organics
Ground Water Samples
Proposed Landfill Site B, Savannah River Site

Parameter	Sample ID	BTP 9C	BTP 9D	BTP10C	BTP10D	BTP11C	BTP11D	BTP12C	BTP12D	IDB 4	IDB 5	IDB 6
Total Organic Carbon	mg/l	3.2	3.43	5.56	2.71	1.49	1	1	1	1	1	1
Total Organic Halogens	µg/l	15.3	5.7	7.3	5.3	5	5	5	5	12.5	5	5
Volatiles												
1,1,1-Trichloroethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
1,1,2,2-Tetrachloroethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
1,1,2-Trichloroethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
1,1-Dichloroethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
1,1-Dichloroethylene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
1,2-Dichloroethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
1,2-Dichloropropane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
2-Chloroethylvinyl Ether	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Benzene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Bromodichloromethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Bromoforn	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Bromomethane	µg/l	LT	10	LT	10	LT	10	LT	10	LT	10	LT
Carbon Tetrachloride	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Chlorobenzene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Chloroethane	µg/l	LT	10	LT	10	LT	10	LT	10	LT	10	LT
Chloroforn	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Chloromethane	µg/l	LT	10	LT	10	LT	10	LT	10	LT	10	LT
cis-1,3-Dichloropropene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Dibromochloromethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Ethylbenzene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Methylene Chloride	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Tetrachloroethylene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Toluene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
trans-1,2-Dichloroethene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
trans-1,3-Dichloropropene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Trichloroethylene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Trichlorofluoromethane	µg/l	LT	10	LT	10	LT	10	LT	10	LT	10	LT
Chloroethene	µg/l	LT	10	LT	10	LT	10	LT	10	LT	10	LT
Phenol												
Phenol	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT
Pesticides/ Herbicides												
2,4-Dichlorophenoxyacetic Acid	µg/l	LT	0.10	LT	0.10	LT	0.10	LT	0.10	LT	0.10	LT
Endrin	µg/l	LT	0.02	LT	0.02	LT	0.02	LT	0.02	LT	0.02	LT
Lindane	µg/l	LT	0.01	LT	0.01	LT	0.01	LT	0.01	LT	0.01	LT
Methoxychlor	µg/l	LT	0.50	LT	0.50	LT	0.50	LT	0.50	LT	0.50	LT
Silvex	µg/l	LT	0.02	LT	0.02	LT	0.02	LT	0.02	LT	0.02	LT
Toxaphene	µg/l	LT	0.50	LT	0.50	LT	0.50	LT	0.50	LT	0.50	LT

- (1) "LT" indicates sample concentration below the quantitation limit.
(2) Bold value indicates a "detect" above the quantitation limit.
(3) Shading indicates sample was analyzed beyond method specified holding time for that constituent/analysis.

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Table 7-2
Summary of Analytical Results - Organics
Ground Water Samples
Proposed Landfill Site B, Savannah River Site

Parameter	Sample ID	IDB 7	IDB 8	IDB 9	IDB 10	IDB 1C	IDB 2A	IDB 2B	IDB 2C	IDB2CC	P 14TA	P 14TB	P 14TC
Total Organic Carbon	mg/l	LT	1	LT	1	LT	1	LT	1	LT	1	LT	1
Total Organic Halogens	µg/l	LT	13.8	LT	9.6	LT	5	LT	5	LT	8	LT	24.5
Volatiles													
1,1,1-Trichloroethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
1,1,2,2-Tetrachloroethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
1,1,2-Trichloroethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
1,1-Dichloroethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
1,1-Dichloroethylene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
1,2-Dichloroethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
1,2-Dichloropropane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
2-Chloroethylvinyl Ether	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
Benzene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
Bromodichloromethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
Bromoform	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
Bromomethane	µg/l	LT	10	LT	10	LT	10	LT	10	LT	10	LT	10
Carbon Tetrachloride	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
Chlorobenzene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
Chloroethane	µg/l	LT	10	LT	10	LT	10	LT	10	LT	10	LT	10
Chloroform	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
Chloromethane	µg/l	LT	10	LT	10	LT	10	LT	10	LT	10	LT	10
cis-1,3-Dichloropropene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
Dibromochloromethane	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
Ethylbenzene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
Methylene Chloride	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
Tetrachloroethylene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
Toluene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
trans-1,2-Dichloroethene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
trans-1,3-Dichloropropene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
Trichloroethylene	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
Trichlorofluoromethane	µg/l	LT	10	LT	10	LT	10	LT	10	LT	10	LT	10
Chloroethene	µg/l	LT	10	LT	10	LT	10	LT	10	LT	10	LT	10
Phenol													
Phenol	µg/l	LT	5	LT	5	LT	5	LT	5	LT	5	LT	5
Pesticides/ Herbicides													
2,4-Dichlorophenoxyacetic Acid	µg/l	LT	0.10	LT	0.10	LT	0.10	LT	0.10	LT	0.10	LT	0.10
Endrin	µg/l	LT	0.02	LT	0.02	LT	0.02	LT	0.02	LT	0.02	LT	0.02
Lindane	µg/l	LT	0.01	LT	0.01	LT	0.01	LT	0.01	LT	0.01	LT	0.01
Methoxychlor	µg/l	LT	0.50	LT	0.50	LT	0.50	LT	0.50	LT	0.50	LT	0.50
Silvex	µg/l	LT	0.02	LT	0.02	LT	0.02	LT	0.02	LT	0.02	LT	0.02
Toxaphene	µg/l	LT	0.50	LT	0.50	LT	0.50	LT	0.50	LT	0.50	LT	0.50

- (1) "LT" indicates sample concentration below the quantitation limit.
- (2) Bold value indicates a "detect" above the quantitation limit.
- (3) Shading indicates sample was analyzed beyond method specified holding time for that constituent/analysis.

Table 7-3
Summary of Analytical Results - Metals, Radiological Parameters and Inorganics
Ground Water Samples
Proposed Landfill Site B, Savannah River Site

Parameter	Sample ID	BTP 1D	BTP 2D	BTP 3D	BTP 4D	BTP 5C	BTP 6C	BTP 6D	BTP 7C	BTP 7D	BTP 8C	BTP 8D	
Metals													
Arsenic	µg/l	LT(1)	2 LT	2 LT	2 LT	2 LT	2 LT	2 LT	2 LT	2	7.38 LT	2	
Barium	µg/l		39.7	52	8.7	1280	135	31	48.3	58.9	16.2	34.2	19.2
Cadmium	µg/l	LT	1.5 LT	1.5 LT	1.5 LT	1.5 LT	1.5 LT	1.5 LT	1.5 LT	1.5 LT	1.5 LT	1.5	
Calcium	µg/l		1050	8210	1012	35400	41820	74240	140000	37300	5470	10800	1050
Chromium	µg/l		3.6	4.8	2.6	33.5	6.5 LT	2.5	5.4	3.3 LT	2.5 LT	2.5 LT	2.5
Copper	µg/l		2.8	3.6 LT	2	120	5.9	2.6	59	5.3	43.7	24.7	2.2
Iron	µg/l		829	1550	348	16600	225	226	2380	1490	694	851	158
Lead	µg/l		12.1	9.88 LT	3	126	3.63 LT	3	6.66	4.37 LT	3 LT	3 LT	3
Magnesium	µg/l		1030	893	178	6760	62.5	3530	1780	2290	840	1150	261
Mercury	µg/l	LT	0.2	0.48 LT	0.2	2.39 LT	0.2 LT	0.2 LT	0.2 LT	0.2 LT	0.2 LT	0.2 LT	0.2
Nickel	µg/l		3.3	9 LT	2.5	82.8 LT	2.5 LT	2.5	26.6	6.7	4.8 LT	2.5 LT	2.5
Selenium	µg/l	LT	3 LT	3 LT	3 LT	3 LT	3 LT	3 LT	3 LT	3 LT	3 LT	3 LT	3
Silver	µg/l	LT	2.5 LT	2.5 LT	2.5 LT	2.5 LT	2.5 LT	2.5 LT	2.5 LT	2.5 LT	2.5 LT	2.5 LT	2.5
Sodium	µg/l		1430	15600	4769	6140	39340	19410	4180	36000	12100	42100	1870
Radiological													
Gross Alpha	pCi/l	LT	3	27	26	72	2.5	2.6	8.1	10	15	7.3	16
Non Volatile Beta	pCi/l	LT	6	33	21	97	16 LT	5	12	12	18	6.8	24
Total Radium	pCi/l		2	5.7	3.3	20	1.6	1.1	5.6	6.3	4.1	2.8	5.4
Tritium	pCi/ml		2.9 LT	1	3.6	2 LT	1 LT	1 LT	1 LT	1	20	4.3	1.5
Inorganics													
Chlorine	mg/l		1.05	6.73	2.82	1.47	1.75	2.1	4.65	2.31	2.18	2.11	1.3
Fluorine	mg/l	LT	0.25 LT	0.25 LT	0.25 LT	0.25	0.35 LT	0.25	0.29	0.28 LT	0.25	0.31 LT	0.25
Ammonia	mg/l	LT(2)	30	30	30	30	383	58.7	152	200	135	177	129
Nitrate	mg/l		2.16	4.37 LT	0.1	0.73 LT	0.1 LT	0.1 LT	0.1 LT	0.1 LT	0.1 LT	0.1	0.78
Sulfate	mg/l	LT	1	11.9	1.8	1.41	11.4	193	16.1	35.3	10.9	18.6 LT	1
Total Phosphate	µg/l		139	350	657	1297	216	652	2590	3450	3880	3450	485

(1) "LT" indicates sample concentration below the detection limit.

(2) Shading indicates sample was analyzed beyond method-specified holding time for that constituent.

(continued, p. 1 of 3)

Table 7-3
Summary of Analytical Results - Metals, Radiological Parameters and Inorganics
Ground Water Samples
Proposed Landfill Site B, Savannah River Site

Parameter	Sample ID	BTP 9C	BTP 9D	BTP10C	BTP10D	BTP11C	BTP11D	BTP12C	BTP12D	IDB 4	IDB 5	IDB 6
Metals												
Arsenic	µg/l	LT 2	LT 2	LT 2	LT 2	LT 2	LT 2	2.53	LT 2	LT 2	LT 2	LT 2
Barium	µg/l	338	2.1	30.3	14.5	43.4	3.2	72.2	52	2.1	8.8	9.4
Cadmium	µg/l	LT 1.5	LT 1.5	LT 1.5	LT 1.5	LT 1.5	7	LT 1.5	LT 1.5	LT 1.5	LT 1.5	LT 1.5
Calcium	µg/l	132000	2590	29300	4290	33100	1910	19300	2480	1520	975	394
Chromium	µg/l	LT 2.5	LT 2.5	LT 2.5	LT 2.5	3.1	LT 2.5	13.5	LT 2.5	LT 2.5	LT 2.5	LT 2.5
Copper	µg/l	3.9	35.1	26.9	12.9	8.1	50.6	5.4	21.7	LT 2	6.8	2.2
Iron	µg/l	361	359	1120	244	2340	1100	7630	796	21.1	483	238
Lead	µg/l	LT 2	LT 2	LT 2	LT 2	LT 2	2	12.6	6.95	3.4	31.6	LT 3
Magnesium	µg/l	72.6	474	1060	520	1500	406	2130	809	166	156	220
Mercury	µg/l	LT 0.2	LT 0.2	LT 0.2	LT 0.2	LT 0.2	LT 0.2	0.2	0.5	LT 0.2	LT 0.2	LT 0.2
Nickel	µg/l	5.6	4.7	6.4	LT 2.5	6.6	5.8	8.2	6.8	LT 2.5	6.1	LT 2.5
Selenium	µg/l	LT 3	LT 3	LT 3	LT 3	LT 3	LT 3	LT 3	LT 3	LT 3	LT 3	LT 3
Silver	µg/l	LT 2.5	LT 2.5	LT 2.5	LT 2.5	LT 2.5	LT 2.5	LT 2.5	LT 2.5	LT 2.5	LT 2.5	LT 2.5
Sodium	µg/l	43400	5830	8620	3620	18900	2670	25400	5600	985	2590	1090
Radiological												
Gross Alpha	pCi/l	LT 5	14	LT 3	9.8	4.9	6.9	LT 3	60	LT 3	LT 3	LT 2
Non Volatile Beta	pCi/l	17	16	9.2	19	12	14	4.8	70	LT 4	LT 6	LT 4
Total Radium	pCi/l	2.7	4.6	2.1	3.6	4.3	3	3	14	1.2	LT 1	1.3
Tritium	pCi/ml	2.3	2.7	LT 1	3.3	LT 1	2	LT 1	1.4	3.6	2.8	2.2
Inorganics												
Chlorine	mg/l	2.37	1.97	2.03	1.45	2.04	1.81	2.52	1.86	0.95	2.17	1.12
Fluorine	mg/l	0.94	LT 0.25	LT 0.25	LT 0.25	LT 0.25	LT 0.25	0.27	LT 0.25	LT 0.25	LT 0.25	LT 0.25
Ammonia	mg/l	432	128	151	136	190	31.4	30	30	145	30	138
Nitrate	mg/l	LT 0.1	0.11	LT 0.1	LT 0.1	0.1	0.46	LT 0.1	0.34	0.41	LT 0.1	0.54
Sulfate	mg/l	20.1	8.88	12.6	3.47	13.8	1.8	54.1	8.59	LT 1	1.14	LT 1
Total Phosphate	µg/l	178	805	1750	1850	1510	7480	1559	1374	48	70.5	73.4

(1) "LT" indicates sample concentration below the detection limit.

(2) Shading indicates sample was analyzed beyond method-specified holding time for that constituent.

(continued, p. 2 of 3)

Table 7-3
Summary of Analytical Results - Metals, Radiological Parameters and Inorganics
Ground Water Samples
Proposed Landfill Site B, Savannah River Site

Sample ID		IDB 7	IDB 8	IDB 9	IDB 10	IDB 1C	IDB 2A	IDB 2B	IDB 2C	IDB2CC	P 14TA	P 14TB	P 14TC												
Parameter																									
Metals																									
Arsenic	µg/l	LT	2	LT	2	LT	2	LT	2	LT	2	LT	2												
Barium	µg/l		7.8		5.3		34.5		12.8		9.3		19.9		85.7		66.3		158		14.8		16.2		11.9
Cadmium	µg/l	LT	1.5	LT	1.5	LT	1.5	LT	1.5	LT	1.5	LT	1.5	LT	1.5	LT	1.5	LT	1.5	LT	1.5	LT	1.5	LT	1.5
Calcium	µg/l		83.3		136		12800		1050		985		13700		63000		31900		69900		1810		2260		2670
Chromium	µg/l	LT	2.5	LT	2.5	LT	2.5	LT	2.5	LT	2.5	LT	2.5	LT	2.5	LT	3.1		25	LT	2.5	LT	2.5	LT	2.5
Copper	µg/l	LT	2		2.3	LT	2	LT	2	LT	2	LT	2	LT	2	LT	2		9.1	LT	2	LT	2	LT	2
Iron	µg/l		95.8		95.2		437		15.1		274		2610		6.1		12.8		19800		6070		2050		1380
Lead	µg/l	LT	3		9.19	LT	3	LT	3	LT	3	LT	3	LT	3	LT	3		10.8	LT	3	LT	3	LT	3
Magnesium	µg/l		343		411		749		463		311		295		32.5		266		3300		401		241		227
Mercury	µg/l	LT	0.2	LT	0.2	LT	0.2	LT	0.2	LT	0.2	LT	0.2	LT	0.2	LT	0.2	LT	0.2	LT	0.2	LT	0.2	LT	0.2
Nickel	µg/l	LT	2.5	LT	2.5	LT	2.5	LT	2.5	LT	2.7	LT	2.5	LT	2.5	LT	2.5		17.5		7.3		5.1		5.2
Selenium	µg/l	LT	3	LT	3	LT	3	LT	3	LT	3	LT	3	LT	3	LT	3	LT	3	LT	3	LT	3	LT	3
Silver	µg/l	LT	2.5	LT	2.5	LT	2.5	LT	2.5	LT	2.5	LT	2.5	LT	2.5	LT	2.5	LT	2.5	LT	2.5	LT	2.5	LT	2.5
Sodium	µg/l		2370		1030		8050		2520		1100		1600		4510		3940		58000		1450		1670		985
Radiological																									
Gross Alpha	pCi/l	LT	4	LT	3	LT	4	LT	2	LT	3	LT	3	LT	3	LT	6		12	LT	4	LT	3	LT	3
Non Volatile Beta	pCi/l	LT	4	LT	4		13	LT	4	LT	5	LT	5		5.6	LT	5		30		5.6		5.5	LT	4
Total Radium	pCi/l		1.2	LT	1	LT	1		1.1	LT	1		1.1	LT	1		1.3	LT	1		4.6		1.4		2
Tritium	pCi/ml		3.5		2.2	LT	1		3		1.6	LT	1	LT	1	LT	1	LT	1	LT	1	LT	1	LT	1
Inorganics																									
Chlorine	mg/l		3.61		0.87		1.82		1.45		1.41		1.26		1.68		1.78		2.88		1.37		1.57		1.5
Fluorine	mg/l	LT	0.25	LT	0.25	LT	0.25	LT	0.25	LT	0.25	LT	0.25		0.47	LT	0.25		0.41	LT	0.25	LT	0.25	LT	0.25
Ammonia	mg/l		126		110		127		137	LT	30		129		157		141		85.8		39.8	LT	30	LT	30
Nitrate	mg/l		0.81		0.84		0.48		0.9		0.64	LT	0.1	LT	0.1		0.46	LT	0.1	LT	0.1	LT	0.1	LT	0.1
Sulfate	mg/l	LT	1	LT	1		1.34	LT	1	LT	1		8.82		15		2.33		45.9		9.33		10.5		9.84
Total Phosphate	µg/l		101		62.7		560		73.4		81.5		203		65.2		88.1		5940		121		134		177

(1) "LT" indicates sample concentration below the detection limit.

(2) Shading indicates sample was analyzed beyond method-specified holding time for that constituent.

2.2 Metals, Radionuclides, and Inorganic Analytes

analytical results for inorganic parameters are listed in Table 7-3. In general, inorganic parameters were within the range expected for the regional aquifers. With a few minor exceptions (discussed below) concentrations of the constituents for which drinking water standards exist were below the respective standards. Exceedances for metals were observed in only one temporary piezometer (BTP-4D), and in that case the concentrations were only marginally above drinking water standards and occurred in one piezometer, BTP 4D. This piezometer also evidenced relatively high values for turbidity, sodium and calcium, while having a normal (5.4 to 5.5) pH. These conditions indicate that sediments around the well assimilated components of the drilling mud (sodium bentonite) that are still being desorbed. With additional production of water from these wells, concentrations of these parameters should drop below drinking water standards.

In piezometer BTP 7D, the tritium concentration was approximately equal to the drinking water standard, indicating that the range in tritium concentrations in the area is from less than 1 to 20 pci/ml, but in all cases within drinking water standards.

Concentrations of inorganic parameters (Table 7-3) indicate that agricultural and other miscellaneous human impacts to ground water have been negligible.

8.0 GEOTECHNICAL PROPERTIES OF SITE SOILS

8.1 Geotechnical Issues Affecting Landfill Siting and Design

The proposed landfill will consist of cells partly excavated below ground and partly constructed above ground (WSRC, 1990a). With this design concept attempts will be made to balance excavation volumes with soil needed to complete the berms or dikes between cells, and to provide daily cover without the need to import additional soil or dispose of excess soil from the site. Therefore, it is important to evaluate the characteristics of soil materials on site with regard to engineering applications.

The objectives of the geotechnical component of this investigation were: (1) investigate the ease/difficulty of excavation of site soils; (2) identify soils potentially suitable for site engineering purposes; (3) evaluate compaction properties of soils potentially suitable for berms, dikes, liners, or caps; (4) assess the relative stability of these soils; and (5) identify any potential suitability or construction problems that may affect development of the landfill facility. Standard penetration tests in combination with limited laboratory characterization of representative soil samples is adequate to assess site soil conditions for these concerns.

8.2 Engineering Properties of Site Soils

The Site B Hydrogeologic Investigation Program Plan (Sirrine, 1990c) provided for geotechnical borings and test pits designed to enable characterization and sampling of shallow (<50 ft) soils. A total of 41 borings were drilled, 39 to 50 ft, and two to approximately 100 ft.

The geologic formation penetrated by the soil borings is known as the Tobacco Road Formation, which is the upper portion of the Barnwell Group, of middle Eocene-age. This

formation is broadly characterized as dominated by clayey sand with silty clay lenses. This description was found to be generally applicable across Landfill Site B. The water table is more than 50 ft below land surface over most of the site.

The logs of the geotechnical soil borings (BSB series) are presented in Appendix I. The test pit logs are presented in Appendix J.

The upper one ft of soil at the site generally consisted of silty sand with low to moderate organic content. These materials should generally be suitable for use as topsoil. The underlying soils in the 0-50 ft depth zone were variable in texture but generally ranged from silty sands to sandy clays. Although some deposits of moderately to highly plastic sandy clay were noted, they do not appear to be sufficiently extensive or consistent to serve as a reliable source for low permeability liner material. Wet soils were noted in some of the borings drilled at lower elevations, and in BSB-2 and BSB-3. In the latter cases the wet conditions may have been associated with perched water.

The results of the geotechnical soil characterization of undisturbed soil samples are summarized in Table 8-1. Geotechnical data for bulk and split-spoon samples is presented in Tables 8-2 and 8-3, respectively. The raw laboratory data for these analyses is provided in Appendix L.

Laboratory analyses confirmed that the soil materials within approximately 30 to 40 ft of ground surface are predominantly sandy clay (CL) and clayey sand (SC) in texture. Sand content in this zone generally ranges from 35 to 60 percent. Atterberg LL values in the range of 50 ± 10 percent were generally observed in these soils, with PI values of 20 to 30. Standard Proctor values for these soils ranged from approximately 101 to 107 pcf at 17 to 22 percent moisture.

Table 8-1
Summary of Soil Geotechnical Characterization Data
Undisturbed Samples
Proposed Landfill Site B, Savannah River Site

Sample	Depth Below Grade (ft)	Initial Dry Density (PCF)	Initial Moisture Content (%)	Percent (1)				Atterberg Limits			Specific Gravity	Permeability (cm/s)	Cation Exchange Capacity (meq/100g)	Organic Content (%)
				Sand	Silt	Clay	Finer #200	LL (%)	PL (%)	Plasticity Index				
BTP-5C	268	88.6	33.0	8.2	56.3	35.5	91.8	92	30	62	—	2.77E-08	33.3	11.6
BTP-6C	274	99.1	26.6	26.7	45.5	27.8	73.3	59	24	35	—	7.98E-10	46.3	10.7
BTP-7C	263	73.9	47.2	0.6	43.9	55.5	99.4	106	52	54	—	3.13E-09	70.4	6.5
BTP-9C	262	95.9	20.9	85.0	7.2	7.8	15.0	23	18	5	—	3.31E-06	— (2)	—
BTP-9C	287	113.1	15.2	81.4	6.4	12.2	18.6	29	17	12	—	1.29E-07	—	—
BTP-10C	302	102.6	21.3	81.9	5.7	12.4	18.1	32	19	13	—	1.19E-06	—	—
BTP-11C	252	98.0	25.1	3.2	74.2	22.6	96.8	39	19	20	—	4.52E-09	—	—
BTP-11C	282	60.9	51.2	14.0	60.3	25.7	86.0	86	60	26	—	2.96E-08	—	—
BTP-12C	183	105.6	18.2	68.2	21.6	10.2	31.8	32	17	15	2.568	8.76E-09	—	—
BTP-12C	303	62.1	63.0	78.9	10.2	10.9	(3) 21.1	100	73	27	—	2.54E-09	—	—
BTP-12C (4)	—	—	—	7.0	57.4	35.6	(4) 93.0	—	—	—	—	—	—	—
BSB-41	277	71.1	45.8	32.3	55.8	11.9	67.7	86	58	28	—	2.27E-08	48.7	7.8
BSB-41	286	70.0	51.9	41.1	37.2	21.7	58.9	101	59	42	2.552	9.76E-09	—	—
IDB-2CC	151	93.4	25.6	46.7	58.8	12.1	53.3	45	21	24	—	7.62E-09	—	—

(1) Particle size determination per Unified Soil Classification System.

(2) "—" Not Requested.

(3) Sample indurated, required mechanical pulverization.

(4) Sample indurated, pulverized mechanically, then re-tested for particle size distribution.

Table 8-2
Summary of Soil Geotechnical Characterization Data
Bulk Samples
Proposed Landfill Site B, Savannah River Site

Sample	Depth (ft)	Initial Moisture Content (%)	Percent (1)				Atterberg Limits		Plasticity Index	Specific Gravity	Maximum Dry Density (PCF)	Optimum Moisture Content (%)
			Sand	Silt	Clay	Finer #200	LL (%)	PL (%)				
BTX-1	5-10	16.8	63.0	16.9	20.1	37.0	42	23	19	— (2)	—	—
BTX-1	15-20	19.5	64.9	—	—	35.1	—	—	—	—	—	—
BTX-2	15-20	14.1	70.4	—	—	29.6	—	—	—	—	—	—
BTX-2	bulk	13.5	67.4	8.4	24.2	32.6	31	19	12	—	111.6	14.0
BTX-3	20-25	25.2	34.3	11.2	54.5	65.7	52	22	30	—	—	—
BTX-3	bulk	17.6	53.5	—	—	46.5	—	—	—	—	104.7	19.7
BTX-4	25-30	16.6	77.6	—	—	22.4	—	—	—	—	—	—
BTX-5	bulk	21.1	57.5	—	—	42.5	—	—	—	—	107.1	17.5
BTX-6	bulk	20.3	45.1	28.3	26.6	54.9	46	23	23	2.709	101.1	22.5
BTX-7	bulk	10.9	75.9	9.0	15.1	24.1	22	18	4	—	115.3	12.9
BTX-7	10-15	15.4	72.6	—	—	27.4	24	16	8	—	—	—
BTX-8	20-25	12.8	75.1	9.1	15.8	24.9	—	—	—	—	—	—
BTX-8	bulk	15.7	67.1	—	—	32.9	—	—	—	—	112.1	15.6
BTX-9	25-30	12.2	80.5	—	—	19.5	27	18	9	—	—	—
BTX-9	bulk	—	—	—	—	—	46	19	27	—	111.1	16.1
BTX-10	5-10	16.5	71.6	—	—	28.4	29	16	13	—	—	—
BTX-10	bulk	13.4	72.3	3.6	24.1	27.7	23	11	12	—	119.8	11.5
BTX-11	20-25	15.5	66.4	7.3	26.3	33.6	37	20	17	—	—	—
BTX-11	bulk	** (3)	**	**	**	**	**	**	**	—	**	**
BTX-12	15-20	14.4	66.7	—	—	33.3	—	—	—	—	—	—
BTX-12	bulk	17.5	50.3	12.1	37.6	49.7	44	22	22	—	—	—
BTX-13	10-15	16.1	73.7	—	—	26.3	—	—	—	—	—	—
BTX-13	bulk	—	—	—	—	—	—	—	—	—	114.4	14.1
BTX-15	5-10	19.3	53.3	9.3	37.4	46.7	—	—	—	—	—	—
BTX-15	bulk	18.1	54.4	—	—	45.6	—	—	—	—	106.8	18.5
BTX-16	20-25	18.9	46.7	9.5	43.8	53.3	—	—	—	—	—	—

(1) Particle size determination per Unified Soil Classification System.

(2) "—" Not Requested.

(3) "****" Not Available.

Table 8-3
Summary of Soil Geotechnical Characterization Data
Split Spoon Samples
Proposed Landfill Site B, Savannah River Site

Sample	Depth (ft)	Initial Moisture Content (%)	Percent (1)				Atterberg Limits		Plasticity Index	Specific Gravity	Percent Organic (%)	Cation Exchange Capacity (meq/100g)
			Sand	Silt	Clay	Finer #200	LL (%)	PL (%)				
BSB-1	39	10.1	82.2	— (2)	—	17.8	—	—	—	—	—	—
BSB-4	34	12.5	69.4	—	—	30.6	—	—	—	—	—	—
BSB-5	41	22.4	79.7	10.2	10.1	20.3	30	26	4	2.930	—	—
BSB-6	45	14.4	—	—	—	—	—	—	—	—	2.70	78
BSB-7	50	15.1	77.9	—	—	22.1	—	—	—	—	—	—
BSB-8	39	14.6	63.5	—	—	36.5	—	—	—	—	—	—
BSB-9	45	18.8	66.0	—	—	34.0	—	—	—	—	—	—
BSB-10	44	12.4	75.2	6.8	18.0	24.8	33	19	14	—	—	—
BSB-10	49	16.6	—	—	—	—	—	—	—	—	2.85	70
BSB-12	40	17.1	73.1	7.0	19.9	26.9	25	21	4	—	—	—
BSB-13	39	12.8	—	—	—	—	—	—	—	—	3.42	84
BSB-14	34	9.1	74.4	5.8	19.8	25.8	—	—	—	—	—	—
BSB-15	35	15.0	69.7	6.8	23.5	30.3	40	21	19	—	—	—
BSB-16	44	12.2	81.9	5.9	12.2	18.1	35	18	17	—	—	—
BSB-20	45	13.9	82.0	—	—	18.0	28	19	9	—	—	—
BSB-21	45	17.0	79.3	5.5	15.2	20.7	39	19	20	—	—	—
BSB-23	40	16.4	78.6	—	—	21.4	—	—	—	—	—	—
BSB-25	45	18.5	64.3	14.2	21.5	35.7	—	—	—	—	—	—
BSB-27	39	15.6	80.5	—	—	19.5	31	20	11	—	—	—
BSB-29	49	14.8	84.9	—	—	15.1	—	—	—	—	—	—
BSB-31	34	8.5	70.3	9.3	20.4	29.7	27	19	8	—	—	—
BSB-33	44	3.7	91.1	—	—	8.9	—	—	—	—	—	—
BSB-35	44	22.0	66.2	—	—	33.8	—	—	—	—	—	—
BSB-36	44	9.5	79.6	5.1	15.3	20.4	27	19	8	—	—	—
BTP-1D	35	15.3	70.8	11.6	17.6	29.2	24	20	4	2.698	—	—
BTP-1D	40	15.3	—	—	—	—	—	—	—	—	2.55	70
BTP-2D	45	20.1	64.9	13.7	21.4	35.1	28	18	10	—	—	—
BTP-4D	39	10.1	82.8	—	—	17.2	—	—	—	—	—	—

(1) Particle size determination per Unified Soil Classification System.

(2) "—" Not Requested.

(3) "----" Not Available.

These shallow clayey soils appear to be very non-uniform laterally. However, this soil material has compactibility and permeability properties suitable for cap construction. This zone appears to be approximately 10 to 15 ft thick. With considerable care these soils can be selectively stockpiled during excavation of the landfill cells for subsequent use in berms or caps. The soils overlying this clayey zone, and below the relatively non-cohesive sandy zone, are primarily clayey sands which should be suitable for general earthwork.

8.3 Potential Suitabilities for Soil Engineering Applications

The topsoil at the site may be considered unsuitable for construction purposes, and, in any event, should be stockpiled for future use in establishing vegetative cover over the cells as they are closed. Laboratory test results for the underlying soils and data from field descriptions and SPT values (blow counts) suggest that the engineering properties of these soils are suitable for use in constructing and maintaining a landfill. Typical SPT values of roughly 7 were logged for the silty sands and sandy clays encountered to a shallow depth of 4 to 6 ft. These SPT values define "loose" conditions for granular soils or "medium stiff" conditions for cohesive silty or clayey soils. These relatively low-strength conditions were also confirmed by trafficability problems and difficulty in moving heavy equipment about the site after rainy weather.

The SPT values for soils below a depth of 4 to 6 ft indicated medium dense to dense, or stiff to very stiff soils. Based on these data these medium and fine-textured soils should support properly designed earth berms and dikes. Also, excavations and cut slopes should also be relatively stable. Relatively non-cohesive silty sands were observed below depths of about 25 ft in the test pits in the northern portion of the site. These conditions may pose stability problems in unprotected, deep excavations. The large Koehring 1066 trackhoe experienced no difficulty in excavating the test pits, with the exception of BTX-10 and BTX-13 in the southern portion of the site, where some caving was noted.

The granular soils at the site are relatively fine grained with very few particles noted larger than medium sand (0.5 mm). With these conditions gravel will have to be imported to the site for haul roads. The Proctor curves available for bulk samples excavated from the test pits indicate those soils will require moderate to high level of moisture control for compaction. The in-situ moisture contents of most of the soils appear to be wetter than optimum for compaction, indicating the soils may require drying prior to construction. The normal drying that occurs during dry weather excavation and handling may be sufficient to allow most soils to be compacted to 95% Proctor density. Excavation of cells and construction of berms could be scheduled to allow wet soils to be set aside to dry prior to preparation for daily cover or capping material applications.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 Overall Compliance with SCDHEC Draft Guidance for Landfill Siting

The following conclusions are offered with respect to the suitability of Site B for the proposed municipal solid waste landfill. These conclusions are outlined according to the framework of the fourteen considerations set forth in the most recent SCDHEC "Guidelines for Establishing the Hydrogeologic Suitability of Proposed Sites for Industrial and Domestic Waste Landfills, (1990)."

9.1.1 Complex Hydrogeologic Conditions

The hydrogeology of Site B and the surrounding area has been thoroughly characterized and is comprehensively presented in Section 6.

The proposed landfill will employ technologies and practices such as composite liner and capping systems and leachate collection systems that will largely eliminate potential ground-water contamination risks. Also, the local hydrogeologic setting of Site B can be easily monitored for prompt detection of releases. Finally, the local aquitards and head reversal conditions provide very favorable natural mechanisms for preventing any impact to the aquifers underlying the site.

9.1.2 Unmonitorable Areas

The uppermost aquifer has been identified and characterized as discussed in Section 6.2.1.5. Flow rates and flow directions and horizontal and vertical flow components have been thoroughly addressed. The aquifer conditions documented at Site B will make early detection of any potential contaminant release relatively straightforward using conventional monitoring technology.

9.1.3 Corrective Action Demonstration

Based on the design concepts and advanced construction technologies proposed for the new landfill, corrective action for the facility is not anticipated to be necessary. The proposed landfill will have a composite liner system with a leachate collection system, and a composite capping system. In the unlikely event of a release, ground-water flow rates in the water table aquifer are slow enough to provide ample time to design and implement corrective action after a release is detected. In any case, given the expected small volume of leachate to be produced, and the even smaller amount that might escape from the facility, any conceivable impact to the water table aquifer would be small and localized. However, based upon the nature of the aquifers, a corrective action program can be implemented for this site, if warranted.

9.1.4 Recharge Areas

Data presented in Section 6 suggests that there is a downward component of flow in the unconfined aquifer above the Green Clay. Also, assuming hydraulic continuity above and below the Green Clay, there is potential for downward leakage across it. As discussed in section 6.2.1.4, the Green Clay is laterally continuous throughout the subsurface at Site B and has very low permeability.

Within the Congaree aquifer, the one control point with both an upper and lower Congaree piezometer (IDB 2B and IDB 2CC), indicates a potential for upward flow. Also, as discussed in section 6.2.3, the vertical hydraulic gradient across the Williamsburg/Rhems confining unit is in the upward direction from the regional Upper Cretaceous (Pee Dee) aquifer to the Congaree aquifer.

In summary, the results of this site hydrogeologic characterization study indicate that while ground water does have the potential to flow downward within the unconfined aquifer, it has little potential to migrate deeper. Data provided in Section 6 established that the unconfined aquifer at Site B is not a source of drinking water, anywhere on the SRS, and that nearby streams separate the aquifer into a hydrologic sub-unit that is areally limited to the central SRS.

9.1.5 Special Ground-Water Areas

According to R.61.68 (Water Classifications and Standards) South Carolina Code of Laws, as amended, all of the ground water in the State of South Carolina is currently classified as GB. At this time there are no Class GA ground waters in the State.

9.1.6 Ground-Water Use

Section 6.2.2 established that no drinking water wells exist within the setback distances cited by the SCDHEC guidance. Further, the most preferred and prolific aquifers in the area are in the confined Cretaceous-age sediments. An upward hydraulic gradient exists from these aquifers to the overlying, shallower aquifers which greatly diminishes the possibility of contamination through downward migration.

9.1.7 Shallow Limestone

Section 5.2.3 describes all calcareous material and zones of lost circulation encountered at Site B. No such zone was observed within 50 ft of the land surface. These conditions occur only sporadically at the Site and their lateral extent and hydrogeologic significance is very limited with respect to the proposed facility.

9.1.8 Fault Zone

As described in Section 5.2.2, no evidence of Holocene faulting was observed during the investigation of Site B. No known "active" faults exist within 1,000 ft of Site B.

9.1.9 Confining Unit

The Williamsburg/Rhems confining unit, as described in Sections 5 and 6, meets all of the criteria set forth in the SCDHEC guidance.

9.1.10 Vertical Potentiometric Relationships

As discussed in Section 9.1.4, an upward hydraulic gradient exists across the Williamsburg/Rhems confining unit at Site B. This gradient indicates that a potential exists for ground water in the upper Cretaceous aquifer to discharge upward into the overlying Congaree aquifer. Available data also indicate an upward flow potential within the Congaree aquifer.

9.1.11 Depth to Ground Water

Section 6.2.1.6 presents evidence that the depth to the water table is approximately 50 ft or greater throughout the site. Some localized perched conditions may exist. The landfill design will take into account the observed water table conditions and allow for "seasonal high" fluctuations in selecting construction elevations for the facility. We conclude that maintenance of a minimum four foot separation between the operational units and the water table will not be a problem.

9.1.12 Surface Water

As previously stated, (see Section 3.2) the landfill will employ a composite liner system and a leachate collection system. These engineering features will

substantially reduce the possibility of a leak and the magnitude and significance of any potential release. Should a release occur, ground-water flow rates in the water table aquifer are slow enough to provide ample time to design and implement corrective action prior to contaminants reaching surface water or any potential water supply aquifer.

9.1.13 Bedrock

Section 5 establishes that bedrock is at least one thousand ft below Site B.

9.1.14 Cap/Liner Material

Based on several studies of clay resources on and around SRS, the probable best option for liner and cap materials is off-site sources. The local kaolin industry has provided liner materials meeting the SCDHEC specification of 1×10^{-7} for several other SRS projects (MWMF Closure, F & H Seepage Basins Closure). Note that the proposed liner and capping systems will be composite designs, utilizing flexible membrane liners as well as natural clay (Figure 2-4). See Section 9.2 for further discussion of cap/liner materials.

9.2 Potential Sources Of Cap/Liner Material

One of the purposes of the geotechnical investigation at Landfill Site B was to evaluate the potential for using on-site soils as cap/liner material. In addition, the "On-site Clay Borrow Study, Mixed Waste Management Facility (MWMF) Closure" prepared by Mueser-Rutledge Consulting Engineers, July 1987, was reviewed for relevancy to Site B. The conclusions of the Mueser-Rutledge study and of the current investigation are similar. Clayey soils exist in SRS Area R-3 that can be compacted to a permeability less than 1×10^{-7} cm/sec. Similar conditions exist at Site B. However, the lateral and vertical continuity of these clayey layers is such that close supervision by an experienced field staff would be necessary

during excavation to identify and segregate the acceptable clays for stockpiling and subsequent use as liner or cap material. Mueser-Rutledge estimated that Area R-3 might contain 240,000 cubic yards of suitable clay.

The clayey soils encountered in the test pits and soil borings at Site B exhibited lower plasticity than the R-3 area clays, indicating that permeability might be marginal. One sample, from Test Pit BTX-3 had a liquid limit of 52 and contained 34% sand. All other samples from the current study of Site B had lower liquid limits and higher sand contents. Mueser-Rutledge concluded that the expense of stripping overburden and setting up a clay borrow operation in Area R-3 might not be cost-effective when balanced against the availability and cost of off-site Tertiary Kaolin. That conclusion would probably also be valid for Site B clays if those soils were to be excavated and transported elsewhere for use. However, the clayey soils at Site B will be a "by-product" during excavation of the landfill cells and may prove to be sufficiently extensive and consistent to justify the extra cost of segregating, testing, and stockpiling them. While this soil may prove marginal for use as liner material, it may provide a substantial portion of the cap material where a permeability of 1×10^{-5} cm/sec is acceptable.

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