United States Department of Energy

Savannah River Site

Record of Decision
Remedial Alternative Selection for the F-Area Retention Basin (281-3F) (U)

WSRC-RP-97-145

Revision 1.1

August 1998

Prepared by:
Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808
Prepared for U.S. Department of Energy under Contract No. DE-AC09-9

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Westinghouse Savannah River Company
Aiken, South Carolina

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RECORD OF DECISION
REMEDIAL ALTERNATIVE SELECTION (U)

F-Area Retention Basin (281-3F)

WSRC-RP-97-145
Revision 1.1
August 1998

Savannah River Site
Aiken, South Carolina

Prepared by:

Westinghouse Savannah River Company
for the
U.S. Department of Energy under Contract DE-AC09-96SR18500
Savannah River Operations Office
Aiken, South Carolina

DECLARATION FOR THE RECORD OF DECISION

Unit Name and Location

F-Area Retention Basin (SRS Building 281-3F)
Savannah River Site
Aiken, South Carolina

The F-Area Retention Basin (FRB) Operable Unit (OU) is listed as a Resource Conservation and Recovery Act (RCRA) 3004 (U) Solid Waste Management Unit/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Unit in Appendix C of the Federal Facility Agreement (FFA) for the Savannah River Site (SRS). This OU includes the retention basin (basin soils), the former process sewer line (pipeline, pipeline sediment, and pipeline associated soils), and the groundwater associated with the unit.

Statement of Basis and Purpose

This decision document presents the selected remedial alternatives for the FRB OU located at the SRS south of Aiken, South Carolina. The selected alternatives were developed in accordance with CERCLA, as amended by SARA, RCRA, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record File for this specific RCRA/CERCLA unit.

Assessment of the Site

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

Description of the Selected Remedy

The preferred alternatives for the FRB OU are: (1) for the basin soil; Alternative S5: Institutional Controls, Grouting, a Low Permeability Cover, and Groundwater Monitoring; (2) for the former process sewer line: Alternative P4: Institutional Controls, Pipeline Grouting, and Soil Excavation and Disposition with Basin Soils; and (3) for the groundwater; Alternative G1: No Action. The waste unit will be physically maintained and institutional controls will remain in place in perpetuity. The field conditions will be evaluated to determine the need to modify the program or to identify if further remedial action is appropriate during the five-year ROD review.

Under Alternative S5, deep basin soil will be grouted from approximately 0.6 m (2 ft) above the basin bottom to approximately 4.3 m (14 ft) below grade. The purpose of grout is to prevent leaching of Sr-90, which is the only contaminant migration COC (CMCOC) to the groundwater above maximum concentration level 8.0 pCi/L. Furthermore, grouting the soil provides an additional layer of protection by offsetting the inherent uncertainty associated with the mathematical model used to predict contaminant migration. Grouting will also immobilize other deep contaminants which represent principal threat source material such as Cs-137, Ra-226, thallium, arsenic, etc., and further reduce infiltration of water through the deeper contaminated soils. Grouting of soils is preferred over only capping because it meets the CERCLA preference for treatment. A cover will be provided over the stabilized soil to minimize stormwater percolation and erosion. The cover is also very effective in reducing direct radiation exposure received from radionuclides in the shallow soil. This alternative includes institutional controls to prevent exposure of current and future workers to hazardous constituents in the waste unit and direct radiation from the waste unit. Since waste is left in place, the future use of land will be restricted to industrial use to prevent unrestricted residential use of the land.

In situ grouting reduces air emissions and is relatively simple to implement. However, *in situ* grouting results in a slight increase in waste volume. The volume of the basin, when clean soil is excavated prior to grouting, will be adequate to accommodate any increase in grouted soil volume. The estimated volume of grout/soil mixture is 6,600 m^3 (8,100 yd^3).

Implementation of institutional controls will involve both short- and long-term actions. For the short-term action, signs will be posted at the FRB OU indicating that this area was used for the disposal of waste material and contains buried waste. Additionally, existing SRS access controls will be used to maintain use of this site for industrial use only. In the long-term, if the property is ever transferred to non-Federal ownership, the U.S. Government will take those actions necessary pursuant to Section 120(h) of CERCLA. These actions will include a deed notification disclosing former waste management and disposal activities as well as any remedial actions taken on the site and any continuing groundwater monitoring commitments. These requirements are also consistent with the intent of the RCRA deed notification required at final closure of the RCRA facility if contamination would remain at the unit. The deed notification shall, in perpetuity, notify any potential purchaser that the property has been used for the management and disposal of radioactive materials and hazardous substances. The deed shall also include deed restrictions precluding residential use of the property. However, the need for these deed restrictions may be reevaluated at the time of transfer in the event that contamination no longer poses an unacceptable risk under residential use. Any reevaluation of the need for deed restrictions would be done through an amended ROD with the Environmental Protection Agency (EPA) and the South Carolina Department of Health and Environmental Control (SCDHEC) approval. In addition, a certified survey of the area will be prepared by a registered land surveyor and will be included in the Post-Construction Report. The survey will be reviewed and updated, as necessary, at the time the site is transferred and will be recorded into the appropriate county recording agency. The FRB OU is located in Aiken County.

Per the EPA-Region IV Land Use Controls (LUCs) Policy, a Land Use Control Assurance Plan (LUCAP) and a Land Use Control Implementation Plan (LUCIP) will be developed and submitted to the regulators for their approval. The LUCAP will be submitted under separate cover whereas the LUCIP will be submitted with the Remedial Work Plan/Remedial Design Report/Remedial Action Work plan (RFWP/RDR/RAWP) for the FRB OU in accordance with the Post-ROD document schedule provided in this ROD. The LUCAP will include the information requested in the EPA policy. The LUCIP details how SRS will implement, maintain, and monitor the land use control elements of the FRB OU ROD to insure that the remedy remains protective of human health.

The LUC objective necessary to ensure the protectiveness of the preferred alternative is:

- Prevent unauthorized access/exposure to contaminated grout and basin soil

The institutional controls required to prevent unauthorized exposure to the contaminated grout and soil include the following:

- Controlled access to the FRB waste unit through existing SRS security gates and perimeter fences and the site use/site clearance programs

- Signs posted in the area to indicate that contaminated grout and soil are present in the waste unit

- Notification of contaminated grout and soil to any future land owner through deed notification as required under CERCLA Section 120(h)

Along with the institutional controls identified above for the FRB soils, the preferred alternative for the process sewer line and associated soils will include pipeline and manholes grouting, and excavation and disposition of pipeline soils (approximate volume $240m^3$ or 300 yd^3) with basin soil. In this alternative, the localized areas of the contaminated soil around the pipeline hot spots will be excavated. If necessary, the sections of pipeline associated with the hot spots will also be excavated. The excavated soil and pipeline will be disposed of at the basin by *in situ* grouting along with soil from the basin. Clean soil from SRS borrow areas will be used to fill excavated areas around the pipeline. This alternative will also include access controls such as installing warning signs around the pipeline area.

The preferred alternative for the FRB OU groundwater is "No Action". The history of the FRB, the results of the groundwater modeling, and the current groundwater data reveal that the FRB-associated groundwater poses no risk to human health or the environment. No contaminant exceeds the maximum contaminant levels (MCLs) stipulated by EPA under the Safe Drinking Water Act. However, to ensure that the grout monolith, formed by *in situ* grouting of soils under Alternatives S5 and P4, has accomplished the required immobility of contamination, a groundwater monitoring program will be established under Alternative S5. The groundwater will be monitored semi-annually until it is confirmed that the remedial response action for the FRB OU has achieved the required stabilization of the contaminants. Groundwater monitoring, in conjunction with institutional controls, will help prevent ingestion of groundwater; verify that no upgradient source of contamination exists; and reduce the uncertainty in the environmental data collected during the characterization of the FRB OU.

The post-ROD document, the Corrective Measures Implementation/Remedial Design Work Plan (CMI/RDWP), will be submitted to the U.S. Environmental Protection Agency (EPA) and the South Carolina Department of Health and Environmental Control (SCDHEC) following the issuance of the ROD. The CMI/RDWP will contain a summary description of the scope of work for the remedial action design, detailed implementation/submittal schedule for subsequent post-ROD documents, and an anticipated field activities start date. The CMI/RDWP will also include regulatory review period, SRS revision period, and final regulatory approval period. The regulatory review period, SRS revision period, and final regulatory review and approval period normally are 45 days, 30 days, and 30 days, respectively.

The SCDHEC has modified the SRS RCRA permit to incorporate the selected remedy.

Statutory Determinations

Based on the Remedial Investigation Report and the Baseline Risk Assessment (RI/BRA prepared under SRS RFI/RI Program Plan), the FRB OU poses no significant risk to the environment but poses a significant risk to human health. Therefore, institutional controls, *in situ* grouting of the contaminated basin soil and covering the grouted soil with a low permeability cover, and confirmatory groundwater monitoring are necessary for the basin soil; institutional controls, pipeline and manhole grouting, and excavation and disposition of soil with the basin soil are necessary for the pipeline and pipeline associated soil. No additional remedial action is required for the FRB OU groundwater. However, as a part of remedial action, the groundwater will be monitored: (1) to confirm that the source remediation has achieved the required stabilization of the contaminants; (2) to relieve any uncertainty in the analytical data; and (3) to verify that there exists no upgradient source contributing any contamination to the FRB OU groundwater. If monitoring detects contamination above MCLs (or Risk-Based Concentrations (RBCs) without MCLs) for those constituents attributable to the FRB OU groundwater (or an upgradient source) for two consecutive monitoring periods, the regulators will be informed within 30 days. A plan for evaluating the data and developing further action needed will be submitted within 90 days for regulatory approval.

In situ grouting of soils and cover will: (1) result in the protection of unit groundwater through the stabilization of unit constituents of concern (COCs); and (2) serve to stabilize the principal threat source material. The grout testing under actual field conditions will be performed to confirm the successful soil stabilization. The remedial action, therefore, will be protective of on-unit human and ecological receptors by shielding exposure and preventing the assimilation of unit COCs. The selected remedy is protective of human health and the environment, and complies with Federal and state Applicable or Relevant and Appropriate Requirements (ARARs). The selected remedy is cost-effective. This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatments that reduce toxicity, mobility, or volume as a principal element.

Section 300.430 (f)(4)(ii) of the NCP requires that a Five-Year Review of the ROD be performed if hazardous substances, pollutants, or contaminants remain in the waste unit. Since hazardous substances will remain on-unit above health-based standards, the United States Department of Energy, the United States Environmental Protection Agency, and the South Carolina Department of Health and Environmental Control have determined that a Five-Year Review of the ROD for the FRB OU will be performed to ensure continued protection of human health and the environment.

8/26/98

Date

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Assistant Manager for Environmental Quality
U. S. Department of Energy
Savannah River Operations Office

SEP 04 1998

Date

Richard D. Green
Division Director
Waste Management Division
U.S. Environmental Protection Agency

10/19/98

Date

R. Lewis Shaw
Deputy Commissioner
Environmental Quality Control
South Carolina Department of Health and Environmental Control

DECISION SUMMARY
REMEDIAL ALTERNATIVE SELECTION (U)

F-Area Retention Basin (281-3F)

WSRC-RP-97-145
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Savannah River Site
Aiken, South Carolina

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DECISION SUMMARY

TABLE OF CONTENTS

SECTION **PAGE**

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

ANS	American Nuclear Society
ARAR	Applicable or Relevant and Appropriate Requirement
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Ci	Curies
COC	Constituent of Concern
COPC	Constituent of Potential Concern
CSM	Conceptual Site Model
DOE	United States Department of Energy
DQO	Data Quality Objectives
EPA	United States Environmental Protection Agency
ERD	Environmental Restoration Department
FFA	Federal Facility Agreement
FRB	F-Area Retention Basin
CMS/FS	Corrective Measures Study/Feasibility Study
ft	foot (feet)
GPR	Ground Penetrating Radar
HI	Hazard Index
HQ	Hazard Quotient
m	meter
MCL	Maximum Contaminant Level
pCi/g	picoCurie per gram
NCP	National Oil and Hazardous Substances Contingency Plan
NEPA	National Environmental Policy Act
NPL	CERCLA National Priorities List
OU	Operable Unit
O&M	Operation and Maintenance
PCR	Post-Construction Report
mCi/g	milliCurie per gram
RAO	Remedial Action Objective
RAWP	Remedial Action Work Plan
RBA	Risk-Based Activity
RBC	Risk-Based Concentration

RCRA	Resource Conservation and Recovery Act
RDR	Remedial Design Report
RDWP	Remedial Design Work Plan
RGO	Remedial Goal Option
RI	CERCLA Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SB/PP	Statement of Basis/Proposed Plan
SCDHEC	South Carolina Department of Health and Environmental Control
SCHWMR	South Carolina Hazardous Waste Management Regulations
SRS	Savannah River Site
TBC	To-Be-Considered (requirement)
TCLP	Toxicity Characteristic Leaching Procedure
USC	Unit-Specific Constituent
WSRC	Westinghouse Savannah River Company

I. SAVANNAH RIVER SITE AND OPERABLE UNIT NAME, LOCATION, DESCRIPTION AND PROCESS HISTORY

Savannah River Site Location, Description, and Process History

The Savannah River Site (SRS) occupies approximately 803 square kilometers (310 square miles) of land adjacent to the Savannah River, principally in Aiken and Barnwell counties of western South Carolina. SRS is a secured U.S. Government facility with no permanent residents and is located approximately 40 kilometers (25 miles) southeast of Augusta, Georgia, and 32 kilometers (20 miles) south of Aiken, South Carolina (Figure 1).

SRS is owned by the United States Department of Energy (DOE). Management and operating services are currently provided by Westinghouse Savannah River Company (WSRC). SRS has historically produced tritium, plutonium, and other special nuclear materials for national defense and the space program. Chemical and radioactive wastes are by-products of nuclear material production processes.

Operable Unit Name, Location, Description, and Process History

The Federal Facility Agreement (WSRC, 1993) lists the F-Area Retention Basin (FRB) as a Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act (RCRA/CERCLA) unit requiring further evaluation using an investigation/assessment process that integrates and combines the RCRA Facility Investigation (RFI) process with CERCLA Remedial Investigation (RI) to determine the actual or potential impact to human health and the environment.

The FRB, designated as Building 281-3F, is located outside and south of the F-Area perimeter fence, approximately 1035 m (3397 ft) from Fourmile Branch (Figure 2). The FRB, with an area of approximately 0.6 acres (2,400 square meters) and approximate dimensions of 61 m (200 ft) long, 36.6 m (120 ft) wide, and 2.1 m (6.9 ft) deep (Figure 3), was designed and operated as an unlined, temporary container [capacity approximately 4.68 million liters (1.2 million gallons)]

Figure 1. Location of F Area at the Savannah River Site

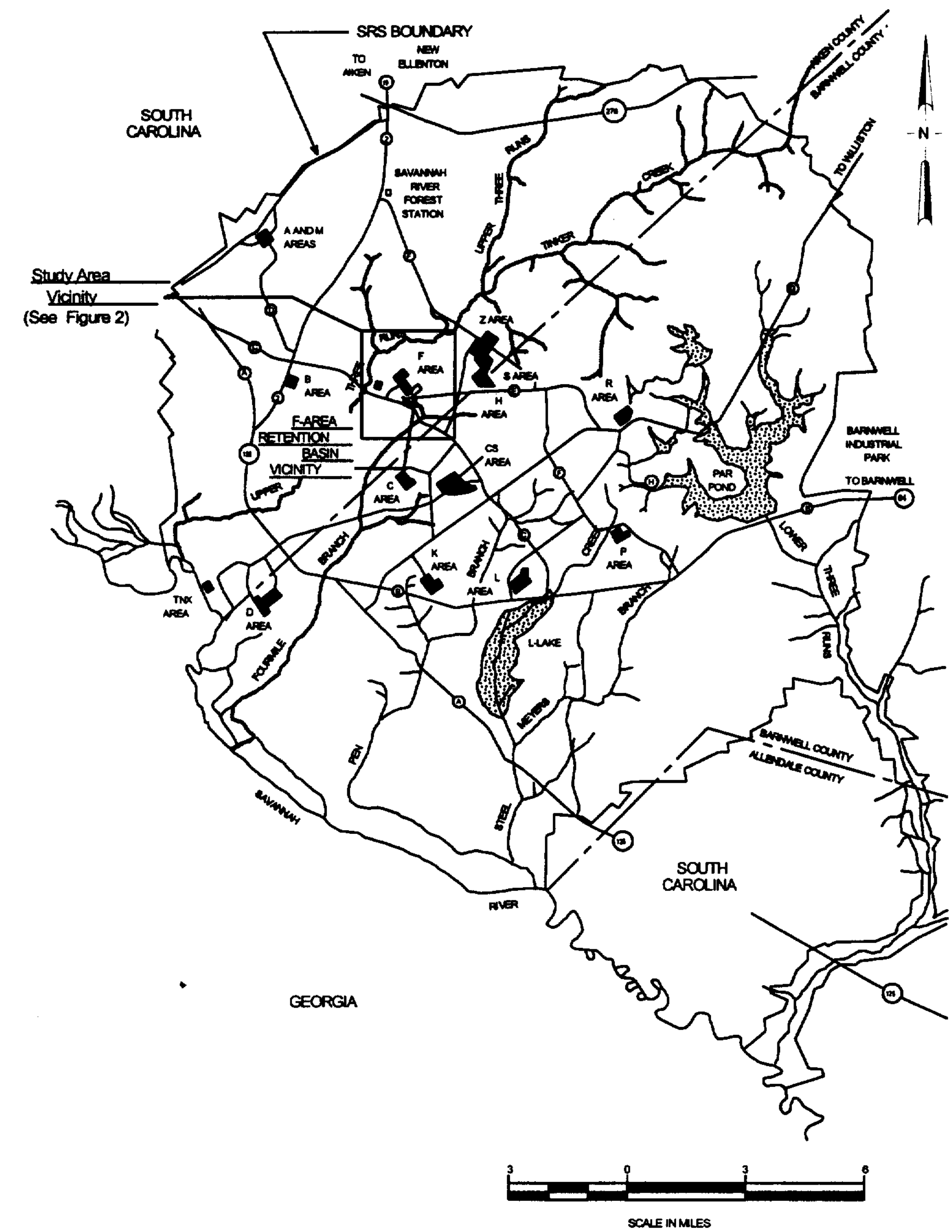


Figure 2. Topographic Map of the F-Area Retention Basin and Surrounding Area

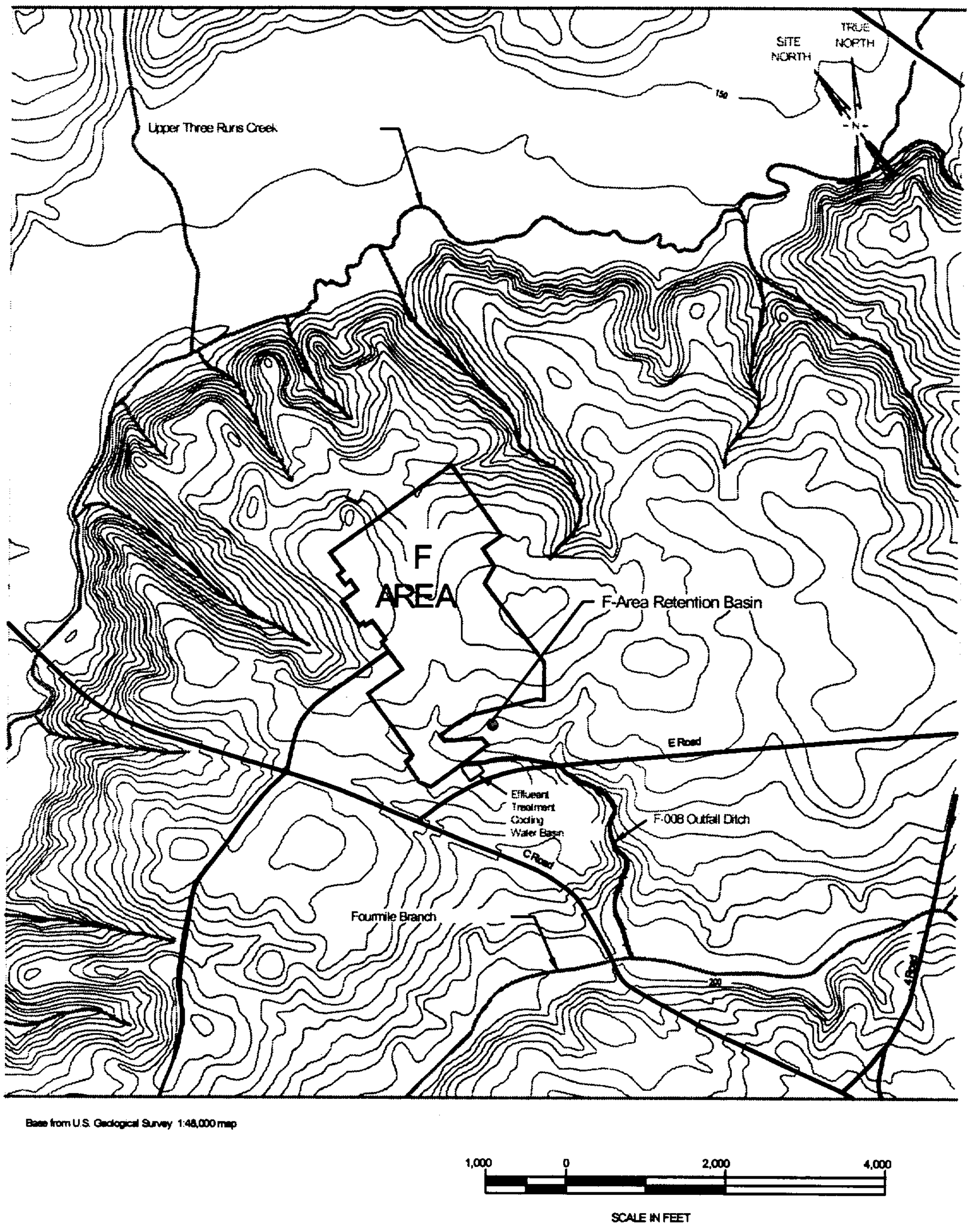
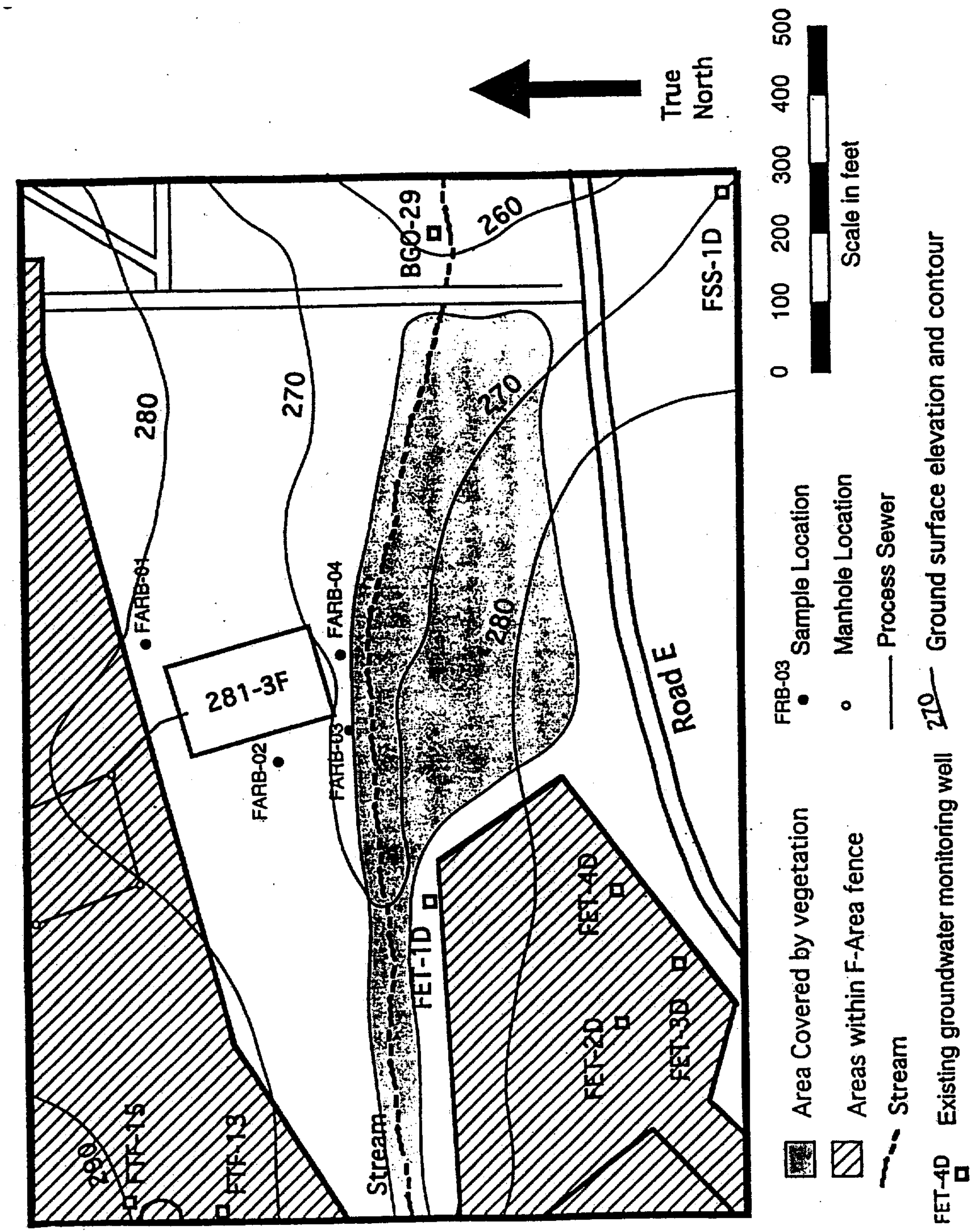


Figure 3. Plan View of the F-Area Retention Basin



for potentially contaminated cooling water from the F-Area Canyon Facility and stormwater drainage from the F-Area Tank Farm. Water was conveyed to the basin by a process sewer line (approximately 168 m (550 ft) of 61-cm (24-inch) diameter and approximately 212 m (700 ft) of 91 cm (36-inch) diameter that discharged into the north side of the basin. One branch of the line conveyed water from the Canyon Facility and the other branch conveyed water from the Tank Farm. Cooling water from the Canyon Facility generally had low levels of radioactivity, while water from the Tank Farm is believed to have had only trace quantities of nonradionuclide chemicals. The quantities of water released to the retention basin and the level of various constituents contained within the water are unknown.

The FRB is currently an inactive basin filled with clean soil and covered with grass. The FRB and its surrounding area lies at an elevation of approximately 275 ft above mean sea level. Surface water runoff drains southeast to Fourmile Branch via an unnamed drainage ditch (tributary) and overland flow.

II. SITE AND OPERABLE UNIT COMPLIANCE HISTORY

SRS Operational History

The primary mission of SRS was to produce tritium (^{3}H), plutonium-239 (^{239}Pu), and other special nuclear materials for our nation's defense programs. Production of nuclear materials for the defense programs was discontinued in 1988. SRS has provided nuclear materials for the space program, as well as for medical, industrial, and research efforts up to the present. Chemical and radioactive wastes are by-products of nuclear material production processes. These wastes have been treated, stored, and in some cases, disposed at SRS. Past disposal practices have resulted in soil and groundwater contamination.

SRS Compliance History

Waste materials handled at SRS are regulated and managed under RCRA, a comprehensive law requiring responsible management of hazardous waste. Certain SRS activities have required federal operating or post-closure permits under RCRA. SRS received a hazardous waste permit from the South Carolina Department of Health and Environmental Control (SCDHEC). The permit was most recently renewed on September 5, 1995. Part IV of the permit mandates that SRS establish and implement an RFI Program to fulfill the requirements specified in Section 3004(u) of the federal permit.

On December 21, 1989, SRS was included on the National Priorities List (NPL). This inclusion created a need to integrate the RFI Program established under RCRA with CERCLA requirements to provide for a focused environmental program. In accordance with Section 120 of CERCLA, DOE has negotiated an FFA (1993) with the United States Environmental Protection Agency (EPA) and the South Carolina Department of Health and Environmental Control (SCDHEC) to coordinate remedial activities at SRS with one comprehensive strategy that fulfills these dual regulatory requirements.

Operable Unit History

The F-Area Retention Basin (FRB) includes the retention basin and the abandoned process sewer line associated with the basin. The history of the FRB prior to characterization activities is briefly described.

F-Area Retention Basin

The basin operated from 1955 until 1972 and was closed in December 1978. This closure included the following activities:

- Sampling soil at four locations in the bottom of the retention basin
- Excavating approximately 0.6 m (2 ft) of soil from within the basin
- Sampling soil from 53 locations from the bottom excavation and basin berm
- Removing and transporting a total of 970 m^3 (1267 yd^3) of contaminated soil to Burial Grounds (Building 643-G) for disposal
- Backfilling the basin with clean soil and seeding the area with grass

Excavation of soil from the bottom of the basin greatly reduced the level of radiological contamination at the basin. The maximum levels of cesium-137 (Cs-137) and strontium-89/90 (Sr-89/90) detected in basin soils prior to excavation were 80,600 picoCuries per gram (pCi/g) and 1540 pCi/g, respectively. The transferred radionuclide inventory was calculated as 11.5 Ci of Cs-137 and 0.5 Ci of Sr-89/90. Following excavation, the maximum levels of Cs-137 detected in FRB soils were 430 pCi/g in the basin and 1410 pCi/g in the berm while the maximum concentrations of Sr-89/90 were 1700 pCi/g in the basin and 1000 pCi/g in the berm.

Process Sewer Line

A portion of the process sewer line extending north from the basin was abandoned at the same time the basin was closed. The branch of the line from the Tank Farm approximately 168 m (550 ft) of 61-cm (24-inch diameter) was sealed off at a point close to manhole P37 (see Figure 6). The wastewater coming from the Tank Farm was diverted by installing a sluice box to Building 281-9F. The branch of the line from the Canyon Facility approximately 212 m (700 ft) of 91-cm (36-inch diameter) was sealed off at manhole P40 (see Figure 6). The abandoned portion of the process sewer line north of the basin and outlet pipe located south of the basin (total length approximately 380 m (1250 ft) is a part of this unit. The process sewer line north of manholes P37 and P40 is still active and is not included in this unit.

The depth to the top of the abandoned process sewer line varies from less than 1 m (3ft) near the original location of the basin to 4.6m (15 ft) for the segment from P40 to P39. There are several access points to the abandoned process sewer line (see Figure 6). Two of the four access points (P39 and one unnumbered manhole) are standard manholes constructed of brick. Access point P38 is a nonstandard manhole constructed of poured concrete walls and floor. The final access point is a valve/junction box located just downstream from manhole P39. The purpose of this junction box was to regulate the amount of liquid released to the retention basin during normal operation.

Drainage Ditch

The FRB was designed to discharge its contents through an outlet into a ditch naturally connected with an unnamed tributary discharging into Fourmile Branch. However, the remedial investigations conducted in response to SRS' established cleanup program revealed that the outfall ditch and the unnamed tributary to Fourmile Branch were not impacted by FRB operations; therefore, they are not considered for cleanup operations under this remedial action.

Operable Unit Compliance History

As previously stated, the FRB OU is listed in the FFA as a RCRA/CERCLA unit requiring further evaluation to determine the actual or potential impact to human health and the environment. A Remedial Investigation (RI) and Baseline Risk Assessment (BRA) were conducted for the unit between 1995 and 1997. The results of the RI and BRA were presented in the RI/BRA report (WSRC, 1997b). The RI/BRA report was submitted in accordance with the FFA-approved implementation schedule and was approved by the EPA and SCDHEC in

October 1997. The Corrective Measures Study/Feasibility Study (CMS/FS) (WSRC, 1997c) and Statement of Basis/Proposed Plan (SB/PP) (WSRC, 1997d) were submitted in accordance with the FFA-approved implementation schedule and were approved by EPA and SCDHEC in December 1997.

The post-ROD documents include Corrective Measures Implementation/Remedial Design Work Plan (CMI/RDWP) and Corrective Measures Implementation/Remedial Design Report/Remedial Action Work Plan (CMI/RDR/RAWP). In accordance with the FFA-approved implementation schedule, the Rev. 0 CMI/RDWP and Rev. 0, CMI/RDR/RAWP will be submitted to EPA and SCDHEC for approval. The Field Start Date for the implementation of the remedial action is scheduled for April 4, 1999.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

Both RCRA and CERCLA require that the public be given an opportunity to review and comment on the proposed remedial alternative. Public participation requirements are listed in South Carolina Hazardous Waste Management Regulations (SCHWMR) R.61-79.124 and Sections 113 and 117 of CERCLA. These requirements include establishment of an Administrative Record File that documents the investigation and selection of the remedial alternatives for addressing the FRB OU soils and groundwater. The Administrative Record File must be established at or near the facility at issue. The SRS Public Involvement Plan (DOE, 1994a) is designed to facilitate public involvement in the decision-making process for permitting, closure, and the selection of remedial alternatives. The SRS Public Involvement Plan addresses the requirements of RCRA, CERCLA and the National Environmental Policy Act, 1969 (NEPA).

The South Carolina Hazardous Waste Management Regulations (SCHWMR) R.61-79.124 and Section 117(a) of CERCLA, as amended, requires the advertisement of the notice of any proposed remedial action and mandates that the public be given an opportunity to participate in the selection of the remedial action. The Statement of Basis/Proposed Plan for the F-Area Retention Basin (281-3F) (WSRC, 1997d), which is a part of the Administrative Record File, highlights key aspects of the investigation and identifies the preferred action for remediating the FRB OU.

The FFA Administrative Record File, which contains the information pertaining to the selection of the response action, is available at the EPA office and at the following locations:

U. S. Department of Energy
Public Reading Room
Gregg-Graniteville Library
University of South Carolina-Aiken
171 University Parkway
Aiken, South Carolina 29801
(803) 641-3465

Thomas Cooper Library
Government Documents Department
University of South Carolina
Columbia, South Carolina 29208
(803) 777-4866

Reese Library
Augusta State University
2500 Walton Way
Augusta, Georgia 30910
(706) 737-1744

Asa H. Gordon Library
Savannah State College
Tompkins Road
Savannah, Georgia 31404
(912) 356-2183

The public was notified of the public comment period through mailings of the *SRS Environmental Bulletin*—a newsletter sent to approximately 3500 citizens in South Carolina and Georgia—and through notices in the *Aiken Standard*, the *Allendale Citizen Leader*, the *Augusta Chronicle*, the *Barnwell People-Sentinel*, and *the State newspapers*. The public comment period was also announced on local radio stations.

The 45-day public comment period began January 20, 1998, and ended on March 5, 1998. A public briefing was provided in the CAB subcommittee meeting on February 23, 1998. In the meeting, SRS briefed the public regarding the path forward for the remediation of FRB. At the meeting, a concern was raised over the need to grout the contaminated soil in addition to capping the basin soil. Consequently, an extension for the public comment period was granted, extending the period to April 4, 1998. A formal public comment was also received which questioned the risk reduction and necessity of soil grouting. CAB recommendation No. 56 (Appendix A) was also received on March 28, 1998. The SRS response to this concern is provided with this ROD in the Responsiveness Summary (Appendix A). It will also be available with the final RCRA permit. The response to public comment and CAB recommendation has been accepted by EPA and SCDHEC.

IV. SCOPE AND ROLE OF THE OPERABLE UNIT WITHIN THE SITE STRATEGY

RCRA/CERCLA Programs at SRS

RCRA/CERCLA units (including the FRB) at SRS are subject to a multi-stage remedial investigation process that integrates the requirements of RCRA and CERCLA as outlined in the RFI/RI Program Plan (WSRC, 1993b). The RCRA/CERCLA process summarized in Figure 4 consists of investigation and characterization of potentially impacted environmental media (such as soil, groundwater, and surface water) comprising the waste unit and surrounding areas; the evaluation of risk to human health and the local ecological community; the screening of possible remedial actions to identify the selected technology which will protect human health and the environment; implementation of the selected alternative; documentation that the remediation has been performed competently; and evaluation of the effectiveness of the technology. The steps of this process are iterative in nature and include decision points which involve concurrence between the DOE (as owner/manager), the EPA and SCDHEC (as regulatory oversight), and the public. The RCRA/CERCLA process was used for the characterization of the FRB OU, and for developing the remedial alternatives and finally selecting the remedial action.

F-Area Retention Basin (281-3F) Remedial Strategy

The FRB OU includes the retention basin (basin soils), the former process server line (pipeline, pipeline sediment, and pipeline associated soils), and groundwater associated with the unit. The F-Area Retention Basin is located within the Fourmile Branch Watershed (see Figure 1). Several source control and groundwater operable units within this watershed will be evaluated to determine future impacts, if any, to the associated streams and wetlands. It is the intent of SRS, EPA, and SCDHEC to manage these sources contamination to minimize impact to the watershed.

Presently, based on the characterization and risk assessment information, the FRB OU does not significantly impact the watershed. The investigation and sampling for the FRB OU considered all unit specific groundwater. Based on the results of the investigation of the groundwater, the contamination in the water table aquifer is not attributable to the wastes associated with FRB OU. Upon disposition of all the source control and groundwater operable units within this watershed, a final, comprehensive evaluation of the watershed will be conducted to determine whether any additional actions are necessary.

The preliminary investigation conducted for the FRB OU identified two primary sources of contamination: (1) the former basin; and (2) the process sewer line leading from the F-Area Canyon Facility and the F-Area Tank Farm to the FRB. To characterize the FRB OU and to identify the primary sources of contamination and primary contaminated media, numerous environmental investigations were conducted at the unit between 1993 and 1997. The *Groundwater Sampling Report with Residential Risk Assessment for the F-Area Retention Basin* (WSRC, 1997a) and the *Remedial Investigation with the Baseline Risk Assessment Report for the F-Area Retention Basin* (WSRC, 1997b) contain detailed analytical data for all the environmental media samples taken in the characterization of the FRB OU. These reports are part of the Administrative Record File (see Section III). The primary media of contamination determined included soils associated with the former basin area primarily the subsurface soils (deeper than 1.2 m [4 ft]); the surface [0-0.6 m (0-4 ft) and subsurface soils associated with process sewer line area; and sediment within the sewer pipeline. Only human health COCs (i.e., Cs-137, Ra-226, K-40, thallium) were identified in the surface soil and only one CMCOC (Sr-90) was identified in the subsurface soil. Radionuclide contaminants in subsurface soil (deep soils, 6-14 feet) represent a principal threat source material (i.e., highly toxic or highly mobile contaminants which would present a significant risk to human health or the environment should exposure occur). No COCs associated with FRB OU were identified for the groundwater. To address the remediation of FRB OU soils, various potential remedial alternatives were developed and evaluated. After evaluation, the alternatives S5 and P4 were selected as the preferred remedies for FRB OU soils and sewer pipeline, respectively. For the groundwater, no action was selected as the preferred remedy. However, groundwater monitoring is included as an integral part of S5 alternative to monitor the effectiveness of the remedial action against any future leaching of Sr-90; to mitigate any uncertainty in the environmental data collected during the investigations; and to confirm that there are no upgradient sources to the FRB OU groundwater. In the event, monitoring detects contamination above MCLs (or RBCs) for those constituents attributable to the FRB OU or an unknown upgradient source, for two consecutive monitoring periods, the regulators will be informed within 30 days. A plan for evaluating the data and developing further action will be submitted within 90 days for regulatory approval. The plan will also include a schedule for assessing the need for corrective action and a schedule for developing the specifics for that corrective action.

The preferred remedies meet the remedial action objectives of the remedial actions, as described in Section VII of the ROD, for the former basin area soil and groundwater as well as the soils

Figure 4. RCRA/CERCLA Logic and Documentation

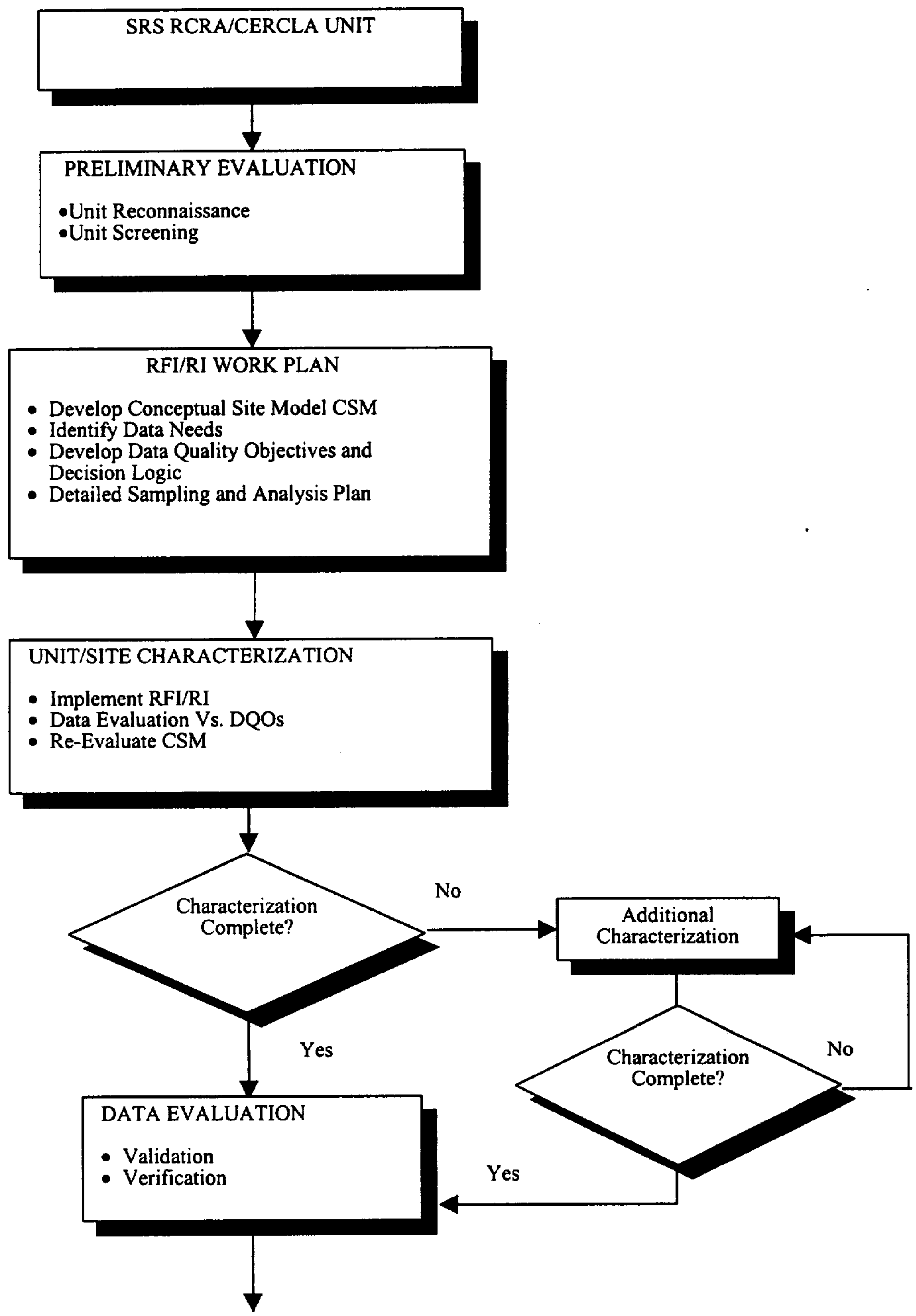
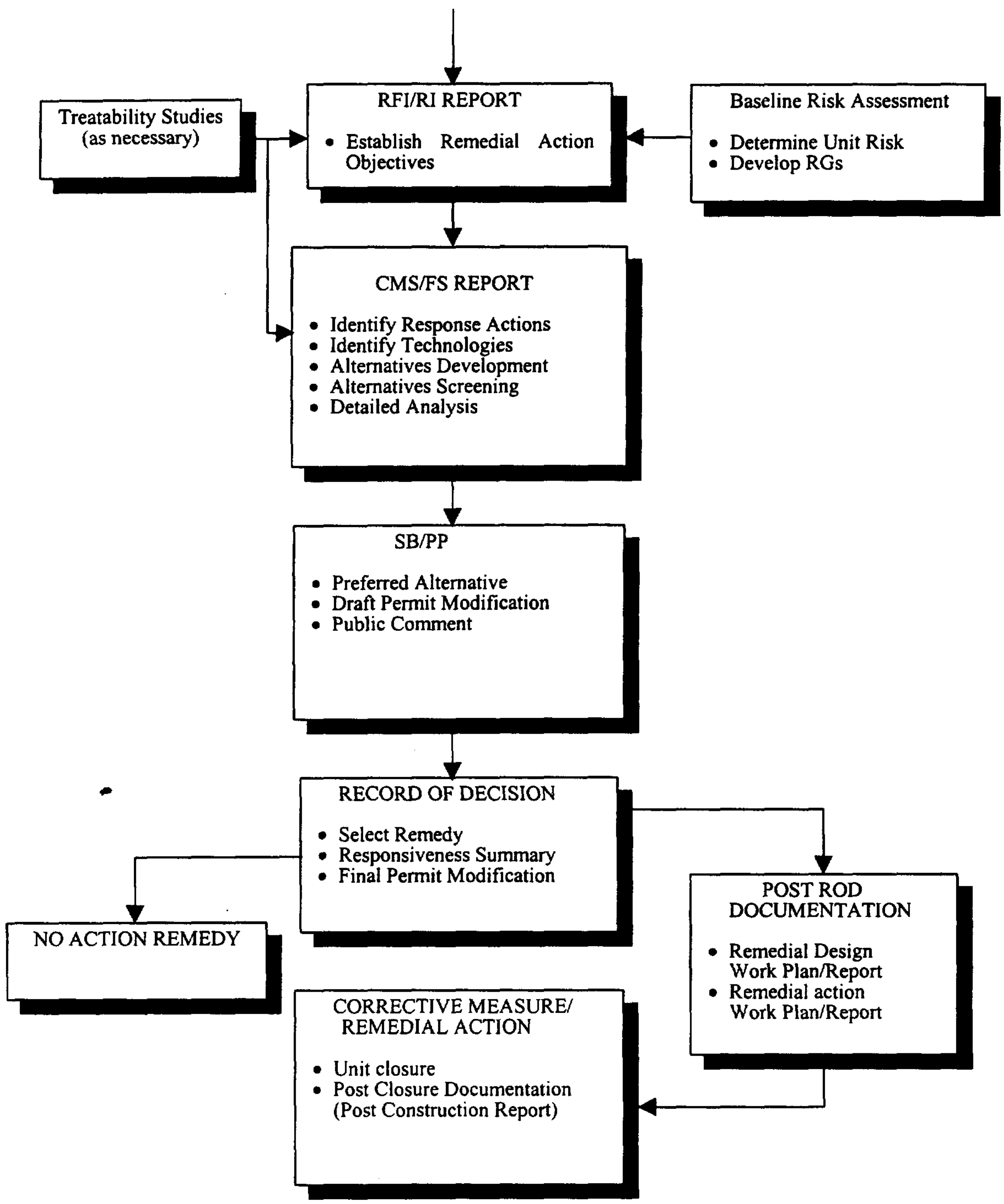


Figure 4. (Cont'd). RCRA/CERCLA Logic and Documentation



associated with the process sewer line area and significantly contribute toward the overall protection of the groundwater as a resource.

V. OPERABLE UNIT CHARACTERISTICS

Media Assessment

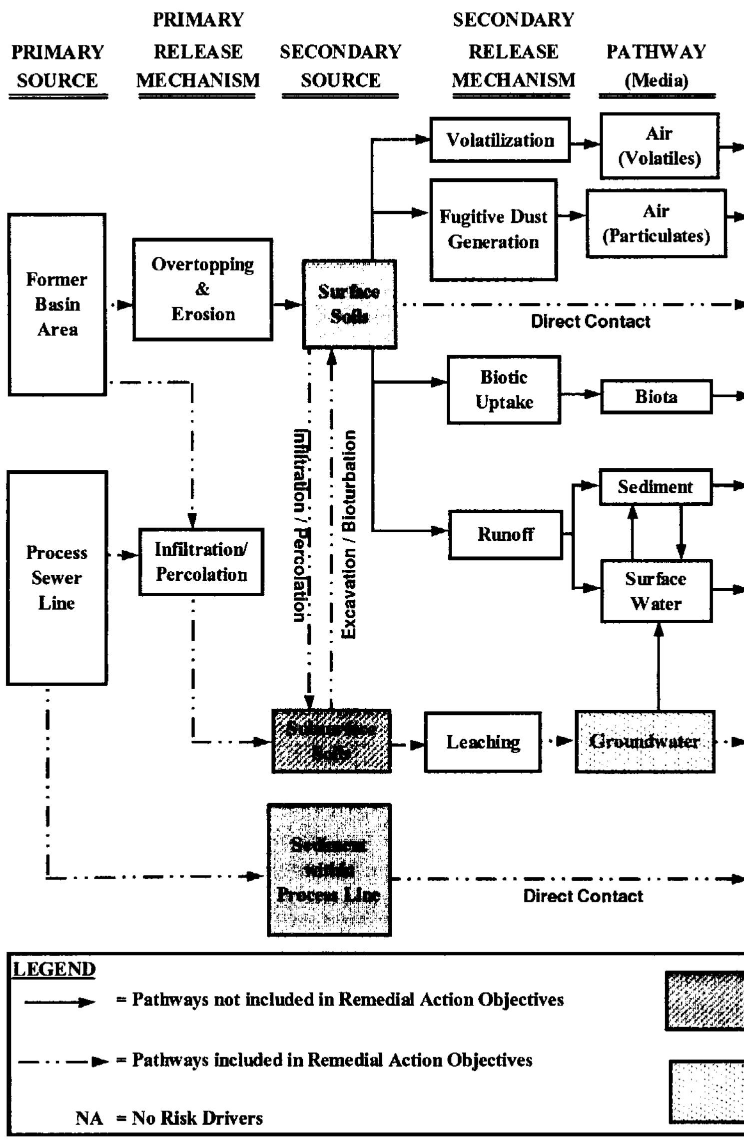
The primary sources of contamination associated with the FRB OU are the former basin and abandoned process sewer line. A Conceptual Site Model (CSM) (Figure 5) was developed for both the basin and the process sewer line to identify the primary sources, primary contaminated media, migration pathways, exposure pathways, and potential receptors for FRB OU. The detailed analytical data for all the environmental media samples taken in the characterization of the FRB OU are contained in two reports: The *Remedial Investigation with the Baseline Risk Assessment Report for the F-Area Retention Basin (U)* (WSRC 1997a); and *Groundwater Sampling Report with Residential Risk Assessment for the F-Area Retention Basin* (WSRC 1997a). The documents are available in the Administrative Record File (see Section III).

The primary data used for the RI/BRA report was collected during the environmental investigations conducted at the unit between 1993 and 1995. These investigations included a soil-gas survey, soil sampling, groundwater sampling, and field measurement of radionuclides. Also, two horizontal bore holes were drilled and monitored for radionuclides in real-time using Environmental-Measurement-While-Drilling Gamma Ray Spectrometer System Technology.

Surface and subsurface soil samples were collected in the area of the former basin, in the adjacent basin overflow area, and in the area along the abandoned process sewer line. Samples were also collected from residual water and sediments in the sewer pipeline. Figure 6 shows sampling locations in and around the F-Area Retention Basin. All samples were analyzed in accordance with EPA-approved protocols. Results of the environment investigation and subsequent analysis indicate the following:

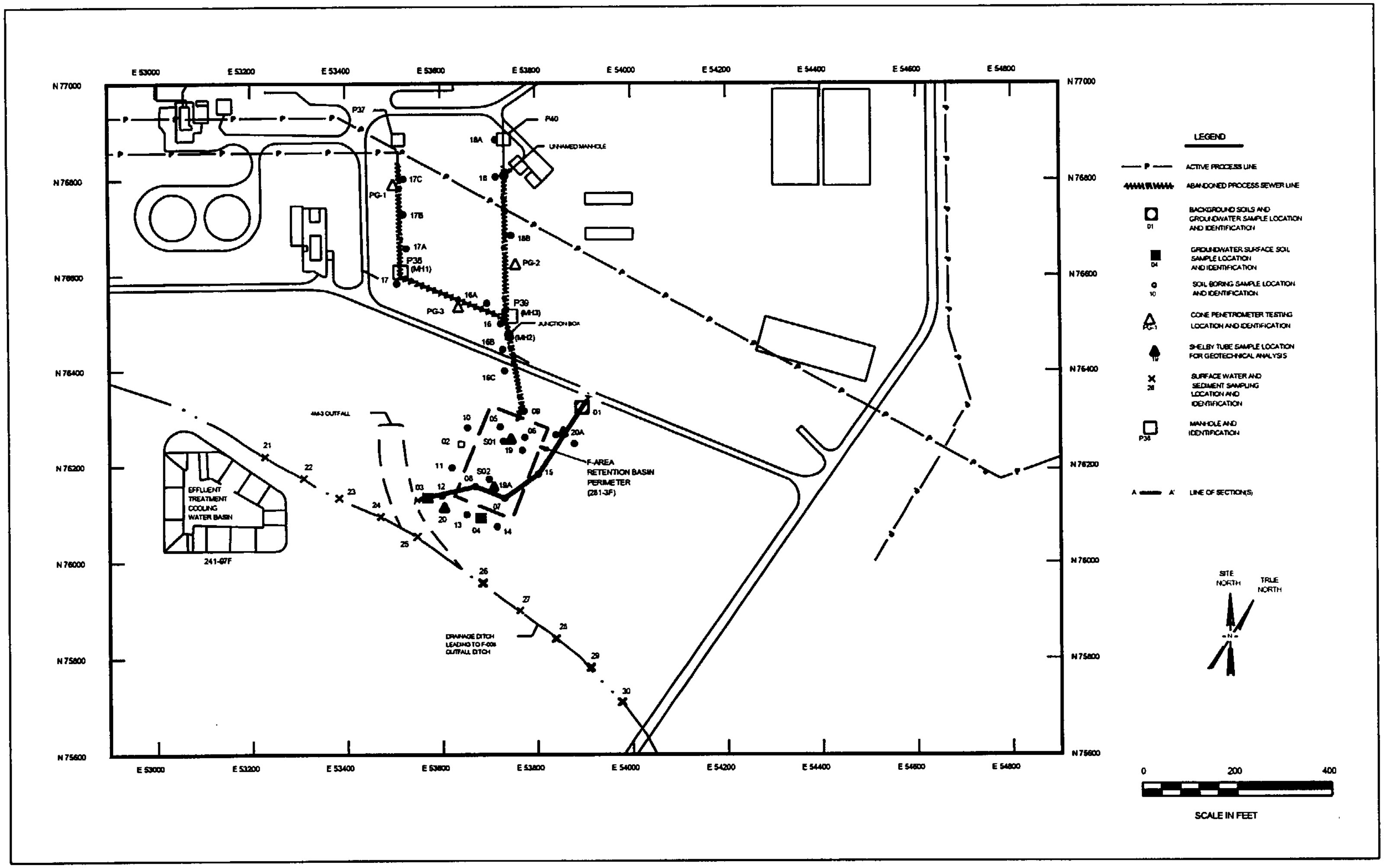
- Groundwater quality has not been adversely affected at this site

Figure 5. Revised Conceptual Site Model for the F-Area Retention Basin and Process Sewer Line



EXPOSURE ROUTE	POTENTIAL HUMAN RECEPTOR: Construction Worker	Industrial Worker	On-Unit Resident	Risk Driver
Inhalation	NA	NA	NA	
Inhalation	<1E-6	<1E-6	<1E-6	
Ingestion	<1E-6	2E-6	2	Tl, As, Sr-90, Ra-226
Dermal Contact	<1E-6	<1E-6	<1E-6	
External Radiation	4E-6	2E-5	2E-4	Cs-137, Ra-226, Ac-228
Ingestion	NA	NA	1E-5	Cs-137, K-40
Ingestion	NA	NA	NA	
Dermal Contact	NA	NA	NA	
External Radiation	NA	NA	NA	
Ingestion	NA	NA	NA	
Inhalation	NA	NA	NA	
Dermal Contact	NA	NA	NA	
External Radiation	NA	NA	NA	
Ingestion	NA	<1E-6	>MCL	Sr-90
Inhalation	NA	NA	<1E-6	
Dermal Contact	NA	NA	NA	
Ingestion	7E-6	NA	NA	Cs-137, Pu-239/240
Dermal Contact	<1E-6	NA	NA	
External Radiation	NA	NA	NA	

Figure 6. Sampling Locations in and Around the F-Area Retention Basin



- Levels of Sr-90 in soil beneath the basin represent a risk that future contaminant migration could result in contamination of the groundwater

- Levels of contaminants (example Sr-90 and Cs-137) at depth represent principal threat source material (i.e., highly toxic or highly mobile contaminants that would present a significant risk to human health or the environment should exposure occur).

- Levels of the remaining radioactive and non-radioactive contaminants in soil beneath the basin do not represent a risk that future contaminant migration could result in contamination of the groundwater

- Levels of several contaminants (e.g., Cs-137) in surface soil represent a potential risk to human health

- Levels of contamination in the surface soil and beneath the basin do not represent a risk to ecological receptors

Nature and Extent of Contamination

The CSM was developed for two primary sources: (1) the former basin area; and (2) the process sewer line area. The CSM also identified primary as well as secondary release mechanisms for both sources.

During characterization, primary contamination sources and release mechanisms were also identified using CSM. The results of the investigations and CSM are summarized below.

Primary Sources and Release Mechanisms

The primary release mechanisms for contamination from the former basin area are infiltration/percolation of contaminants to groundwater and overflow of the basin. The overflow of the basin could result in the discharge of contaminants to surface soils and to the nearby drainage ditch. The sole primary release mechanism identified by CSM for contaminants associated with the process sewer line area is the escape of contaminants through defects in the line, followed by percolation of contaminated water to the groundwater.

Secondary Sources and Release Mechanisms

The CSM identified surface soil and subsurface soil (deep soil) in the basin and around the perimeter of the basin as secondary sources for the former basin area. The surface soil and subsurface soil (deep soil) along the abandoned process sewer line were also identified as secondary sources for the abandoned process sewer line. The sediment in the process sewer line is an additional secondary source for the process sewer line.

The secondary release mechanisms for the basin surface soil included volatilization, fugitive dust generation, biotic uptake, and runoff. Leaching was identified as the secondary release mechanism for subsurface soils. The secondary release mechanisms for the process sewer line included volatilization, fugitive dust generation and biota uptake for surface soil and leaching for the subsurface soils. No secondary release mechanism was identified for the sediment in the process sewer line.

Unit Specific Constituents

Constituent concentrations found in soil, groundwater, and surface water were compared against twice the background concentrations. The groundwater concentrations were compared with EPA primary Drinking Water Standards (i.e., MCLs) or twice the mean background concentrations, where no MCL exists. Unit constituents that exceeded twice the background concentration were considered Unit-Specific Constituents (USCs). These USCs were used to define the nature and extent of contamination at the unit and were evaluated in detail in the RI/BRA report to reflect risk to human health or the environment. Table 1 contains the list of USCs identified for the FRB source OU. These include 7 inorganics, 16 organics, and 22 radionuclides.

Former Basin Area

USCs were detected in subsurface soils within the former basin area. The metals arsenic and beryllium and several radiological parameters exceeded maximum screening level concentrations. Primarily, Cesium-137 and Strontium-90 were the radiological parameters with the highest detected concentrations. Their concentrations exceeded twice the background concentrations by factors of 38,000 and 2,570, respectively. Europium-154 also exceeded the maximum screening level concentration for deep soils. Beryllium slightly exceeded its maximum screening level in one surface soil sample. Cesium-137 and Radium-226 (a naturally occurring isotope) slightly exceeded their maximum screening levels in several surface and

Table 1. Unit-Specific Constituents Identified for the FRB Source Operable Unit

Inorganics	Organics	Radionuclides
Arsenic	Acetone	Actinium-228
Barium	Carbon disulfide	Americium-241
Beryllium	2-Chlorophenol	Carbon-14
Chromium	Dibenzofuran	Cesium-137
Lead	1,1-Dichloroethane	Cobalt-57
Nickel	Dichloromethane	Cobalt-60
Thallium	Di-n-butyl phthalate	Europium-154
	Ethylbenzene	Europium-155
	Methyl ethyl ketone	Lead-212
	N-Nitrosodiphenylamine	Nickel-63
	Styrene	Plutonium-238
	Tetrachloroethene	Plutonium-239/240
	Toluene	Potassium-40
	Trichloroethylene	Promethium-147
	Trichlorofluoromethane	Radium-226
	Xylenes	Sodium-22
		Strontium-90
		Technetium-99
		Thorium-234
		Uranium-233/234
		Uranium-235
		Uranium-238

shallow subsurface soil samples taken in the basin area. USCs were also identified in surface soils and shallow subsurface soils within the former basin area. However, these USCs are not associated with operation of the basin since the former basin was backfilled in 1978 with clean soil. Hence, only USCs identified in subsurface soils could be attributable to past operations.

USCs were also detected in soils adjacent to the former basin (overflow area). Beryllium, Cesium-137, Thallium, Radium-226, and Plutonium 239/240 were detected and exceeded twice the background levels. These detections, however, closely matched the detected levels in the background borings and did not exhibit any discernible pattern of contamination. Therefore, the soils in the basin overflow area do not appear to have been adversely impacted by basin overflow.

Process Sewer Line Area

USCs were detected in residual water in the abandoned process sewer line and manholes. Primarily, Cesium-137 and Strontium-90 were the radiological parameters with the highest detected concentrations. Cesium-137 exceeded its maximum screening level concentration by a factor of 327 while Strontium-90 exceeded its maximum screening level concentration by a factor of 94.4. These were also the largest margins by which the maximum screening level concentrations were exceeded.

USCs were detected in residual sediments in the abandoned process sewer line. The inorganic constituents Arsenic and Beryllium exceeded their maximum screening level concentrations. Cesium-137, Strontium-90, and Plutonium-239/240 were the radiological parameters with the highest detected concentrations that exceeded their maximum screening level concentrations.

The concentrations exceeded their twice background levels by factors of 24,600, 118, and 86.3, respectively.

USCs were detected in soils adjacent to the abandoned process sewer line. Arsenic and Beryllium were the inorganic constituents that exceeded maximum screening level concentrations. The radiological parameters that exceeded maximum screening level concentrations were Cesium-137 and Strontium-90. Their maximum concentrations occurred in deep samples and exceeded their twice background levels by factors of 368 and 51.9, respectively.

Groundwater

The only contaminant detected (a single detect) in groundwater was trichloroethylene at sampling location FRB-2 (see Figure 6), but it was also detected in the background well. This could indicate that the trichloroethylene originated from an area hydraulically upgradient from

the site, particularly since a trichloroethylene source was not found in the soil. Metals other than common cations were not detected consistently. Only one radiological analyte was detected above twice background concentrations, and only in one round of sampling. However, based on the data collected in January 1997 and February 1997, activities associated with the former basin do not appear to have impacted the groundwater.

Groundwater Transport Analysis

In response to a recommendation from the Citizens Advisory Board (CAB), transport modeling was performed for the most prevalent radioactive constituents (e.g., Sr-90 and Cs-137). This analysis was performed using RESRAD modeling for leachability of contaminants. Results of this analysis indicate that only Sr-90 is predicted to reach the groundwater at levels which exceed relevant standards. This analysis supersedes overly conservative calculations reported in the RFI/BRA which indicated that TC-99 and Sr-90 could potentially contaminate groundwater. However, the remedy to stabilize the Sr-90 will also reduce the mobility of Tc-99 and the other radioactive contaminants present in the soil.

VI. SUMMARY OF OPERABLE UNIT RISKS

As part of the F-Area Retention Basin RFI/RI process, a baseline risk assessment (BRA) was prepared to evaluate the potential risk to human health and the environment from chemical and radioactive contaminants identified in investigations at the FRB. The following sections outline the results of the human health and ecological risk characterizations conducted as part of the assessment. A complete discussion of the risk assessment methodology, receptor analysis, risk characterizations, and uncertainty within the characterizations can be found in the *Groundwater Sampling Report with Residential Risk Assessment for the F-Area Retention Basin* (WSRC, 1997a) and the *Remedial Investigation with the Baseline Risk Assessment Report for the F-Area Retention Basin* (WSRC, 1997b).

Unit-specific data from the RFI/RI were used to identify and screen constituents of potential concern (COPCs). Exposure point concentrations were calculated and used to estimate potential exposures and risks to humans and wildlife. Carcinogenic risks and hazard indices (HIs), based on a combination of exposure scenarios, locations, and receptors identified in the CSM, were calculated and then compared to EPA risk guidelines [i.e., 1 x 10^{-4} to 1 x 10^{-6} carcinogenic risk, HI > 1, and ecological effects quotient (EEQ) > 1]. COPCs were screened and identified as preliminary COCs (PCOCs) and designated as primary or secondary COCs, based on their individual contribution to total media risk or hazard.

Human Health Risk Assessment

To evaluate the risk to human receptors due to the contamination at the FRB, unit-specific analytical data are used to identify COPCs. Exposure point concentrations are determined for each COPC to estimate the potential exposure for various receptors and exposure scenarios. The current land use scenario is inactive industrial use and an infrequent on-unit visitor (researcher or sampler) was postulated but quantitative risks were not determined for this receptor because SRS programs and procedures are implemented to protect workers from harmful exposure to contaminants at waste units. Receptors for the future land use exposure scenario identified for the former basin area included an on-unit industrial worker and an on-unit resident (adult/child). Receptors identified for future land use at the process sewer line area included an on-unit industrial worker, an on-unit resident (adult/child), and an on-unit construction worker (Figure 5).

Following the selection of human receptors for evaluation, the carcinogenic risks and the noncarcinogenic health hazards were estimated for each COPC and for each pathway/receptor combination based on EPA guidance (EPA, 1989b).

Carcinogenic risk is defined as the incremental probability of an individual developing cancer over a lifetime as a result of pathway-specific exposure to cancer-causing contaminants. The risk to an individual resulting from exposure to non-radioactive chemical carcinogens is expressed as the increased probability of cancer occurring over the course of a 70-year lifetime. At Superfund sites incremental risk from carcinogens is compared to the EPA target risk range of one in ten thousand (1 x 10^{-4}) to one in one million (1x 10^{-6}).

Noncarcinogenic hazards are also evaluated to identify a level at which there may be concern for potential noncarcinogenic health effects. The hazard quotient (HQ), which is the ratio of the exposure dose to the reference dose, is calculated for each contaminant. HQs are summed for each exposure pathway to determine the specific HI for each exposure scenario. If the HI exceeds unity (1.0), there is the potential for adverse health hazards.

Former Basin Area

Future Land Use Carcinogenic Risks

The future on-unit industrial worker has three exposure routes with carcinogenic risks within the target range of 1×10^{-4} to 1×10^{-6} (Table 2). External radiation exposure to surface soil has a risk of 2×10^{-5} primarily due to Cs-137 and Ra-226. Ingestion of subsurface soil has a risk of 2×10^{-6} primarily due to arsenic. External radiation exposure to subsurface soil has a risk of 9×10^{-6} primarily due to Cs-137 and Ra-226. The risks for the future worker from all other pathways are less than the EPA action level (1×10^{-6}).

Several pathways for the future on-unit resident have estimated risks within the target range (Table 2). External exposure to radionuclides in surface soil has a risk of 2×10^{-4} primarily due to Cs-137, K-40, and Ra-226. Ingestion of produce grown on surface soil has a risk of 1×10^{-5} primarily due to plant uptake of Cs-137 and K-40. Exposure to subsurface soil has a risk of 8×10^{-6} from ingestion primarily due to arsenic, Pu-239/240, Ra-226, and Cs-137. External exposure to radionuclides in subsurface soil has a risk of 8×10^{-5} primarily due to Cs-137 and Ra-226. Ingestion of produce grown on subsurface soil has a risk of 5×10^{-6} primarily due to plant uptake of Cs-137 and K-40. RESRAD modeling indicates that the MCL for Sr-90 (8 pCi/L) will be exceeded by leaching from deep soils (>4 feet deep) with the peak concentration of 79 pCi/L reached in 76 years (*E7 Calc Note reference*).

Noncarcinogenic Hazards

The BRA shows that potential adverse noncarcinogenic health effects are not likely to occur for the future on-unit worker because the sum of HIs for all pathways evaluated is less than the value of 1.0 (Table 2).

The HIs for hypothetical future resident exposures equal or exceed 1.0 for the ingestion of surface soil (0-1 foot) and subsurface soil (0-4 feet) (Table 2). The HI for ingestion of surface soil equals 1 and is primarily the result of thallium. The HI for ingestion of subsurface soil equals 2 and is primarily the result of thallium and arsenic.

Table 2. Summary of Risk-Based COPCs, Grouped by Exposure Route

Receptor *	Exposure Route/Medium	Preliminary COCs	Carcinogenic Risks	Hazard Index
Former Basin Area				
Hypothetical Future Worker	External Radiation / Surface Soil	Cs-137, Ra-226	2×10^{-5}	
	External Radiation / Subsurface Soil	Cs-137, Ra-226	9×10^{-6}	
	Ingestion / Subsurface Soil	As	2×10^{-6}	
Hypothetical Future Resident	External Radiation / Surface Soil	Cs-137, K-40, Ra-226	2×10^{-4}	
	Ingestion / Surface Soil	Tl		1
	Ingestion / Produce Grown on Surface Soil	Cs-137, K-40	1×10^{-5}	
	External Radiation / Subsurface Soil	Cs-137, Ra-226	8×10^{-5}	
	Ingestion / Subsurface Soil	As, Tl, Pu-239/240, Ra-226, Cs-137	8×10^{-5}	2
	Ingestion / Produce Grown on Subsurface Soil	Cs-137, K-40	5×10^{-6}	
	Ingestion / Deep Soil Leaching to Groundwater	Sr-90	Exceedance of MCL	
Process Sewer Line Area				
Hypothetical Future Worker	External Radiation / Surface Soil	Cs-137, Ra-226, Ac-228	1×10^{-5}	
	External Radiation / Subsurface Soil	Cs-137, Ra-226, Ac-228	9×10^{-6}	
Hypothetical Future Construction Worker	External Radiation / Surface Soil	Cs-137, Ra-226	4×10^{-6}	
	External Radiation / Subsurface Soil	Cs-137, Ra-226	4×10^{-6}	
	Ingestion / Sediments within Pipeline & Manholes	As, Cs-137, Pu-239/240	8×10^{-6}	
Hypothetical Future Resident	External Radiation / Surface Soil	Cs-137, Ra-226, Ac-228	1×10^{-4}	
	Ingestion / Surface Soil	As	3×10^{-6}	
	Ingestion / Produce Grown on Surface Soil	Cs-137, K-40	5×10^{-6}	
	External Radiation / Subsurface Soil	Cs-137, Ra-226, Ac-228	1×10^{-4}	
	Ingestion / Subsurface Soil	As, Ra-226, Sr-90	5×10^{-6}	
	Ingestion / Produce Grown on Subsurface Soil	Cs-137, K-40	5×10^{-6}	

* **No Ecological Receptors were identified as being impacted by USCs.**

As = arsenic
Tl = Thallium
Cs-137 = Cesium-137
Ra-226 = Radium-226
K-40 = Potassium-40
Pu-239/240 = Plutonium-239/240
Ac-228 = Actinium-228
Sr-90 = Strontium-90

Total Pathway Risks and Hazard Indices

Carcinogenic risks and noncarcinogenic hazards associated with the individual exposure pathways for surface soil (0-1 ft) and subsurface soil (0-4 ft) have been summed to obtain total pathway risks and HIs for each receptor (worker and resident).

The total pathway risk values for the hypothetical future on-unit worker and hypothetical future on-unit resident are 3×10^{-5} and 3×10^{-4}, respectively. The risk values that exceeded the EPA point of departure (1×10^{-6}) for the future receptors are a result of exposure to constituents in soil. Additionally, leaching of Sr-90 from deep soil to the groundwater will exceed the MCL by almost 10-fold in 76 years.

Total pathway HIs exceeded 1.0 for the future on-unit resident. These HIs were 1 [for pathways excluding subsurface soil (0-4 ft)] and 2 [for pathways excluding surface soil (0-1 ft)]. The noncarcinogenic hazards for the future on-unit resident were a result of exposure to metals in surface and subsurface soil.

Process Sewer Line Area

Future Land Use Carcinogenic Risks

The future on-unit industrial worker has two exposure routes with carcinogenic risks within the target range of 1×10^{-4} to 1×10^{-6} (Table 2). External radiation exposure to surface soil has a risk of 1×10^{-5} primarily due to Ra-226, Cs-137, and Ac-228. External radiation exposure to subsurface soil has a risk of 9×10^{-6} primarily due to Ra-226, Cs-137, and Ac-228. The risks for the future worker from all other pathways are less than the EPA action level (1×10^{-6}).

The future on-unit construction worker has two exposure routes with carcinogenic risks within the target range of 1×10^{-4} to 1×10^{-6} (Table 2). External radiation exposure to surface soil has a risk of 4×10^{-6} primarily due to Ra-226 and Cs-137. External radiation exposure to subsurface soil has a risk of 4×10^{-6} primarily due to Ra-226 and Cs-137. Ingestion of sediments contained within the pipeline and manholes has a risk of 8×10^{-6} primarily due to arsenic, Cs-137, and Pu-239/240. The risks for the future worker from all other pathways are less than the EPA point of departure (1×10^{-6}).

Several pathways for the future on-unit resident have estimated risks within the target range (Table 2). Ingestion of surface soil has a risk of 3 x 10^{-6} primarily due to arsenic. External exposure to radionuclides in surface soil has a risk of 1 x 10^{-4} primarily due to Cs-137, Ac-228, and Ra-226. Ingestion of produce grown on surface soil has a risk of 5 x 10^{-6} primarily due to plant uptake of Cs-137 and K-40. Exposure to subsurface soil has a risk of 5 x 10^{-6} from ingestion primarily due to arsenic, Ra-226, and Sr-90. External exposure to radionuclides in subsurface soil has a risk of 1 x 10^{-4} primarily due to Ac-228, Cs-137, and Ra-226. Ingestion of produce grown on subsurface soil has a risk of 5 x 10^{-6} primarily due to plant uptake of Cs-137 and K-40.

Noncarcinogenic Hazards

The BRA shows that potential adverse noncarcinogenic health effects are not likely to occur for the future on-unit worker, construction worker, and resident because the sum of HIs for all pathways evaluated is less than the value of 1.0 (Table 2).

Total Pathway Risks and Hazard Indices

Carcinogenic risks and noncarcinogenic hazards associated with the individual exposure pathways for surface soil (0-1 ft), subsurface soil (0-4 ft), and sediment in the pipeline and manholes have been summed to obtain total pathway risks and HIs for each receptor (worker and resident).

The total pathway risk values for the hypothetical future on-unit worker, future construction worker, and hypothetical future on-unit resident are 1 x 10^{-5}, 3 x 10^{-2} and 5 x 10^{-4}, respectively. The risk values that exceeded the EPA point of departure (1 x 10^{-6}) for the future receptors are a result of exposure to constituents in soil.

Total pathway HIs did not exceed the threshold of 1.0 for any of the exposure pathways.

Table 3. Contaminants of Concern for Soil at the FRB Operable Unit with Maximum Detected Concentrations and Remedial Goals

Former Basin Area			
Medium	**Analyte**	**Maximum Detect**	**RG for soil**
Surface Soil (0-1 foot)	Cesium-137 Potassium-40 Radium-226 Thallium*	0.29 pCi/g 2.49 pCi/g 0.931 pCi/g 6.12 mg/kg	0.74 pCi/g 2.53 pCi/g 0.226 pCi/g 25.9 mg/kg
Subsurface Soil (0-4 foot)	Arsenic Cesium-137* Potassium-40 Radium-226 Thallium*	7.13 mg/kg 10.9 pCi/g 3.04 pCi/g 0.931 pCi/g 6.93 mg/kg	11.1 mg/kg 0.74 pCi/g 2.53 pCi/g 0.226 pCi/g 25.9 mg/kg
Groundwater (current)	None	N/A	N/A
Leachability to Groundwater from FRB Soil	Strontium-90	79 pCi/L @ 76 yrs (modeled level)	109 pCi/g**

Process Sewer Line Area			
Medium	**Analyte**	**Maximum Detect**	**RG for soil**
Surface Soil (0-1 foot)	Arsenic* Actinium-228 Cesium-137 Lead-212* Potassium-40 Radium-226	20.8 mg/kg 1.57 pCi/g 2.69 pCi/g 1.65 pCi/g 2.42 pCi/g 1.21 pCi/g	11.1 mg/kg 0.202 pCi/g 0.74 pCi/g 2.19 pCi/g 2.53 pCi/g 0.226 pCi/g
Subsurface Soil (0-4 foot)	Arsenic* Actinium-228 Cesium-137 Lead-212* Potassium-40 Radium-226 Strontium-90	17.7 mg/kg 2.51 pCi/g 21.3 pCi/g 2.44 pCi/g 1.49 pCi/g 2.60 pCi/g 21.8 pCi/g	11.1 mg/kg 0.202 pCi/g 0.74 pCi/g 2.19 pCi/g 2.53 pCi/g 0.226 pCi/g 233 pCi/g
Groundwater (current)	None	None	N/A
Sediment within the Pipeline & Manholes	Arsenic* Cesium-137* Plutonium-239/240*	16.3 mg/kg 2040 pCi/g 32.2 pCi/g	63.9 mg/kg 1.1 pCi/g 26.3 pCi/g

* Secondary COCs

** RG is the level of leachable contaminants from FRB soil that will not exceed the MCL in the future. The RG is derived from the RESRAD modeling for leachability (K-CLC-F-00030). The MCL for Strontium-90 is 8.0 pCi/L (CFR 1991).

Ecological Risk Assessment

The BRA also addressed the ecological risk associated with the former basin area and the process sewer line area. Risks from both nonradionuclide and radionuclide constituents were evaluated.

Quantitative risk estimations were based on a comparison of estimated intake to a predetermined toxicity reference value, expressed as a HQ. The assessment concluded that no ecological risk is associated with FRB OU.

Constituents of Concern

COCs were selected for the FRB because they exceed ARARs, because they exceed risk-based criteria in the BRA, or because they are projected to have the potential to leach to the groundwater at levels exceeding a maximum contaminant level (MCL). Primary COCs are defined in the human health risk assessment as constituents that contribute a chemical-specific risk of more than 1×10^{-6} or an HQ of greater than 0.1 to any media risk estimate that exceeds a 1×10^{-4} risk or an HI of 3. COCs projected to exceed an MCL due to soil leachability are also considered primary COCs. Secondary COCs are defined as those constituents in each medium contributing a chemical-specific risk greater than 1×10^{-6} or a HQ of at least 0.1 to a media with a risk greater than 1×10^{-6}, but not more than 1×10^{-4}, or a HI of one or greater, but not more than three. Final COCs are listed in Table 3. A pictorial representation of the distribution of Sr-90 where the soil concentration exceeds the leachability limit of 109 pCi/g (that would exceed the MCL of 8.0 pCi/L) is included in Figure 7. Figures 8 and 9 show that the Sr-90 concentrations outside of the basin area are below levels of concern.

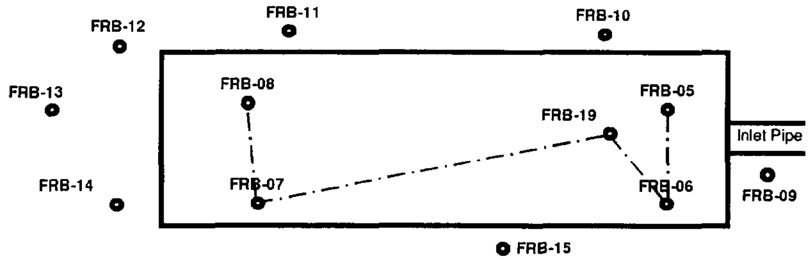
Principal Threat Source Material

Evaluated levels of radioactive contaminants in the FRB OU soils at depth meet the definition of principal threat source material. Principal threat source materials are those contaminants that are highly toxic or highly mobile and would represent a significant risk to human health or the environment should exposure occur. Cs-137, Ra-226, thallium, arsenic, and Sr-90 are present in the FRB OU soils at depth with Cs-137 and Sr-90 representing the highest levels. Distribution of Sr-90 by depth is shown in Figures 7, 8, and 9. Figures 10 through 12 present the distribution of Cs-137 by depth. Principal threat source material at depth are shown in Table 4.

Table 4. Principal Threat Source Material Contamination at Depth for the FRB Operable Unit with Their Maximum Detected Concentrations

Medium	Former Basin Area	
Subsurface Soil at Depth	Cs-137	2200 pCi/g
	Sr-90	1080 pCi/g
	Ra-226	1.37 pCi/g

Figure 7. Distribution of Sr-90 by Depth – FRB Basin Area

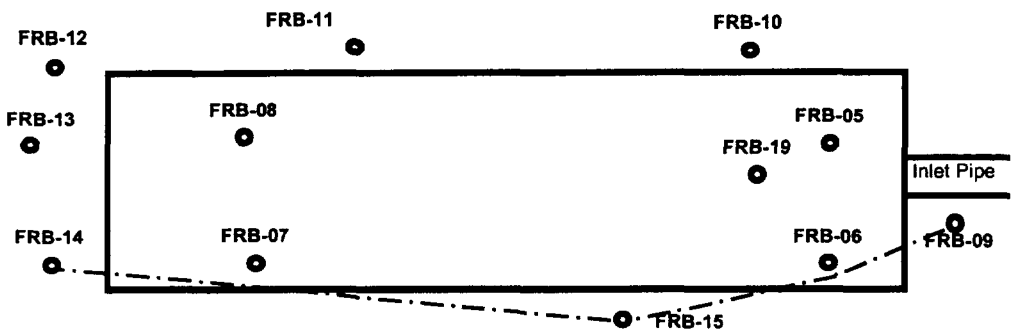


Sr-90 Distribution by Depth Drawing not to scale

Elevation above MSL	Surface Elevation:	FRB-08 269.90	FRB-07 271.90	FRB-19 274.40	FRB-06 276.20	FRB-05 273.40
276						
275					0.346	
274						
273				-0.27		
272	Ground Surface					2.61
271			1.75			
270						0.0713
269	Basin Bottom at 264 ft MSL	2.24	1.43			0.0713
268			1.43			
267		5.25				
266		5.25				
265					0.571	
264					0.571	9.99
263		23.2	91.3	12.3		9.99
262		23.2	91.3	12.3		
261		102		93.1		
260		102		93.1		
259		13.8	13.4			
258		13.8	13.4			
257		8.35	8.7			
256		8.35	8.7			81.5
255			1.62			81.5
254			1.62			13
253						13
252						32.7
251						32.7
250						
249						
248						
247						
246						
245				38.7		
244				38.7		
243				13.3		
242				13.3		
241				24.9		
240				24.9		

Exceeds RESRAD Soil Leachability Level of 109 pCi/g that would exceed the MCL of 8.0 pCi/L.

Figure 8. Distribution of Sr-90 by Depth – FRB Basin Area



Sr-90 Distribution by Depth

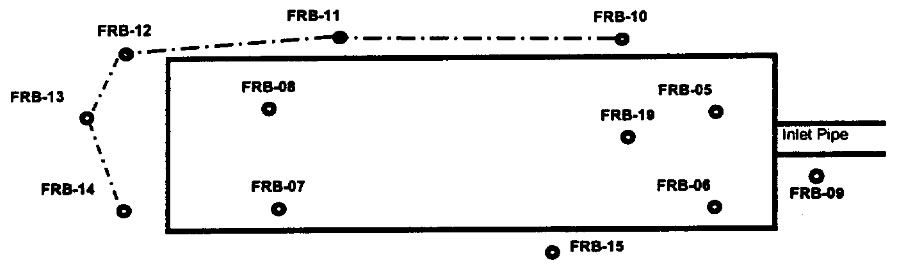
Drawing not to scale

Elevation above MSL	FRB-14	FRB-15	FRB-09
Surface Elevation:	269.70	272.70	277.10
278			
277			
276			-0.27
275			
274			-0.407
273			-0.407
272		2.14	
271			
270		3.42	
269	-0.426	3.42	
268		2.08	
267	-0.321	2.08	
266	-0.321		
265			
264			
263			
262			
261			
260			4.46
259			4.46
258			-0.198
257			-0.198
256		3.28	
255		3.28	
254		2.37	
253	-0.248	2.37	
252	-0.248		
251	-0.621		
250	-0.621		
249			
248			

Ground Surface

Basin Bottom at 264 ft MSL

Figure 9. Distribution of Sr-90 by Depth – FRB Basin Area



Sr-90 Distribution by Depth

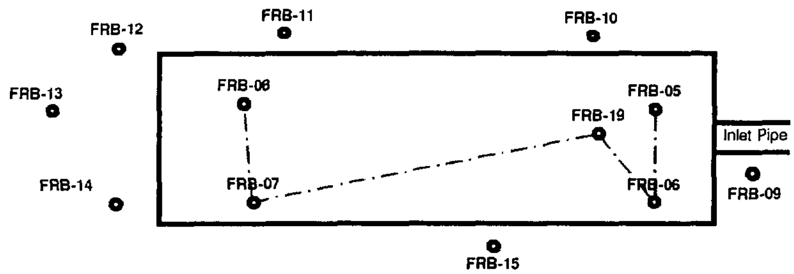
Drawing not to scale

Ground Surface

Basin Bottom at 264 ft MSL

Elevation above MSL	Surface Elevation: FRB-14 269.70	FRB-13 269.00	FRB-12 269.20	FRB-11 270.70	FRB-10 272.30
273					
272					
271					-0.334
270				-0.509	-0.334
269	-0.426				-1
268		-0.62	-0.698	-0.497	-1
267	-0.321			-0.497	
266	-0.321	-0.711	-0.903		
265		-0.711	-0.903		
264					
263					
262					
261					
260					
259					
258					
257					
256					
255					-0.401
254				-0.0607	-0.401
253	-0.248			-0.0607	-0.445
252	-0.248	-1.05	-0.018	5.68	-0.445
251	-0.621	-1.05	-0.018	5.68	
250	-0.621	-0.064	-0.371		
249		-0.064	-0.371		
248					

Figure 10. Distribution of Cs-137 by Depth – FRB Basin Area



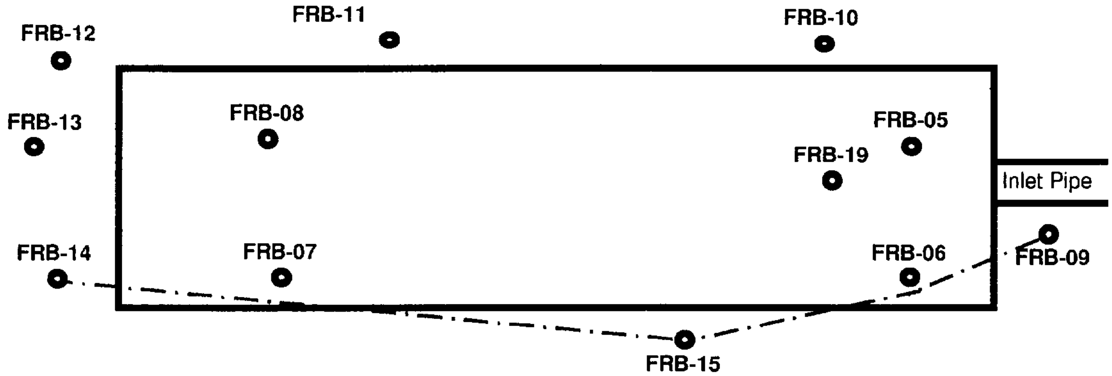
Cs-137 Distribution by Depth

Elevation above MSL	FRB-08	FRB-07	FRB-19	FRB-06	FRB-05
Surface Elevation:	269.90	271.90	274.40	276.20	273.40
276					
275				0.25	
274					
273			0.12		
272					0.10
271		0.29			
270					0.09
269	0.09	0.09			0.09
268		0.09			
267	0.07				
266	0.07				
265				0.46	
264				0.46	
263					
262					
261		0.33			
260		0.33			
259	0.04	0.07			
258	0.04	0.07			
257	0.12	0.07			
256	0.12	0.07			0.26
255		0.10	0.20		0.26
254		0.10	0.20		0.12
253			0.25		0.12
252			0.25		0.03
251					0.03
250					
249			0.42		
248			0.42		
247			0.01		
246			0.01		
245			0.00		
244			0.00		
243			0.00		
242			0.00		
241			0.01		
240			0.01		

Ground Surface

Exceeds Industrial Worker RGO (0.74 pCi/g @ 1E-6 risk level)

Figure 11. Distribution of Cs-137 by Depth – FRB Basin Area

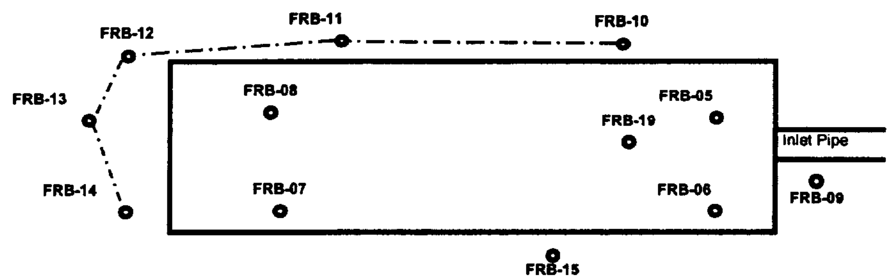


Cs-137 Distribution by Depth

Ground Surface

Elevation above MSL	FRB-14	FRB-15	FRB-09
Surface Elevation:	269.70	272.70	277.10
278			
277			
276			
275			
274			
273			
272		0.07	
271			
270		0.02	
269	0.41	0.02	
268		0.00	
267	0.04	0.00	
266	0.04		
265			
264			
263			
262			
261			0.02
260			0.02
259			-0.01
258			-0.01
257			
256		0.00	
255		0.00	
254		0.01	
253	0.00	0.01	
252	0.00		
251	0.00		
250	0.00		
249			
248			

Figure 12. Distribution of Cs-137 by Depth – FRB Basin Area



Cs-137 Distribution by Depth

Ground Surface

Elevation above MSL	FRB-14 (Surface Elevation: 269.70)	FRB-13 (269.00)	FRB-12 (269.20)	FRB-11 (270.70)	FRB-10 (272.30)
273					
272					0.04
271				0.05	0.04
270	0.41				0.01
269		0.06	0.02	0.00	0.01
268	0.04			0.00	
267	0.04	0.01	0.00		
266		0.01	0.00		
265					
264					
263					
262					
261					
260					
259					
258					
257					
256					0.02
255				0.00	0.02
254	0.00			0.00	0.00
253	0.00	0.00	0.03	0.01	0.00
252	0.00	0.00	0.03	0.01	
251	0.00	0.03	0.00		
250		0.03	0.00		
249					
248					

VII. REMEDIAL ACTION OBJECTIVES AND DESCRIPTION OF THE CONSIDERED ALTERNATIVES FOR THE FRB OPERABLE UNIT

Remedial Action Objectives

Remedial Action Objectives (RAOs) specify COCs, media of concern, potential exposure pathways, and remediation goals. The RAOs are based on the nature and extent of contamination, threatened resources, and the potential for human and environmental exposure. RAOs are developed based upon ARARs or other information from the RI/BRA report. ARARs are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal, state, or local environmental laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site. Initially, remedial technologies are selected based on the RAOs. However, with additional information, the preferred treatment technologies are modified to achieve the goals.

There are three types of ARARs: action-specific, chemical-specific, and location-specific. Action-specific ARARs set controls on the design, performance, and other aspects of implementation of specific remedial activities. Chemical-specific ARARs are media-specific and health-based concentration limits developed for site-specific levels of constituents in specific media. Location-specific ARARs consider federal, state, and local requirements that reflect the physiographical and environmental characteristics of the unit for the immediate area. The action-specific, chemical-specific , or location-specific ARARs (requirements) and to-be-considered requirements relevant to establishing remedial action objectives for the FRB OU identified is shown in Tables 5 through 7.

The RI/BRA report (WSRC, 1997b) has indicated that the secondary sources (i.e., surface soils contaminated with radionuclides) associated with the former basin and process sewer line pose significant carcinogenic risks (approximately 2×10^{-4}) to human health by external exposure to radiation. Since threatened, endangered, or sensitive species are not found at the unit and since it does not offer attractive or unique cover or forage opportunities for wildlife, ecological receptors are not at significant risk from the unit. Although limited risk is associated with the pipeline and manhole sediment (approximately 8×10^{-6}), radioactivity detected inside the pipeline sediment does pose potential future risks associated with this source. The RI/BRA report further indicates that presently there is no contamination in the water table aquifer attributable to the unit. Groundwater modeling indicates there exists a future potential for Sr-90 to leach out and enter the groundwater above MCL. Hence, based on the RI/BRA report conclusions, the feasibility study (FS) was conducted to consider actions that could reduce the risks associated with the former basin area soils, process sewer line area soils, pipeline sediment, and reduce the potential for the COCs to leach out, and enter the groundwater.

Based on the risks posed by the radionuclides in the soils and pipeline sediment, the general remedial action objectives for the FRB OU are as follows:

- Reduce risks to human health associated with COCs through
  - external exposure to radiological constituents by direct contact with the former basin area soil, surface water, and sewer line area soil,
  - ingestion of former basin area and sewer pipeline area soils and pipeline sediment or produce grown in soils with radiological constituents, and
- Prevent or mitigate exposure to highly toxic or highly mobile contaminants that represent principal threat source material.
- Prevent or mitigate the leaching and migration of Sr-90 to unit groundwater. MCL for Sr-90 is 8.0 pCi/L.

Since groundwater data collected in January 1997 and February 1997 reflected no present risk from groundwater associated with this unit, no RAO was developed for the groundwater.

Summary of the risks associated with FRB OU (see Table 2) indicates that one exposure scenario for the former basin area equals or exceeds an excess carcinogenic risk of one in ten thousand (1 x 10^{-4}). This scenario, which is addressed by the RAOs, is external radiation from surface soils (on-unit resident). The risk is 2 x 10^{-4} and COCs contribution to this risk include Cs-137, K-40, and Ra-226. Scenarios for which risk is within the one in ten thousand to one in one a million (1 x 10^{-4} to 1 x 10^{-6}) range are soil ingestion (industrial worker and on-unit resident), dermal contact with sediment and surface water (on-unit resident), biota ingestion (on-unit resident), and external radiation from surface soils (industrial worker).

The scenario for the process sewer line area (pipeline sediment and soils) that equals or exceeds a risk of 1 x 10^{-4} for excess cancer is external radiation from surface soils (on-unit resident). The risk is 1 x 10^{-4} and COCs contributing to this risk include Cs-137, Ra-226, and Ac-228. Scenarios for which risks are within the 1 x 10^{-6} to 1 x 10^{-4} range are surface soil ingestion (on-unit resident), sediment ingestion (construction worker), external radiation from surface soil (industrial worker), and soil and sediment ingestion (on-unit construction worker).

Table 5. Chemical-Specific Requirements

CITATION(S)	STATUS	REQUIREMENT SUMMARY	REASON FOR INCLUSION	ALTERNATIVE(S)
40 CFR 50.6	Applicable	The concentration of particulate matter (PM_{10}) in ambient air shall not exceed 50 $\mu g/m^3$ (annual arithmetic mean) or 150 $\mu g/m^3$ (24-hour average concentration).	Earth-moving activities will generate airborne dust that will have the potential to exceed the levels specified. Dust suppression will likely be required to minimize dust emissions.	S3, S4, P4
40 CFR 192.12	Relevant and Appropriate	The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than (1) 5 pCi/g, averaged over the first 15 cm (5.9) of soil below the surface, and (2) 15 pCi/g, averaged over 15-cm (5.9-in) thick layers of soil more than 15 cm (5.9 in) below the surface.	Radium-226 has been identified as a COC for soil.	S1, S3, S4, P1, P4
SC R 61-58.5(B)(2) and 40 CFR 141.62	Relevant and Appropriate	The proposed MCL for thallium is 1 mg/L	Thallium has been identified as a COC for soil and may leach into the groundwater.	S1, S3, S4, P1, P4, G1, G2
SC R 61-58.5(B)(2) and 40 CFR 141.62	Relevant and Appropriate	The MCL for arsenic is 0.05 mg/L.	Arsenic has been identified as a COC for soil and may leach into the groundwater.	S1, S3, S4, P1, P4, G1, G2
SC R 61-58.5(B)(2) and 40 CFR 141.62	Relevant and Appropriate	The MCL for cesium-137 is 200 pCi/L.	Cesium-137 has been identified as COC for soil and may leach into the groundwater.	S1, S3, S4, P1, P4, G1, G2
SC R 61-58.5(B)(2) and 40 CFR 141.62	Relevant and Appropriate	The proposed MCL for potassium-40 is 300 pCi/L.	Potassium-40 has been identified as a COC for soil and may leach into the groundwater.	S1, S3, S4, P1, P4, G1, G2
SC R 61-58.5(B)(2) and 40 CFR 141.62	Relevant and Appropriate	The proposed MCL for radium-226 is 14.7 pCi/L.	Radium-226 has been identified as a COC for soil and may leach into the groundwater.	S1, S3, S4, P1, P4, G1, G2
SC R 61-58.5(B)(2) and 40 CFR 141.62	Relevant and Appropriate	The MCL for strontium-90 is 8.0 pCi/L.	Strontium-90 has been identified as a COC for soil and the RERRAD shows that it can leach out and enter the groundwater.	S1, S3, S4, P1, P4, G1, G2
SC R 61-58.5(B)(2) and 40 CFR 141.62	Relevant and Appropriate	The proposed MCL for plutonium 239/240 is 62.1 pCi/L.	Plutonium 239/240 has been identified as a COC for soil and may leach into the groundwater.	S1, S3, S4, P1, P4, G1, G2
SC R 61-58.5(B)(2) and 40 CFR 141.62	Relevant and Appropriate	The MCL for actinium-228 is 3270 pCi/L.	Actinium-228 has been identified as a COC for soil and may leach out into the groundwater.	S1, S3, S4, P1, P4, G1, G2

Table 6. Action-Specific Requirements

CITATION(S)	STATUS	REQUIREMENT SUMMARY	REASON FOR INCLUSION	ALTERNATIVE(S)
40 CFR 264.310	Relevant and Appropriate	Cap (or cover) must have permeability less than or equal to the bottom liner systems.	Soil and sediment addressed by this removal action is not RCRA hazardous waste. This requirement is identified as relevant and appropriate for the low permeability cover. The hydraulic conductivity of the cover will be less than or equal to the soils at the bottom of the basin or underneath the former process sewer line.	S3, S5
SC R 61.62.6, Section III	Applicable	Particulate matter must be controlled in such a manner and to the degree that it does not create an undesirable level of air pollution.	Earth-moving activities have the potential to generate airborne particulate matter.	S3, S4, S5, P4, P5A
DOE Order 5820.2A, Chapter III	TBC	Low-level radioactive waste must be managed in a manner that protects public health and safety, assures that external exposure to the waste does not exceed 25 mrem/yr to any member of the public, and protects groundwater resources.	Contaminated soil generated during this remedial action will likely be considered low-level radioactive waste.	S1, S3, S4, S5, P1, P4, P5A

Table 7. Location-Specific Requirements

CITATION(S)	STATUS	REQUIREMENT SUMMARY	REASON FOR INCLUSION	ALTERNATIVE(S)
16 USC 1531	Applicable	The remedial action must be conducted in a manner to conserve endangered or threatened species.	There are threatened and endangered species at the SRS; however, as stated in the FRB RI/BRA, this action will not affect these species.	S1, S3, S4, S5, G1, G2, P1, P4, P5A
16 USC 661	Applicable	The remedial action must be conducted in a manner to protect fish or wildlife.	This remedial action has the potential to affect wildlife in the vicinity of the FRB and former process sewer line. This action will not affect fish located at the SRS or in nearby bodies of water.	S1, S3, S4, S5, G1, G2, P1, P4, P5A
SC R 51.62.6, Section III	Applicable	The remedial action must be conducted in a manner that minimizes impacts to migratory birds and their habitats.	Migratory bird populations may be presented in the vicinity of SRS.	S1, S3, S4, S5, G1, G2, P1, P4, P5A
DOE Order 5820.2A, Chapter III	Applicable	The remedial action must minimize the destruction, loss, or degradation of wetlands.	Wetlands may be located in the vicinity of the FRB and former process sewer line; however, they will be unaffected by this action.	S1, S3, S4, S5, G1, G2, P1, P4, P5A

Description of the Considered Alternatives for FRB Operable Unit

As part of the investigation/assessment process for the FRB OU, a CMS/FS was performed using data generated during the assessment phase. The CMS/FS evaluated various treatment processes and technologies that can be used to remediate the contaminated soil attributed to the FRB OU and groundwater. Detailed information regarding the development and evaluation of remedial alternatives can be found in the *Corrective Measures/Feasibility Study for the F-Area Retention Basin (U)* (WSRC, 1997c).

After screening a number of treatment processes and technologies, various treatment alternatives were developed. Fifteen potential remedial alternatives were identified initially to address the remediation at the former basin area and the process sewer line area. After initial screening, nine alternatives were considered for detailed analysis. Since primary and secondary COCs for the former basin area soil and process sewer line area soil are radionuclides and metals with very similar physical and chemical properties, the remedial alternatives identified in the FS report are applicable to all unit primary and secondary COCs.

Considered Alternatives for Soils

Four alternatives were evaluated for remedial action of the soil. Each alternative is briefly described below. For additional information regarding the description of the alternatives, their cost estimates and their analyses, see the *Corrective Measures/Feasibility Study for the F-Area Retention Basin (281-3F) (U)*, (WSRC, 1997c).

Alternative S1 - No Action

Under this alternative, no action will be taken for the soil, which means leaving the FRB OU soil in its current condition with no additional controls. EPA policy and regulations require the consideration of a No Action alternative to serve as a baseline against which the other alternatives can be compared.

There is no reduction of risk with this alternative. The only reduction in risks resulting from the No Action alternative are due to natural decay of radionuclides, primarily Cs-137 and Ra-226. The half-lives of Cs-137 and Ra-226 are 30 years and 1600 years, respectively. Therefore, natural decay of Cs-137 and Ra-226 will not reduce the external radiation risk significantly from a No Action alternative for the next 30 years. Sr-90 could also leach out and enter the groundwater in 30 years with concentrations above MCL (8.0 pCi/L). The Remedial Action Objective for principal threat source material would not be addressed under this alternative.

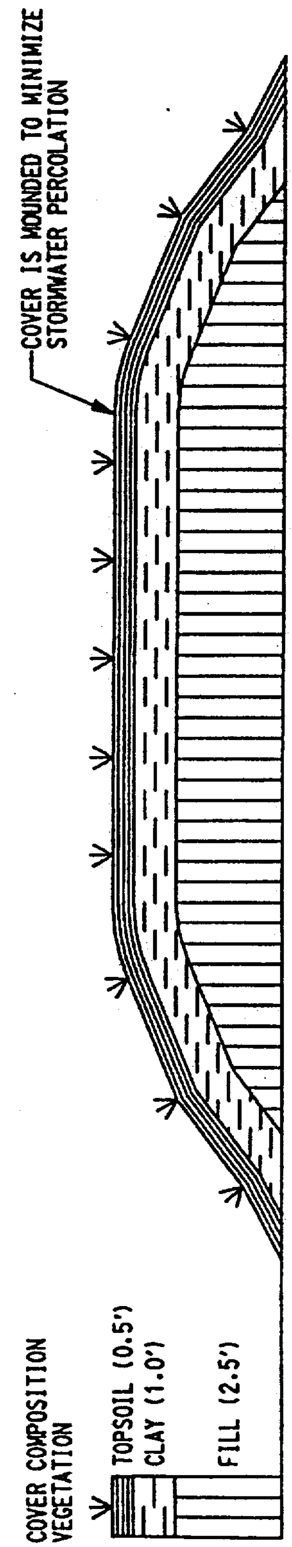
No costs are associated with this alternative. However, the total present worth cost for the five-year ROD reviews for 30 years (for cost estimating purpose only; actual five-year ROD reviews will be required in perpetuity), is approximately $9,600.

Alternative S3 - Institutional Controls and Low Permeability Cover

This alternative will include institutional controls and a low permeability cover placed over the basin. The cover is designed to minimize stormwater percolation. Stormwater percolation is further minimized by mounding the cover and diverting stormwater by constructing a runoff control system around the cover. A vegetative cover is placed over the low permeability cover to minimize erosion (see Figure 13 for illustration). Under institutional controls, deed restrictions and/or notifications will be provided if the government sells the property. Five-year CERCLA ROD reviews will also be performed for this alternative for 30 years. The 30-year period is for cost estimating purposes only; actual five-year ROD reviews will be required in perpetuity.

The institutional controls will involve both short-term and long-term actions. For the short-term action, signs will be posted at the FRB OU indicating that this area was used for the disposal of waste material and contains buried waste. Additionally, existing SRS access controls will be used to maintain use of this site for industrial use only. In the long-term, if property is ever transferred to non-Federal ownership, the U.S. Government will take those actions necessary pursuant to Section 120(h) of CERCLA. These actions will include a deed notification disclosing former waste management and disposal activities as well as any remedial actions taken on the site and any continuing groundwater monitoring commitments. These requirements are also consistent with the intent of the RCRA deed notification required at final closure of the RCRA facility if contamination would remain at the unit. The deed notification shall, in perpetuity, notify any potential purchaser that the property has been used for the management and disposal of radioactive materials and hazardous substances. The deed shall also include deed restrictions precluding residential use of the property. However, the need for these deed restrictions may be reevaluated at the time of transfer in the event that contamination no longer poses an unacceptable risk under residential use. Any reevaluation of the need for deed restrictions would be done through an amended ROD with the Environmental Protection Agency (EPA) and the South Carolina Department of Health and Environmental Control (SCDHEC) approval. In addition, if the site is ever transferred to non-Federal ownership, a survey plat of the

Figure 13. Low Permeability Cover Cross Section



area will be prepared. The plat will be certified by a professional land surveyor, and recorded with the appropriate county recording agency.

Per the EPA-Region IV Land Use Controls (LUCs) Policy, a Land Use Control Assurance Plan (LUCAP) and a Land Use Control Implementation Plan (LUCIP) will be developed and submitted to the regulators for approval. The LUCAP will be submitted under separate cover whereas the LUCIP will be submitted with the post-ROD documents for the FRB OU.

The LUCIP will clearly identify the objectives of the land use controls for the FRB OU. The land use control objectives for the FRB OU are to: reduce risks to human health from direct exposure to radiological COCs by direct contact with basin soil, surface water, sewer line soil, and ingestion of soils and/or produce grown in FRB OU soils; and prevent leaching and migration of Sr-90 to groundwater. The specific manner of achieving the land use control objectives will be included in the LUCIP as part of the post-ROD documents. The LUCIP will also specify the assumptions made concerning current and expected future land use and exposure scenarios. The land use scenarios used in the risk assessment as well as the DOE policy on current and future land use projections are discussed in Section VI.

Under the current land use scenarios, the most reasonable receptor for the FRB OU considered is a visitor who is exposed to the FRB OU area on an infrequent or occasional basis. Under future land use scenarios, the receptor and exposure pathways considered included: an industrial worker exposed to surface soils, redistributed deep soils, and groundwater; a future resident exposed to surface and excavated deep soils, air, groundwater, homegrown produce and external radiation; and a construction worker exposed to surface and subsurface soils, groundwater and sediment within the sewer pipeline. For a construction worker and future resident, both carcinogenic risks and non-carcinogenic hazards also considered exposure to modeled concentrations in groundwater due to leachability of soil contaminants. All the assumptions made concerning current and expected future land use scenarios used in the risk assessment will also be included in the LUCIP as part of the post-ROD documents. The LUCIP will also specify those exposure scenarios, which may not be protective of the human health and the environment under less restrictive land uses.

A low permeability engineered cover will be sufficient to minimize infiltration, intrusion, and surface erosion. The cover design will be approved by the EPA and SCDHEC prior to construction. The low permeability cover will encompass an area of approximately 4,000 square meters (1.0 acre) and will be maintained for 30 years. The 30-year period is for cost estimating only; actually the cover will be maintained in perpetuity. Based on the known half-lives of the predominant radiological risk drivers (i.e., Cs-137 and Ra-226), only Cs-137 will have gone through approximately one half-life. In addition, institutional controls will remain in place as long as the waste remains a threat to human health or the environment.

A properly engineered cover will function as a physical barrier to prevent direct human exposure to soil-borne contamination and thus will be protective of human health and the environment. A low permeability cover is a performance-based engineering approach since it does not reduce the total mass of COCs. The soil cover will be adequate to reduce the annual effective dose associated with continuous exposure to Cs-137 and Ra-226 to within regulatory limits. In addition, a properly maintained cover will minimize infiltration and subsequent leaching of contamination from unsaturated soil to the groundwater.

Under this remedial alternative, two remedial action objectives are satisfied by: (1) limiting infiltration into the area, thereby reducing the leaching of primary and secondary COCs to unit groundwater; and (2) preventing human or ecological access, thereby reducing risks to human health and the environment. The third remedial action objective to prevent or mitigate the potential exposure to highly toxic or highly mobile contaminants (the principal threat source material) would not be met.

The total present value estimate for this alternative is approximately $286,000. These costs include estimated capital costs approximately $267,000 and operation and maintenance costs, approximately $19,000, for the cover for 30 years and review of the remedy every five years for 30 years, as required by the NCP. The 30-year period is for cost estimating purposes only; actual five-year reviews will be required in perpetuity.

Alternative S4 - Institutional Controls and Grouting

This alternative consists of institutional controls and grouting the soils *in situ* to reduce contaminant mobility and stabilize principal threat source material. A vegetative cover will be installed over the stabilized soil to minimize erosion. The estimated depth range of *in situ* grouting is approximately 1.8 to 4.3 m (6 to 14 ft). The depth range, 6 to 14 ft has been selected for two reasons: (1) Cs-137 and Sr-90 is mostly distributed in the deep soil beneath the former basin in the depth range of 6 to 14 ft as is apparent from Figures 14 and 15; and (2) the permeability of the grouted mass will be no greater than 1 x 10^{-6} cm/s, thereby preventing infiltration to the soils beyond the 14 ft depth. Therefore, Sr-90 and any other contaminants present in the soil beyond 14 ft depth will have less potential for migrating to the groundwater.

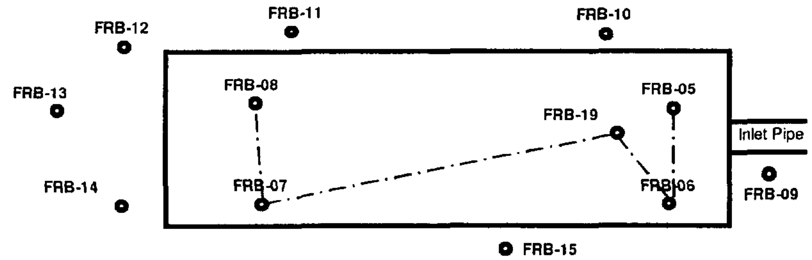
Deed restrictions and/or notifications will be provided if the government chooses to sell the property. Five-year CERCLA ROD reviews will be performed for 30 years. The 30-year period is for cost estimating only; the actual reviews will be required in perpetuity.

This alternative will involve excavating the basin to remove the nominal eight feet of clean soil that was placed in the basin when the basin was closed, cleaned and backfilled in 1978; grouting, or solidification/stabilization (S/S) of the soil in the bottom of the basin down to a 1.8 m (6 feet) depth (4.3 m or 14 feet depth from the present surface of the basin, with an approximate volume of 6,600 m^3 or 8,100 yd^3); backfilling the basin with clean soil; and grading the top surface of the basin. Institutional controls will be same as identified in Alternative S3. In situ S/S involves mixing the S/S reagents into the waste by a mechanical means such as a jet-grouting system or a long-reach backhoe fitted with a grouting device (see Figures 16 and 17 for illustration). A treatability study has been conducted on L-Area Oil and Chemical Basin (LAOCB) soils, which has characteristics almost identical to F-Area Retention Basin soil *(Laboratory-Scale Immobilization Study Report for L-Area Oil and Chemical Basin)* (WSRC, 1996). This study has determined that S/S agents can immobilize unit-specific contaminants; specifically, a mixture of Portland cement, bentonite, and sodium silicate was found to effectively immobilize contaminants, primarily radionuclides such as Cs-137 and Co-60.

In situ S/S does not reduce the total mass or toxicity of the COCs. However, it is a proven performance-based engineering approach that reduces the mobility of the primary and secondary COCs. Based on the results of a literature search and a treatability study performed on LAOCB soils, the in situ S/S reagents are considered effective at reducing the leachability of contaminants. Specifically, the various S/S reagent samples (with LAOCB soil) were subjected to the toxicity characteristic leaching procedure (TCLP) and the extended American Nuclear Society (ANS) 16.1 procedure to simulate leaching of contaminants over time. Analysis of the two leaching tests performed on LAOCB soil samples mixed with S/S reagents demonstrated that all of the samples released 0.41% and 1.61% or less of gross alpha and gross beta, respectively.

Alternative S4 meets remedial action objectives by: (1) preventing infiltration into the basin area through immobilizing contaminants present in the basin, thereby preventing migration of primary and secondary COCs to groundwater; (2) preventing human or ecological access, thereby reducing risks to human health and the environment; and (3) preventing or mitigating the

Figure 14. Distribution of Sr-90 by Depth – Depicting the Zone of High Concentration – FRB Basin Area Alternative S5 – Institutional Controls, Grouting, Low Permeability Cover, and Groundwater Monitoring



Sr-90 Grout Zone

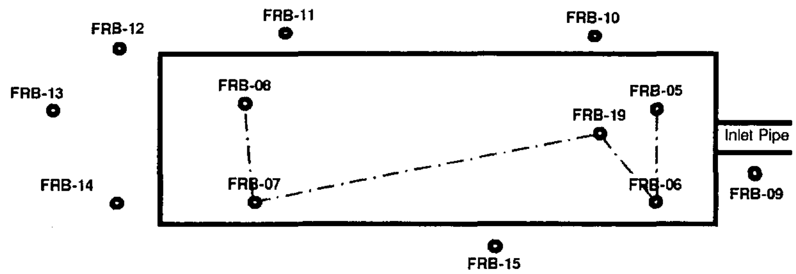
Drawing not to scale

Elevation above MSL	Surface Elevation:	FRB-08 269.90	FRB-07 271.90	FRB-19 274.40	FRB-06 276.20	FRB-05 273.40
276						
275					0.346	
274						
273				-0.27		
272	Ground Surface					2.61
271			1.75			
270						0.0713
269	Basin Bottom at 264 ft MSL	2.24	1.43			0.0713
268			1.43			
267		5.25				
266		5.25				
265					0.571	
264					0.571	9.99
263		23.2	91.3	12.3		9.99
262	Grout Zone	23.2	91.3	12.3		
261		102		93.1		
260		102		93.1		
259		13.8	13.4			
258		13.8	13.4			
257		8.35	8.7			
256		8.35	8.7			81.5
255			1.62			81.5
254			1.62			13
253						13
252						32.7
251						32.7
250						
249						
248						
247						
246						
245				38.7		
244				38.7		
243				13.3		
242				13.3		
241				24.9		
240				24.9		

Exceeds RESRAD Soil Leachability Level of 109 pCi/g that would exceed the MCL of 8.0 pCi/L.

Grout Zone beginning 2 feet above the basin bottom and extending to 6 feet below the basin bottom.
Basin bottom is at 264 feet above mean sea level (MSL).

Figure 15. Distribution of Cs-137 by Depth – Depicting the Zone of High Concentration – FRB Basin Area Alternative S5 – Institutional Controls, Grouting, Low Permeability Cover, and Groundwater Monitoring



Cs-137 Distribution by Depth

Elevation above MSL	FRB-08	FRB-07	FRB-19	FRB-06	FRB-05
Surface Elevation:	269.90	271.90	274.40	276.20	273.40
276					
275				0.25	
274					
273			0.12		
272					0.10
271		0.29			
270					0.09
269	0.09	0.09			0.09
268		0.09			
267	0.07				
266	0.07				
265				0.46	
264				0.46	
263					
262					
261		0.33			
260		0.33			
259	0.04	0.07			
258	0.04	0.07			
257	0.12	0.07			
256	0.12	0.07			0.26
255		0.10	0.20		0.26
254		0.10	0.20		0.12
253			0.25		0.12
252			0.25		0.03
251					0.03
250					
249			0.42		
248			0.42		
247			0.01		
246			0.01		
245			0.00		
244			0.00		
243			0.00		
242			0.00		
241			0.01		
240			0.01		

Ground Surface

Grout Zone

Exceeds Industrial Worker RGO (0.74 pCi/g @ 1E-6 risk level)

Grout Zone

potential exposure to highly toxic or highly mobile contaminants, i.e., the principal threat source material.

The short- and long-term institutional controls and LUC information described under Alternative S3 would also be applicable under Alternative S4.

The total present value estimate for this alternative is approximately $1,228,000. These costs include estimated capital costs approximately $1,209,000 and operation and maintenance costs approximately $19,000 for the grouted monolith for 30 years and review of the remedy every five years for 30 years, as required by the NCP. The 30-year period is for cost estimating purposes only; the actual five-year ROD reviews will be required in perpetuity.

Alternative S5 – Institutional Controls, Grouting, Low Permeability Cover, and Groundwater Monitoring

Alternative S5 is a combination of alternatives S3 and S4 and consists of grouting the soils *in situ* to reduce contaminant mobility and providing a low permeability cover over the grouted soils. A vegetative cover is placed over the low permeability cover to minimize erosion.

This alternative like S3 will be effective in preventing contact with and ingestion of contaminated soil. Like Alternative S4, it will also be very effective in reducing potential leaching of contaminants from soil to groundwater. Additionally, deed restrictions and/or notification will be provided if the government sells the property. Five-year ROD reviews will also be performed for this alternative.

Under this alternative, contamination in the basin soil will be immobilized and covered with clean soil and a low permeability cover as discussed under Alternative S3. These actions would meet all the three remedial action objectives by:

- preventing infiltration into the soil through cover and immobilizing contaminants present in the basin via in situ S/S, thereby preventing migration of primary and secondary COCs to groundwater;

- preventing human or ecological access, thereby reducing risks to human health and the environment;

Figure 16. Backhoe Soil Mixing

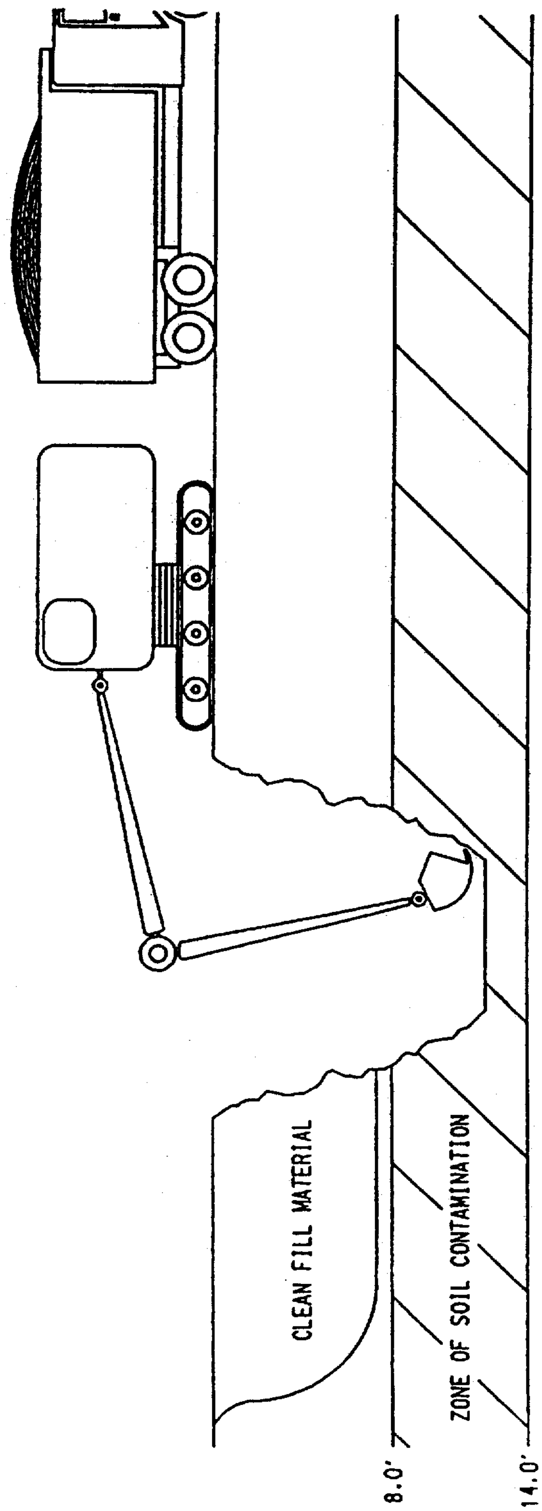
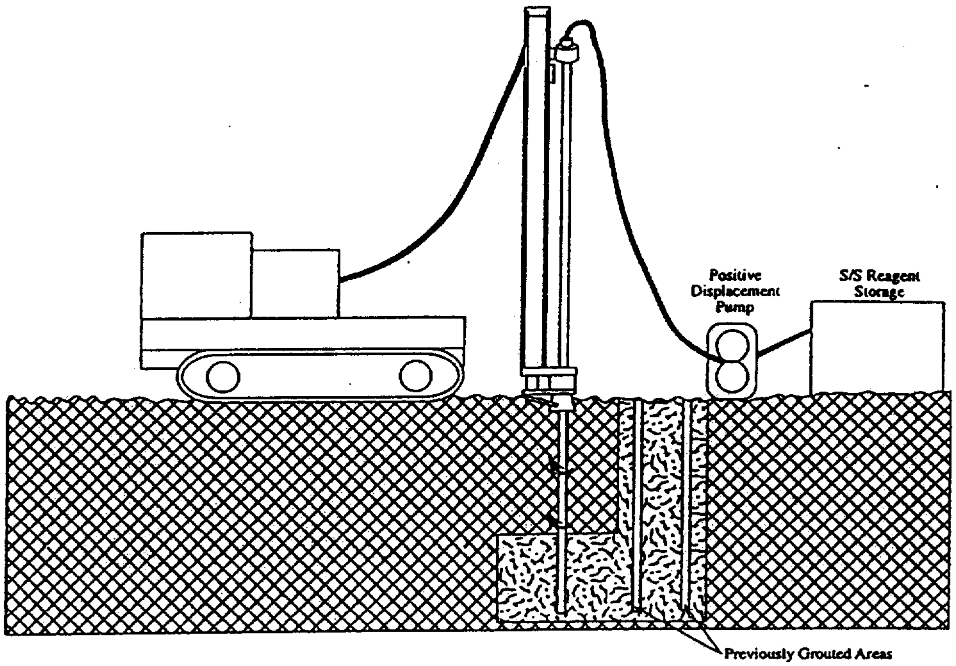
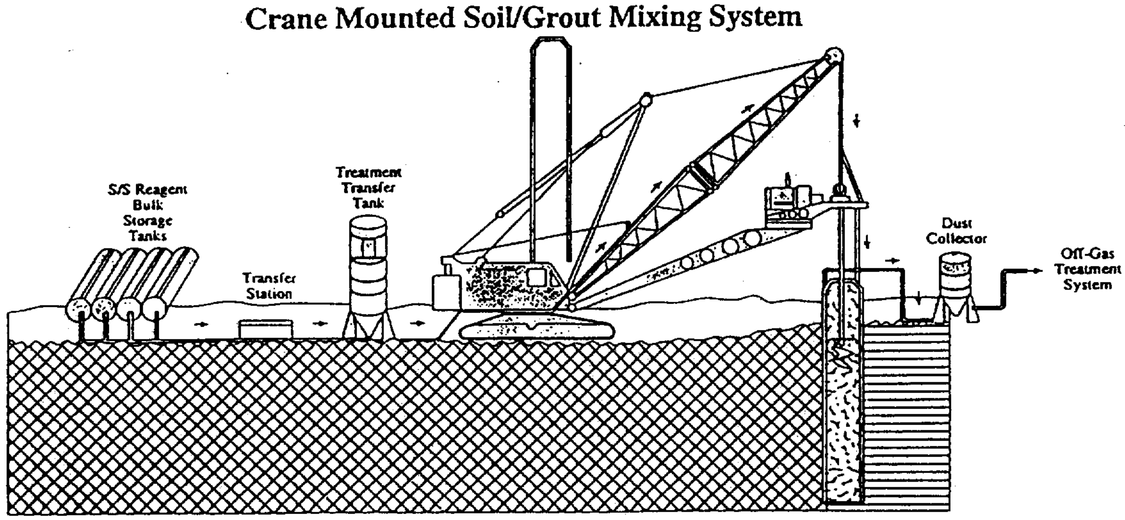


Figure 17. Jet and Soil Mixing Grouting Techniques

Track Mounted Jet-Grout Drilling



Crane Mounted Soil/Grout Mixing System



- preventing or mitigating potential exposure to highly mobile or toxic contaminants which represent the principal threat source material; and

- reducing the radioactive dose (direct radiation exposure) received from Cs-137 and Ra-226 by nearly 100%, assuming an approximate cover thickness of four feet.

This alternative also includes groundwater monitoring to confirm that the source remediation has achieved the required stabilization of the contaminants; to relieve any uncertainty in the analytical data; and to verify that there exists no upgradient source contributing any contamination to the FRB OU groundwater. The existing monitoring wells (FRB-01, -02, -03, and –04) will be used to collect groundwater samples semi-annually (see Figure 18 for monitoring well locations, groundwater flow direction, and location for the upgradient well).

The analytes monitored will include Cs-137, Sr-90, TCE, and other COCs and normal field measurements specified in the post-ROD document work plans. If monitoring detects contamination above MCLs (or RBCs without MCLs) for those constituents attributable to the FRB OU or an unknown upgradient source, for two consecutive monitoring periods, the regulators will be informed within 30 days. A plan for evaluating the data and developing further action will be submitted within 90 days for regulatory approval. The results of the monitoring will be reported annually; however, no raw data will be provided.

The short-term and long-term institutional controls and LUC information described under Alternative S3 would also be applicable under Alternative S5.

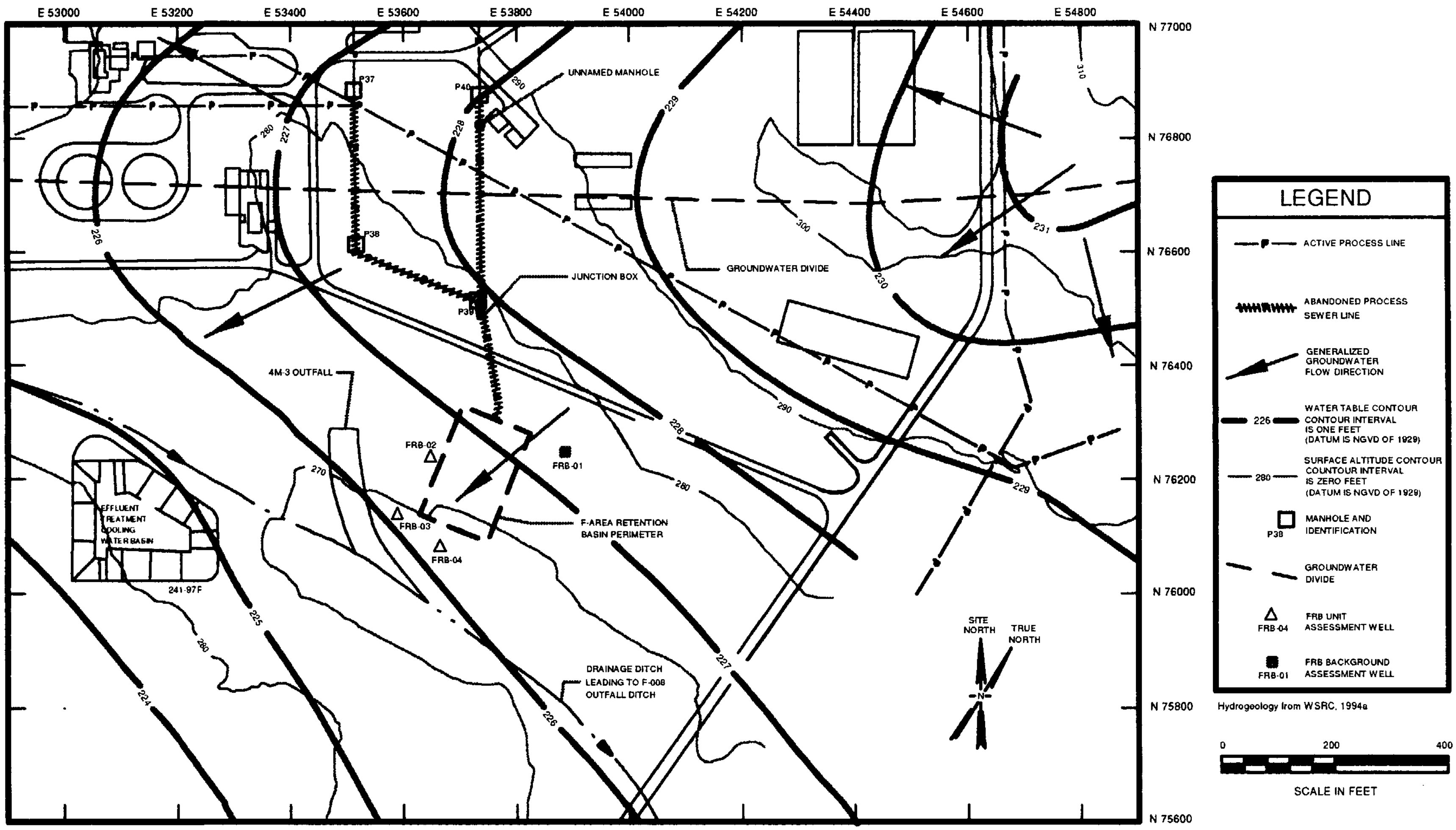
The total present value estimate for this alternative is approximately $1,461,000 with total estimated capital costs approximately $1,442,000 and O&M costs approximately $19,000.

This estimate includes costs for groundwater monitoring, operation and maintenance of the cover for 30 years, and review of the remedy every five years for 30 years as required by the NCP. The 30-year period is for cost estimating purposes only; actual five-year reviews will be required in perpetuity.

Considered Alternatives for Groundwater

Since no impact to the groundwater from the operation of the basin was discovered, only two alternatives were evaluated for groundwater. The alternatives are described below.

Figure 18. Locations of FRB Monitoring Wells and Upgradient Well



Alternative G1 - No Action

This alternative involves leaving the groundwater associated with FRB OU in its current condition with no additional controls. EPA policy and regulations require the consideration of a No Action alternative to serve as a baseline against which the other alternatives can be compared.

Because no further action is taken at the unit, the groundwater remains in its present condition. No costs are associated with this alternative.

Alternative G2 - Groundwater Monitoring

This alternative involves maintaining control of the basin area and monitoring the groundwater annually until it is confirmed that the remedial response action for the FRB OU has achieved the required stabilization of the contaminants. This alternative alone will not be effective in preventing future ingestion of shallow aquifer groundwater. No monitoring is required based on no basin impact. However, groundwater monitoring was considered as an element of the soil remedy.

However, groundwater monitoring when performed in conjunction with institutional controls will be effective in preventing the ingestion of groundwater and thereby reducing the risks to human health. If contamination is detected above the maximum contamination level, then further groundwater response actions will be necessary. If monitoring conditions change, SRS will request alteration or termination of the monitoring program.

The short-term and long-term institutional controls and LUC information described under Alternative S3 would also be applicable under Alternative G2.

There are no capital costs associated with this alternative; however, total estimated O&M costs are approximately $114,000. Therefore, the total present worth cost for this alternative is approximately $114,000. These costs include a five-year ROD review for 30 years. The 30-year period is for cost estimating purposes only; actual five-year reviews will be required in perpetuity.

Considered Alternatives for Process Sewer Line

Three alternatives were evaluated for remediation of the process sewer line and pipeline-associated soils. The alternatives are described below.

Alternative P1 - No Action

This alternative involves leaving the process sewer line, like the basin, in its current condition with no additional controls. EPA policy and regulations require the consideration of a No Action alternative to serve as a baseline against which the other alternatives can be compared. Because no further action is taken at the unit, the process sewer line along with the basin soil remains in its present condition. There is no reduction in the risk posed by the radionuclides present in the soil, which include Ac-228, Cs-137, K-40, Ra-226, and Sr-90.

No costs are associated with this alternative. However, the total present worth cost for five-year ROD reviews for 30 years is approximately $9,600. The 30-year period is for cost estimating purposes only; actual five-year reviews will be required in perpetuity.

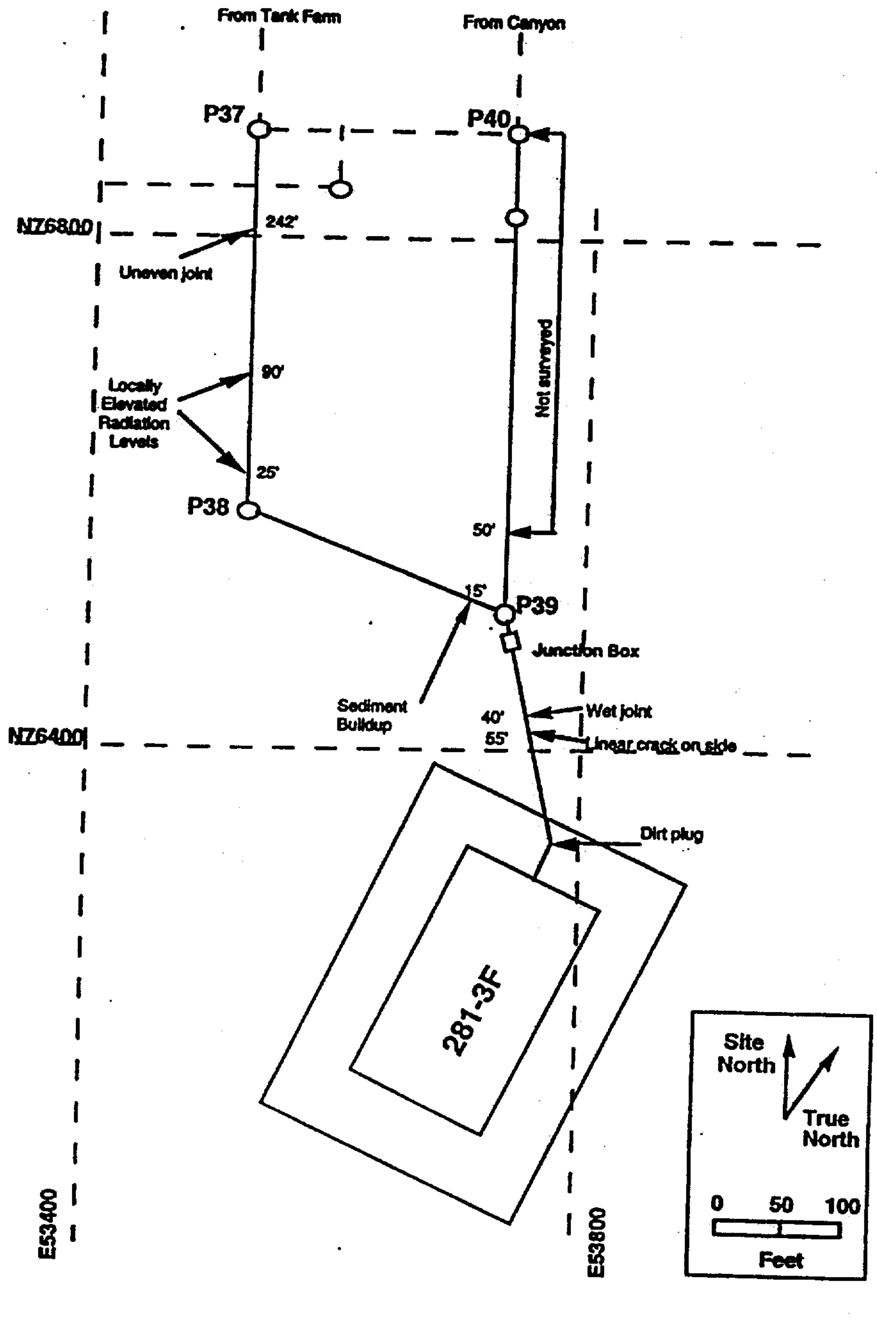
Alternative P4 - Institutional Controls, Pipeline Grouting, Soil Excavation, and Disposal of Soil with Basin Soil

This alternative includes pumping grout into the pipeline and manholes to stabilize contaminants, thereby restricting access to the contaminants inside the pipeline. This alternative also involves excavating localized areas of contaminated soil (areas around the trouble spots determined by robotics investigation and soil sampling) (Figure 19) around the pipeline area using standard earth-moving equipment. The volume of contaminated soil will be determined by comparing the existing sampling data against the acceptance criteria (concentration levels not to exceed 20 pCi/g for alpha and 50 pCi/g for beta and gamma emitters). The material (unacceptable contaminated soil with an estimated volume of approximately 240 m^3 or 300 yd^3) is then transported to the basin for disposal along with the basin soils. Deed restrictions and/or notifications would be provided if the government were to sell the property. Five-year ROD reviews are also included in this alternative.

The short-term and long-term institutional controls and LUC information described under Alternative S3 would also be applicable to P4.

Because the source of contamination is removed under this alternative, the remedial action objectives are met. The sewer line soil hot spots and, if necessary, associated sections of pipeline are excavated and combined with the basin grout mass, thereby reducing the risk from the most contaminated areas of the sewer line soils.

Figure 19. Location of Potential Trouble Spots



The total present worth cost for this alternative is approximately $320,000 with total estimated capital costs approximately $310,000 and estimated O&M costs $96,000. These costs include five-year ROD reviews for 30 years. The 30-year period is for cost estimating purposes only; actual five-year reviews will be required in perpetuity.

Alternative P5A - Excavation and Off-Unit Disposal (SRS Disposal)

This alternative involves excavating and removing the pipeline and associated contaminated soil and using clean backfill from an SRS source to return the area to natural grade. Topsoil will also be used to support a vegetative layer.

Concrete debris (estimated volume of 45 m^3 [58 yd^3]) generated during removal of the pipeline will be transported to E-Area Low Level Radioactive Disposal Facility for disposal. Assuming a 150% bulking factor for the concrete pipe, the volume of pipeline that will be broken and sized into small pieces will be approximately 68m^3 (87 yd^3). Contaminated soil (estimated volume of approximately 240 m^3 [300 yd^3]) will be dispositioned with basin soils.

This alternative meets ARARs. Residual concentrations of Ra-226 in soil will meet the relevant ARAR. Excavation of contaminated material (pipeline and soil) can be performed in a manner that meets air emission ARARs; that is, using conventional earth-moving equipment and standard dust suppression techniques. Current access restrictions prevent inadvertent intrusion into the area. Risks to remediation workers from operating heavy earth-moving equipment and handling contaminated soil and sediment can be managed by following the project-specific health and safety plan. Equipment and materials required for this remedial action are readily obtained by SRS.

Implementation of this alternative will be difficult as a large amount of soil (2728 m^3 [3567 yd^3]) must be excavated and managed while removing the pipeline. There will also be difficulties associated with removing the 0.6 m (2 ft) and 0.9 m (3 ft) diameter pipeline from the ground due to its size and weight. Another process line (unrelated to this unit and not addressed by this alternative) runs close to the former process sewer line. Therefore, excavation activities must be carefully planned and conducted to avoid disturbing this other process line. Disposal capacity at SRS for the disposal of low-level radioactive waste is also limited. Because the source of contamination will be removed under this alternative, remedial action objectives will be met by eliminating any risk to groundwater, human health, and the environment.

The cost of this alternative is approximately $410,000 (total present value cost). There are no O&M costs for this alternative and these costs also do not include costs for five-year ROD reviews since no ROD review will be required for this alternative.

VIII. SUMMARY OF COMPARATIVE ANALYSIS OF THE ALTERNATIVES

Evaluation Criteria

Each remedial alternative was evaluated using the nine criteria established by the National Oil and Hazardous Substances Contingency Plan. The criteria were derived from the statutory requirements of CERCLA Section 121 and are listed below:

- Overall protection of human health and the environment
- Compliance with applicable or relevant and appropriate requirements (ARARs)
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

In selecting the preferred alternative, these nine criteria were used to evaluate the alternatives developed in the Corrective Measure Study/Feasibility Study for the FRB *(U)* (WSRC, 1997c). First seven of the criteria are used to evaluate all the alternatives. The preferred alternative is further evaluated based on the final two criteria, state acceptance and the community acceptance. The first two criteria (overall protection of human health and the environment, and compliance with ARARs) are also categorized as threshold criteria. The next five criteria are categorized as primary balancing criteria. The last two criteria (state acceptance and community acceptance) are categorized as modifying criteria.

Detailed Evaluation

The remedial action alternatives discussed in Section VII were evaluated using the nine criteria. A detailed evaluation of the alternatives is provided in the Feasibility Study (WSRC, 1997c).

Comparative Analyses

This section discusses how well each alternative addresses the CERCLA evaluation criteria. The alternatives are discussed in relative order of performance with respect to the particular criterion. Table 8 provides a summary of the comparative analyses.

Overall Protection of Human Health and the Environment

For soil remedial alternatives, Alternative S5 is the most protective because it involves stabilizing the waste and providing a cover to minimize stormwater percolation. Alternative S4 is the second most protective because it involves stabilizing the waste source only. Alternative S3 offers the next best level of protection. Alternative S1, the No Action alternative, offers the least protection.

For groundwater, both alternatives, Alternative G1 and Alternative G2 are equally protective of human health and the environment.

For the process sewer line area, Alternative P5A is the most protective of human health and the environment followed by Alternatives P4 and P1.

Compliance with ARARs

Alternatives S1, S3, S4, S5, P1, P4, and P5A comply with ARARs for soil. Alternative G2 complies with groundwater ARARs.

Long-Term Effectiveness

Of the soil alternatives, Alternative S5 offers the most long-term effectiveness. The second most effective is Alternative S4, followed by S2, and then Alternative S1 (No Action).

Both groundwater alternatives, Alternative G1 and Alternative G2, are equally effective over the long term for groundwater.

Alternative P5A offers the most protection over the long term for the process sewer line area, followed by Alternatives P4 and then P1 (No Action).

Table 8. Comparative Analysis Summary

Alternative	CERCLA Criterion			
	Overall Protection of Human Health of the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment
S1: No Action	**Least protective soil alternative**	**Complies with ARARs**	**Least effective soil alternative in the long term**	**Does not reduce toxicity, mobility, or volume**
S3: Institutional Controls and Low Permeability Cover	**Protective, but not to the extent of S4 or S5**	**Complies with ARARs**	**Effective in the long term, but not as effective as S4**	**Reduces contaminant mobility, but not to the extent of S4**
S4: Institutional Controls, and Grouting,	**Second most protective soil alternative**	**Complies with ARARs**	**Second most effective soil alternative in the long term**	**Second most effective in reducing contaminant mobility for soil alternatives**
S5: Institutional Controls, Grouting, and Low Permeability Cover	**Most protective soil alternative**	**Complies with ARARs**	**Most effective soil alternative in the long term**	**Most effective in reducing contaminant mobility for soil alternatives**
G1: No Action	**Equally protective groundwater alternative**	**Compliance with groundwater ARARS can not be demonstrated**	**Equally effective groundwater alternative in the long term**	**Does not reduce toxicity, mobility, or volume**
G2: Groundwater Monitoring	**Equally protective groundwater alternative**	**Complies with groundwater ARARs**	**Equally effective groundwater alternative in the long term**	**Does not reduce toxicity, mobility, or volume**
P1: No Action	**Least protective pipeline alternative**	**Complies with soil ARARs**	**Least effective pipeline alternative in the long term**	**Does not reduce toxicity, mobility, or volume**
P4: Institutional Controls, Pipeline Grouting, and Soil Excavation and Disposition with FRB Soils	**Second most protective pipeline alternative**	**Complies with soil ARARs**	**Second most effective pipeline alternative in the long term**	**Second most effective in reducing contaminant toxicity, mobility, or volume for pipeline alternatives**
P5A:Excavation and Off-Unit Disposal (SRS Disposal)	**Most protective pipeline alternative**	**Complies with Soil ARARs**	**Most effective pipeline alternative in the long term**	**Most effective in reducing contaminant toxicity, mobility, or volume for pipeline alternatives**

Table 8. (Cont'd). Comparative Analysis Summary

Alternative	CERCLA Criterion		
	Short-Term Effectiveness	Implementability	Cost
S1: No Action	**Most effective soil alternative in the short term**	**Easiest soil alternative to implement**	**$9,578**
S3: Institutional Controls and Low Permeability Cover	**Equally effective as S4 and S5 in the short term**	**Readily implemented; less difficult than S4**	**$285,132**
S4: Institutional Controls, and Grouting	**Equally effective as S3 and S5 in the short term**	**Second most difficult soil alternative to implement**	**$1,227,694**
S5: Institutional Controls, Grouting, and Low Permeability Cover, Groundwater Monitoring	**Equally effective as S3 and S4 in the short term**	**Most difficult soil alternative to implement**	**$1,460.929**
G1: No Action	**Equally effective groundwater alternative in the short term**	**Easiest groundwater alternative to implement**	**No Cost**
G2: Groundwater Monitoring	**Equally effective groundwater alternative in the short term**	**Easily implemented; however, more difficult than G1**	**$113,331**
P1: No Action	**Most effective pipeline alternative in the short term**	**Easiest pipeline alternative to implement**	**$9,578**
P4: Institutional Controls, Pipeline Grouting, and Soil Excavation and Disposition with FRB Soils	**Second least effective pipeline alternative in the short term**	**Second most difficult pipeline alternative to implement**	**$319,265**
P5A: Excavation and Off-Unit Disposal (SRS Disposal)	**Least effective pipeline alternative in the short term**	**Most difficult pipeline alternative to implement**	**$409,134**

Reduction of Toxicity, Mobility, or Volume

No alternative completely reduces toxicity, mobility, and volume at the waste unit. Alternative S5 ranks the highest in this category for the soil alternatives because it achieves the greatest reduction in contaminant mobility. Alternatives S4 and S3 also reduce contaminant mobility, but to a lesser extent than Alternative S5. Alternative S1 (No Action) does not affect toxicity, mobility, or volume.

Alternatives G1 and G2 have no effect on toxicity, mobility or volume.

Alternative P5A, which removes contaminated material from the waste unit, ranks first in this category for process sewer line area alternatives. Alternative P4 ranks second because it reduces contaminant mobility. Alternative P1 (No Action) has no effect on toxicity, mobility, or volume.

Short-Term Effectiveness

Alternative S1 offers the most short-term effectiveness of the soil alternatives. Alternatives S3, S4, and S5 rank equally in this category as they all provide the same degree of worker exposure during implementation.

Both groundwater alternatives, Alternative G1 and Alternative G2 are equally effective in the short term.

Alternative P1 is most effective in the short term for the process sewer line area alternatives. Alternative P4 is moderately effective due to limited remedial worker exposure to contaminants. Alternative P5A is the least effective alternative due to potential worker exposure to contaminated material. None of the alternatives should affect the community during remediation. The site-specific health and safety plan addresses remedial worker risks from equipment operation for alternatives involving physical activities.

Implementability

Alternatives S1, S3, S4, and S5 are readily implemented; Alternatives S4 and S5 are more difficult because they will require testing to determine the appropriate grout mixtures.

Alternative G1 is the easiest to implement for groundwater, followed by Alternative G2.

Alternative P1 is the easiest pipeline alternative to implement, followed by Alternative P4. Alternative P5A is the most difficult to implement.

Cost

The No Action alternative, S1, is the least expensive of the soil alternatives (total present worth cost, $9,578; capital cost $0, and O&M costs, $9,578), followed by Alternatives S3 (total present worth cost $285,132; capital costs, $266,908; and O&M costs, $118,224), S4 (total present worth cost $1,227,644; capital cost, $1,209470; and O&M costs, $18,224), and S5 (total present work costs, $1,460,929; capital costs, $1,441,705; and O&M costs, $18,224).

The least expensive groundwater alternative is No Action, G1 (no cost), followed by Alternative G2 (total present worth cost $113,331; capital costs $0; O&M costs, $113,331).

The No Action alternative for the process sewer line and pipeline soil, P1, is also the least expensive in its category ($9,578). Alternative P1 is followed by Alternatives P4 (total present worth cost, $319,265; capital costs, $309,687; O&M costs, $9,578) and P5A (total present worth cost, $409,134; capital costs, $409,134; O&M costs $0).

State and community Acceptance

Alternative S1 does not provide short and long-term protectiveness of human health and the environment and consequently, has not met state and Federal regulatory acceptance. Alternatives S3 and S4 do provide for reduced containment mobility, however, these alternatives do not provide a permanent reduction in contaminant mobility and have not met state and Federal regulatory acceptance. The state and Federal regulatory agencies have accepted and approved Alternative S5 because it is the least expensive in the long term that provides a most-effective permanent reduction in contaminant mobility and poses minimal risk to remedial workers and community. In addition, the Alternative S5 has met the community acceptance.

Both Alternatives G1 and G2 are equally protective of groundwater since no impact to the groundwater from the operation of the F-Area Basin has been discovered. However, alternative G1, in conjunction with institutional controls, will be protective of human health by preventing the ingestion of groundwater at less cost. Also, groundwater monitoring, which forms an integral part of the Alternative S5, when implemented in conjunction with Alternative S5, will ensure that no contaminant leaches out and enter the groundwater after the contaminated soil is grouted and thereby, will protect the remedial workers as well as the community. The state and Federal regulatory agencies have accepted Alternative G1. In addition, this alternative has met with community acceptance.

Alternative P1 does not provide short and long-term protectiveness of human health and the environment and consequently, has not met state and Federal regulatory acceptance. Alternative P5A does provide for the protection of human health by permanent reduction in the contaminant mobility; however, this alternative is most difficult to implement since this alternative involves significant waste handling and transport. Consequently, Alternative P5A has not met state and Federal acceptance or community acceptance.

The state and Federal regulatory agencies have accepted and approved Alternative P4. This alternative when implemented in conjunction with Alternative S5, will provide a permanent reduction in contaminant mobility, pose minimal risk to the remedial workers and the community, and is the least expensive alternative. In addition, the alternative has met the community acceptance.

IX. THE SELECTED REMEDY

The selected remedies for the FRB OU are: (1) for the basin soils: Alternative S5: Institutional Controls, Grouting, a Low Permeability Cover, and Groundwater Monitoring; (2) for the former process sewer line: Alternative P4: Institutional Controls, Pipeline Grouting, Soil Excavation and Disposition in the Basin Soils, and; (3) for the groundwater: Alternative G1: No Action. The waste unit will be physically maintained and institutional controls will remain in place in perpetuity. Field conditions will be evaluated to determine the need for modifying the control program or to identify if further remedial action is appropriate during the five-year ROD review.

Since each remedy requires institutional controls, these controls are discussed here instead in the more detailed description of each selected remedies provided below. Implementation of institutional controls will involve both short- and long-term actions. For the short-term action, signs will be posted at the FRB OU indicating that this area was used for the disposal of waste material and contains buried waste. Additionally, existing SRS access controls will be used to maintain use of this site for industrial use only. In the long-term, if the property is ever transferred to non-Federal ownership, the U.S. Government will take those actions necessary pursuant to Section 120(h) of CERCLA. These actions will include a deed notification disclosing former waste management and disposal activities as well as any remedial actions taken on the site and any continuing groundwater monitoring commitments. These requirements are also consistent with the intent of the RCRA deed notification required at final closure of the RCRA facility if contamination would remain at the unit. The deed notification shall, in perpetuity, notify any potential purchaser that the property has been used for the management and disposal of radioactive materials and hazardous substances. The deed shall also include deed restrictions precluding residential use of the property. However, the need for these deed restrictions may be reevaluated at the time of transfer in the event that contamination no longer poses an unacceptable risk under residential use. Any reevaluation of the need for deed restrictions would be done through an amended ROD with the Environmental Protection Agency (EPA) and the South Carolina Department of Health and Environmental Control (SCDHEC) approval. In addition, a certified survey of the area will be prepared by a registered land surveyor and will be included in the post-ROD documents. The survey will be reviewed and updated, as necessary, at the time the site is transferred and will be recorded with the appropriate county recording agency. The FRB OU is located in Aiken County.

Per the EPA-Region IV Land Use Controls (LUCs) Policy, a Land Use Control Assurance Plan (LUCAP) and a Land Use Control Implementation Plan (LUCIP) will be developed and submitted to the regulators for their approval. The LUCAP will be submitted under separate cover whereas the LUCIP will be submitted with the Remedial Work Plan/Remedial Design Report/Remedial Action Work Plan (RDWP/RDR/RAWP) for the FRB OU in accordance with the post-ROD document schedule is provided in Figure 16. The LUCAP will include the information requested in the EPA policy. The LUCIP details how SRS will implement, maintain, and monitor the land use control elements of the FRB OU ROD to insure that the remedy remains protective of human health.

The LUC objective necessary to ensure the protectiveness of the preferred alternative is:

Prevent unauthorized access/exposure to contaminated grout and basin soil

The institutional controls required to prevent unauthorized exposure to the contaminated grout and soil include the following:

- Controlled access to the FRB waste unit through existing SRS security gates and perimeter fences and the site use/site clearance programs

- Signs posted in the area to indicate that contaminated grout and soil are present in the waste unit

- Notification of contaminated grout and soil to any future landowner through deed notification, as required under CERCLA Section 120(h)

The present worth, capital, and Operation and Maintenance (O&M) costs for each selected remedy is provided Table 9.

Table 9. Selected Remedy Cost

Remedy	Present Worth Cost	Capital Cost	O&M Cost
Alternative S5* (Soils)	$1,461,000	$1,442,000	$19,000
Alternative P4 (Process Sewer)	$320,000	$310,000	$10,000
Alternative G1* (Groundwater)	No Cost	No Cost	No Cost
Total Cost	$1,781,000	$1,752,000	$29,000

*Alternative S5 includes the costs for groundwater monitoring.

The selected remedy will meet all of the RAOs by eliminating the potential for direct radiation, exposure, ingestion of soils, and eliminating future impacts to groundwater. The selected remedies comply with all applicable or relevant and appropriate Federal and state requirements/regulations.

The SCDHEC has modified the SRS RCRA permit to incorporate the selected remedies.

Soils

Under the selected remedy (Alternative S5), deep basin soil will be grouted from approximately 0.6 m (2 ft) above the basin bottom to approximately 1.8 m (6 ft) below the basin bottom or approximately 4.3m (14 ft.) below grade. The purpose of the grout is to prevent leaching of Sr-90, which is the only contaminant migration COC (CMCOC), to the groundwater above the MCL of 8.0 pCi/L. Furthermore, grouting the soil provides an additional layer of protection by offsetting the inherent uncertainty associated with the mathematical model used to predict contaminant migration. Grouting will also immobilize other deep contaminants which represent principal threat source material such as Cs-137, Ra-226, thallium, arsenic., etc and further reduce infiltration of water through the deeper contaminated soils. Tc-99 was originally identified in the RFI/RI/BRA as a CMCOC. Subsequent evaluation with the RESRAD model eliminated it as a concern. However, as is the case with other radioactive/non-radioactive contaminants, the selected remedy will also immobilize Tc-99. Grouting of the soils is preferred over only capping because it meets the CERCLA preference for treatment. A cover will be provided over the stabilized soil to minimize storm water percolation and erosion. The cover is also very effective in reducing direct radiation exposure received from radionuclides in the shallow soil. This alternative includes institutional controls (discussed above) to prevent exposure of current and future workers to all the Human Health COCs in the waste unit and direct radiation from the waste unit. Since waste is left in place, the future use of land will be restricted to industrial use to prevent unrestricted residential use of the land.

In situ grouting reduces air emissions and is relatively simple to implement. However, *in situ* grouting results in a slight increase in waste volume. The volume of the basin, when clean soil is excavated prior to grouting, will be adequate to accommodate any increase in grouted soil volume. The estimate volume of grout/soil mixture is 6,600 m^3 (8,100 yd^3). .

Process Sewer Line

The selected remedy for the process sewer line and associated soils will include pipeline and manhole grouting, and excavation and disposition of pipeline soils (approximate volume 240 m^3 or 300 yd^3) into the basin and institutional controls. In this alternative, the localized areas of the contaminated soil around the pipeline hot spots will be excavated. If necessary, the sections of pipeline associated with the hot spots will also be excavated. The excavated soil and pipeline will be treated in the basin by *in situ* grouting along with soil from the basin. Clean soil from SRS borrow areas will be used to fill excavated areas around the pipeline. Completion of this remedial action will meet all applicable or relevant and appropriate Federal and state requirements/regulations, and all the remedial action objectives by reducing risk associated with the process sewer line to acceptable levels. This alternative includes institutional controls (discussed above) to prevent exposure of current and future workers to all the Human Health COCs in the waste unit and direct radiation from the waste unit. Since waste is left in place, the future use of land will be restricted to industrial use to prevent unrestricted residential use of the land.

Groundwater

The selected remedy for the FRB OU groundwater is "No Action". The history of the FRB, the results of the groundwater modeling, and the current groundwater data prove that the FRB-associated groundwater poses no risk to human health or the environment. Through computer modeling and sampling it has been shown the FRB OU has not contributed to contamination in the groundwater. However, to ensure that the grout-waste mixture has accomplished the required immobility of contamination, a groundwater-monitoring program will be established under the selected remedy for basin soils (Alternative S5). The groundwater will be monitored semi-annually until it is confirmed that the remedial response action for the FRB OU has achieved the required stabilization of the contaminants.

Since waste is left in place in the FRB waste unit, the future use of land will be restricted to industrial use to prevent unrestricted residential use of the land and five-year ROD reviews will be required.

X. STATUTORY DETERMINATIONS

Based on the RI/BRA report, the FRB OU poses future risks and hazards to the on-unit resident, construction worker, and industrial worker. The future risks are associated with: external exposure to COC radionuclides by direct contact into the FRB OU soils; potential exposure to principal threat source material; ingestion of FRB OU soils and pipeline sediment and/or produce grown in soils contaminated with radionuclides; and ingestion of groundwater containing Sr-90 (which can leach out and migrate to groundwater) with concentrations above MCL. Therefore, institutional controls, *in situ* grouting of soils, and installation of a low permeability cover over the grouted soils in the basin are necessary for the former basin area soils. Institutional controls, pipeline grouting, excavation, and disposal of pipeline associated soils with basin area soils are necessary for the process sewer line area. No action is required for the groundwater; however, groundwater shall be monitored to confirm that the source remediation has achieved the required stabilization of contaminants. The grouting (using S/S treatment) will reduce the mobility of the radionuclides (the principal threat source material), thereby preventing migration of radionuclides to the groundwater. The soil cover provided over the grouted soil will shield radiation exposure from the radionuclides contained in the grouted soil in the basin and also prevent ingestion of soil and/or produce grown in FRB OU soils.

The selected remedy is protective of human health and the environment, complies with federal and state ARARs, and is cost-effective. The ARARs are met by minimizing the potential for contaminant migration into the groundwater by stabilizing the soil into a nonleachable form. (The size and location of the waste unit radioactive contaminants preclude a remedy in which contaminants could be excavated and treated effectively). For cost comparison among the considered alternatives and to determine the most cost-effective alternatives, cost estimates prepared for the alternatives were based on a variety of cost estimations data, including generic unit costs, vendor information, and prior similar estimates prepared for other SRS sites with almost identical characteristics. Cost estimates were prepared for capital costs, O&M costs, and present worth costs. Finally, for selecting the cost-effective remedial action for the FRB OU, an analysis was performed by considering the following factors:

- the effective life of the remedial action
- the uncertainty regarding some of the COCs, especially radionuclides that could stay absorbed in the contaminated soil for over 1,000 years and could pose a future long-term unacceptable risk even beyond 100 to 200 years
- the preference for treatment versus containment per CERCLA requirements, and
- long-term versus short-term in situ management of radioactive wastes

Based on the analysis, the selected remedial action was determined as a cost-effective measure that would provide a permanent reduction of contaminant mobility, meet the statutory requirements of CERCLA, ensure future compliance with ARARs (MCLs or RBCs), and present a reasonable value for the protection of human health and the environment.

Contaminated soils represent principal threat source material and will be stabilized to prevent or mitigate exposure to highly toxic contaminants and permanently reduce mobility of highly mobile contaminants at depth. The selected remedy utilizes long-term permanent solutions and treatment technology to the maximum extent practicable and satisfies the preference for treatment.

Since soil and pipeline sediment is grouted below grade, long-term weathering and the potential for leaching of contaminants are minimized. Worker and public safety is ensured by minimizing contact with contaminated media.

Section 300.430 (f) (4) (ii) of the NCP requires that a five-year review of the ROD be performed if hazardous substances, pollutants, or contamination remain in the waste unit. The three parties (DOE, SCDHEC, and EPA) have determined that a five-year review of the ROD for the FRB OU will be performed to ensure continued protection of human health and the environment.

XI. EXPLANATION OF SIGNIFICANT CHANGES

A public comment and CAB recommendation were received on the Statement of Basis/Proposed Plan; raising a concern regarding the need to grout the soil in addition to capping the basin soil. A response to the concern is included in the Responsiveness Summary (Appendix A of this document). No significant changes were made as a result of public comment. The selected alternatives from the Statement of Basis/Proposed Plan remain the selected remedial action.

XII. RESPONSIVENESS SUMMARY

The Responsiveness Summary is provided as Appendix A of this document.

XIII. POST-ROD DOCUMENTS SCHEDULE AND DESCRIPTION

1. The Post-ROD documents schedule is listed below and is illustrated in Figure 20.

2. Corrective Measures Implementation/Remedial Design Work Plan (CMI/RDWP), Revision 0, for the FRB OU will be submitted for EPA and SCDHEC review 2 calendar days after issuance of the ROD.

3. SRS revision of the CM/RDWP will be completed 30 calendar days after receipt of all regulatory comments.

4. Corrective Measures Implementation/Remedial Design Report/Remedial Action Work Plan (CMI/RDR/RAWP), Revision 0, will be submitted 75 calendar days after issuance of the ROD.

5. SRS revision of the CMI/RDR/RAWP will be completed 45 calendar days after receipt of all regulatory comments.

6. Remedial Action Start on the soils will begin following EPA and SCDHEC approval of the CMI/RDR/RAWP.

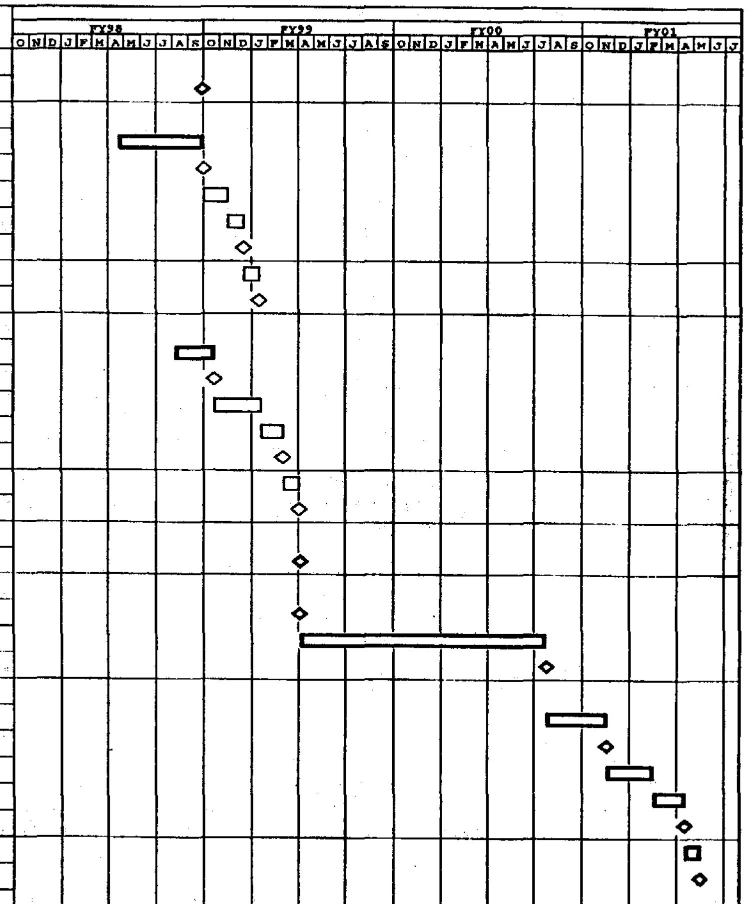
7. Post-Construction Report (PCR), Revision 0, will be submitted to EPA and SCDHEC after completion of the remedial action.

Post-ROD Document Description

A brief description of the post-ROD documents is provided. Corrective Measures Implementation/Remedial Design Work plan (CMI/RDWP)

Figure 20. FRB Post-ROD Document Schedule

ACTIVITY DESCRIPTION	EARLY START	EARLY FINISH	ORIG DUR
RECORD OF DECISION			
EPA/SCDHEC ROD ISSUANCE		28SEP98	0
CORRECTIVE MEASURE/REMEDIAL DESIGN WORKPLAN			
DEVELOP CM/RD WORKPLAN	22APR98	30SEP98	113
SRS SUBMITTAL OF REV. 0 CM/RDWP		30SEP98	0
EPA/SCDHEC REVIEW REV 0 RDWP	1OCT98	16NOV98	47
SRS INCORPORATE EPA/SCDHEC COMMENTS	17NOV98	16DEC98	30
SRS SUBMITTAL REV. 1 CM/RDWP		16DEC98	0
EPA/SCDHEC FINAL REVIEW REV. 1 CM/RDWP	17DEC98	15JAN99	30
EPA/SCDHEC APPROVAL REV. 1 CM/RDWP		15JAN99	0
REMEDIAL DESIGN REPORT/REMEDIAL ACTION WORKPLAN			
DEVELOP CM/RDR/RA WORKPLAN	7AUG98	20OCT98	52
SRS SUBMITTAL OF REV. 0 CM/RDR/RAWP		20OCT98	0
EPA/SCDHEC REVIEW OF REV. 0 RDR/RAWP	21OCT98	18JAN99	90
SRS INCORPORATE EPA/SCDHEC COMMENTS	19JAN99	2MAR99	43
SRS SUBMITTAL OF REV. 1 RDR/RAWP		2MAR99	0
EPA/SCDHEC FINAL REVIEW REV. 1 RDR/RAWP	3MAR99	1APR99	30
EPA/SCDHEC APPROVAL OF REV. 1 RDR/RAWP		1APR99	0
R A START			
R A START		4APR99	0
CONSTRUCTION ACTIVITIES			
CONSTRUCTION START COVER/GWMZ	4APR99		0
CONSTRUCTION	4APR99	22JUL00	476
CONSTRUCTION COMPLETE		24JUL00	0
POST CONSTRUCTION REPORT/FINAL REMEDIATION PLAN			
DEVELOP POST CONSTRUCTION REPORT	25JUL00	17NOV00	83
SRS SUBMITTAL OF REV.0 POST CONSTRUCTION REPORT		17NOV00	0
EPA/SCDHEC REVIEW	18NOV00	15FEB01	90
SRS INCORPORATE EPA/SCHDEC COMMENTS	16FEB01	16APR01	60
SRS SUBMITTAL OF REV.1 POST CONSTRUCTION REPORT		16APR01	0
EPS/SCHDEC FINAL REVIEW & APPROVAL	17APR01	16MAY01	30
EPA/SCDHEC APPROVAL		16MAY01	0



Plot Date 24AUG98
Data Date 13JUN94
Project Start 13JAN94
Project Finish 16MAY01

Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

Sheet 1 of 1

ENVIRONMENTAL RESTORATION
PROJECT 1121 F-RETENTION BASIN
RCRA/CERCLA ASCAD IMPLEMENT SCHEDULE

Date	Revision	Checked	Approved

Based on the data and information contained in the previous documents pertaining to FRB OU (including RI/BRA Report, Corrective Measures Study/Feasibility Study, Statement of Basis/Proposed Plan, and Record of Decision), CMI/RDWP will provide a description of the remedial action design for the FRB OU.

The remedial action design discussed in CMI/RDWP would include a basic scope description of the following tasks that will be performed during the remedial design:

- Topographic survey and preparation of site drawings
- Preparation of erosion control plan
- Development of acceptance criteria for the S/S process, and preparation of construction specifications for S/S activities
- Preparation of statement of work for final soil matrix design
    - Design of the soil cover system
    - Determination of institutional controls for the basin and process sewer line
    - Schedule for developing the LUCIP under EPA Region IV policy on Land use Controls at Federal Facilities
    - Preparation of groundwater monitoring plan
    - Preparation of health and safety and cover system maintenance plans

Corrective Measures Implementation/Remedial Design Report/Remedial Action Work Plan (CMI/RDR/RAWP)

This document will combine the contents and purposes of the two post-ROD documents: the Corrective Measures Implementation/Remedial Design Report (CMI/RDR) and the Corrective Measures Implementation/Remedial Action Work Plan (CMI/RAWP). This combined document will primarily outline and describe the remedial design and remedial action planned for the FRB OU and will address:

1. a remedial design summary highlighting the critical design inputs and outputs that are consistent with the remedial action objectives stated in the ROD; and

2. construction strategy summary highlighting the critical components of the construction phase, including the remedial action schedule, a design change procedure, requirements of health and safety aspects driving the construction phase and project closeout. The current schedule for completing post-ROD documents and RA start may require a phased approach to the completion of this document (e.g., validation of soil solidification mix design not completed until after RA start). This document will also include a brief discussion on the contents of the post-construction report. The CMI/RDR/RAWP will primarily include:
   - Site drawings showing the boundaries of the basin and locations of process sewer lines and manholes, etc.
   - Design Criteria including performance criteria and acceptance activities for S/S remedial action
   - Design plans and specifications
   - Permitting requirements
   - Post-documentation identification and schedule to accommodate phased RA approach
   - Erosion control plan
   - Groundwater monitoring well maintenance plan
   - Land Use Controls Implementation Plan (LUCIP)
   - Remedial action schedule and remedial design change control
   - Waste management plan, including decontamination requirements
   - Health and safety plan
   - Maintenance plan, including institutional control requirements
   - Requirement for project closeout
   - Post-construction report description

XIV. REFERENCES

CFR 1991 Reference: Code of Federal Regulations. National Primary Drinking Water Regulations, 40 CFR, Part 141, pp. 578-715. Washington, DC.

EPA, 1988. *Guidance for conducting Remedial Investigations and Feasibility Studies under CERCLA*, EPA/S40/G-89/004, Washington, DC (1988).

EPA, 1989a. *Risk Assessment Guidance for Superfund (RAGS),* Volume I: Human Health Evaluation Manual (Part A), Office of Emergency and Remedial Response, USEPA/540/1-89/002, Washington, DC (1989).

EPA, 1989b. *Risk Assessment Guidance for Superfund (RAGS),* Volume II: Environmental Evaluation Manual, Office of Emergency and Remedial Response, USEPA/540/1-89/001, Washington, DC (1989).

EPA, 1998, *Assessing Land Use Controls at Federal Facilities*, a memorandum issued by EPA Federal Facilities Branch, 4WD-FFB, dated April 21, 1998.

FFA, 1993, *Federal Facility Agreement for the Savannah River Site*, Administrative Docket Number 89-05-FF, Effective Date: August 16, 1993, WSRC-05-94-42

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DOE, 1994a. *Public Involvement, A Plan for the Savannah River Site*, Savannah River Operations Office, Aiken, SC (1994).

WSRC, 1994b. Phase II Remedial Investigation Work Plan for the F-Area Retention Basin (281-3F) (U), WSRC RP-94-498, Savannah River Site, Aiken, SC (May 1994).

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EPA, 1995. *Region IV, Supplemental Guidance to RAGS: Region IV Bulletins, Ecological Risk Assessment* (November 1995).

WSRC, 1996. *Laboratory-Scale Immobilization Study Report for the L-Area Oil and Chemical Basin*, WSRC-RP-95-15, Rev. 0, Savannah River Site, Aiken, SC

WSRC, 1997a. *Groundwater Sampling Report with Residential Risk Assessment for the F-Area Retention Basin (281-3F) (U)*, WSRC-RP-96-00905, Revision 0, March 1997.Savannah River Site, Aiken, SC

WSRC, 1997b. *Remedial Investigation with the Baseline Risk Assessment Report for the F-Area Retention Basin (281-3F) (U)*, WSRC-RP-96-356, Revision 1.2, Savannah River Site, Aiken, SC.

WSRC, 1997c. *Corrective Measures Study/Feasibility Study for the F-Area Retention Basin (281-3F) (U),* WSRC-RP-96-00906, Revision 1.2, Savannah River Site, Aiken, SC (November 1997).

WSRC, 1997d. *Statement of Basis/Proposed Plan for the F-Area Retention Basin (281-3F) (U),* WSRC-RP-97-00128, Revision 1.2, Savannah River Site, Aiken, SC (November 1997).

APPENDIX A

RESPONSIVENESS SUMMARY

Responsiveness Summary

The 45-day public comment period for the Statement of Basis/Proposed Plan (SB/PP) for the F-Area Retention Basin (281-3F) began on January 20, 1998, and ended on March 5, 1998. SRS briefed the public on the path forward for the remediation of the basin in a Citizens Advisory Board (CAB) subcommittee meeting held on February 23, 1998. At the meeting, a concern was raised over the need to grout the soil in addition to providing a low permeability cap over the basin area. Subsequently, an extension for the public comment period was granted extending the public comment period to April 4,1998. A formal public comment (made by Todd V. Crawford) was received which questioned the risk reduction and necessity of the soil grouting. A formal CAB recommendation (see attached Recommendation No. 56) was also received on March 28,1998. A response to these concerns is provided below. The public and CAB comments are italicized and the response is bolded.

Public Comment:

The Remedial Action Objectives are stated as:

- *Prevent future ingestion of shallow aquifer groundwater*
- *Prevent direct contact with and ingestion of soils*
- *Prevent direct contact with and ingestion of sediments from the abandoned process sewer line*
- *Prevent the transport of contaminants from subsurface soils to groundwater*

The first three of the above are met now and would be met in the future considering that institutional controls are part of all alternatives and land use plans clearly put the F-Area Retention Basin and associated pipelines in an industrial area.

The first of the Remedial Action Objectives above removes the concern about the last one. On top of that there is other contamination in the shallow groundwater in the vicinity which would negate interest in drinking the water.

The scenarios upon which the risk numbers are based are not stated in enough detail to evaluate. They must have been based on direct exposure to the contaminated soils, which are now under about 10 feet of clean dirt. Such direct exposure could not happen unless institutional controls were lost for the 200-Area plateau. If this happens the F-Area Retention Basin would be a minor problem compared to other locations in the 200-Area. If loss of institutional controls was assumed, the risk numbers would sure be misleading to the public.

Contaminates of concern include Arsenic. It is not clear if this came from the F-Area processes or is a result of early cotton farming. Or is the Arsenic and the Radium-226 from coal pile runoff? Is the K-40 from the processes or is it the naturally occurring K-40? Additionally, evaluation of the risk reduction as a function of the various alternatives for remedial action is not included. It appears that the main justification for the grouting of the basin soil under Alternative S5 is to reduce leaching but perhaps a cap on top of the current clean fill would be sufficient. The primary contaminate of concern for leaching is Sr-90 with a 28.6 year half life so caps may well make significant difference in concentrations reaching the groundwater. How much remediation is justified when nobody will be drinking the water?

CAB Recommendation:

Because the F-Area Retention Basin and associated pipelines are in the nuclear industrial area and will be under institutional controls followed by deed restrictions, and because this site has been buried for 20 years with no identified contaminant migration, the SRS Citizens Advisory Board believes that the Remedial Action Objectives can be met with less extensive remediation. CAB recommends a low-permeability cap for the basin, continued groundwater monitoring and grouting the inside of the pipeline. These changes should reduce the total remediation costs by about $1 million.

Response:

A risk assessment for the F-Area Retention Basin Source Operable Unit (FRB OU) was performed in accordance with CERCLA guidance. The relative risk values for the FRB OU indicate that remediation is required per the statutory requirements of CERCLA. Both the former basin and process sewer line areas represent a risk to a future on-unit resident as well as to a future industrial worker. Radionuclides including cesium-137, radium-226, actinium-228, and strontium-90 are the primary risk drivers for the direct radiation pathways and represent over 90 percent of the risk. These contaminants also present a future long-term groundwater risk resulting from their leaching out from the soil and entering the groundwater at levels above applicable state regulations(i.e., MCLs).

Since the FRB OU poses unacceptable risk and a remedial action is appropriate, a Corrective Measures Study/Feasibility Study (CMS/FS) was performed to identify appropriate remedial alternatives. The alternatives were selected and screened in accordance with CERCLA guidance and a detailed analysis of the selected alternatives was performed using the nine evaluation criteria as required by the NCP. Alternative S5: Institutional Controls, Grouting, Low Permeability Cover, and Groundwater Monitoring was selected because it would provide a permanent reduction in contaminants (radionuclides) mobility and prevent contact with and ingestion of contaminated soil. To ensure the effectiveness of this alternative, groundwater monitoring downgradient of the grouted mass is also included in this alternative. This alternative is also very effective in reducing potential direct radiation exposure received from radionuclides and grouting the soil also provides an additional layer of protection by offsetting the inherent uncertainty associated with the mathematical model used to predict contaminant migration. EPA and SCDHEC approved both the CMS/FS and the SB/PP documents that justified the selected remedy. The selected remedy provides the best alternative because it meets EPA preference for treatment versus containment per CERCLA requirements and provides an additional layer of protection.

The quantifiable reduction of baseline risk is an essential consideration in remedy selection. All remedial alternative evaluations analyze the risk remaining after remediation. This is done through the setting of risk-based remediation goal options (RGOs). Not all cleanup objectives, however, are risk-based. The National Contingency Plan includes a preference for treatment of principal threat wastes. Therefore, to determine the future risk posed by the radionuclides (principal threat wastes) the risk-based modeling was performed during the development of the Remedial Investigation/Baseline Risk Assessment (RI/BRA) report for the FRB OU. It was determined that some of the contaminants of concern (COCs), especially radionuclides, could stay absorbed in the contaminated soil for over 1000 years and could pose a future long-term unacceptable risk even beyond 100 to 200 years. The selected remedy (Alternative S5) incorporates this preference as a key element of the prudent long-term management of radioactive waste in situ.

The soil cover provided over the former basin area and contaminated soil associated with the process sewer line area, without grouting the soil, could provide a permanent long-term solution by simply containing the contaminants if well maintained for an extended period of time.

However, in terms of total remediation cost, the soil cover would cost less initially but would likely need redesign/reconstruction two or three times during the entire remediation cycle, which could go beyond 100/200 years. In the long term, the cost of the soil cover would approximate the cost of the selected remedy. Hence, in situ grouting coupled with a low permeability cover was determined to be the best alternative that would provide permanent reduction of contaminant mobility, meet the statutory requirements of CERCLA, and also ensure future compliance with applicable state regulations (i.e., MCLs).

Savannah River Site Citizens Advisory Board

Recommendation No. 56

March 24, 1998

Remediation of F-Area Retention Basin

Background:

The F-Area Retention Basin is an unlined basin 120 by 200 feet, which collected lightly contaminated cooling water from the F-Area Canyon Facility as well as stormwater drainage from the F-Area Tank Farm. The basin was used from 1955 to 1972. In 1978, its soil was sampled and analyzed, contaminated soil removed, and the basin closed. Closure consisted of filling the basin with about 7 to 10 feet of clean dirt and seeding the surface with grass.

Numerous environmental investigations were completed on the retention basin and the connecting process sewer line between 1993 and 1997. Extensive sampling data and analyses were published along with pathway and risk calculations.[1] The most significant contaminates are Arsenic and Cesium-137. Also, fate and transport analyses have indicated that levels of certain radionuclides (e.g., technetium, strontium) could exceed acceptable concentrations in the groundwater under the basin. The risk analyses, under conservative assumptions, indicate a risk above the CERCLA guidelines only for an onsite resident exposed to the remaining contaminated soils in the basin. However, there is currently no risk to onsite workers or the offsite public. Further, this site is located in an industrial cleanup zone (see Motion 2).

Remedial Action Objectives for an onsite resident have been identified and remediation alternative have been evaluated.[2] These Remedial Action Objectives are: prevent future ingestion of shallow aquifer groundwater; prevent direct contact with and ingestion of soils (basin and pipeline); prevent direct contact with and ingestion of sediments from the abandoned process sewer line; and prevent the transport of contaminants from subsurface soils to groundwater (basin and pipeline). Remedial alternatives were evaluated for basin soils (4 alternatives), for groundwater (2 alternatives) and process sewer line and pipeline soils (3 alternatives). [2,3] All alternatives require institutional control and the recording of basin and pipeline locations as deed restrictions before releasing the land to the public. The preferred

[1] Remedial Investigation Report with the Baseline Risk Assessment for the F-Area Retention Basin (281-3F), final, WSRC-RP-96-356, Rev. 1.2, July 1997
[2] Corrective Measures Study/Feasibility Study for the F-Area Retention Basin (281-3F), Final, WSRC-RP-96-00906, Rev. 1.2, November 1997
[3] Statement of Basis/Proposed Plan for the F-Area Retention Basin (281-3F), Final, WSRC-RP-97-00128, Rev. 1.2, November 1997

alternatives are: for the basin soils – institutional controls, grouting and low permeability cover ($1,460,929); for groundwater – no action ($9,578); and for the process sewer line and pipeline soils – institutional controls, pipeline grouting and soil excavation and disposition with the basin soils ($319,265). The reduction in risk was not evaluated quantitatively for any of these alternatives; however, the relative risk reductions were evaluated qualitatively.

Recommendation:

Because the F-Area Retention Basin and associated pipelines are in the nuclear industrial area and will be under institutional controls followed by deed restrictions, and because this site has been buried for 20 years with no identified contaminant migration, the SRS Citizens Advisory Board believes that the Remedial Action Objectives can be met with less extensive remediation. We recommend a low-permeability cap for the basin, continued groundwater monitoring and grouting the inside of the pipeline. These changes should reduce the total remediation costs by about $1 million.

Because the amount of risk reduction for different remediation alternatives is critical in the selection of cost effective remediation strategies, the SRS Citizens Advisory Board recommends that in the future that all SRS remediation studies include analyses of the risk remaining after remediation for the most likely alternative and the most probable pathway and exposure scenarios.

Furthermore, the extensive analyses and documentation for the F-Area Retention Basin and associated pipeline probably cost as much or more than the planned remediation. This leads us to make the more general recommendation that the three agencies (DOE, EPA and SCDHEC) expeditiously implement the Plug-In-ROD approach to reduce future paperwork costs.