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Savannah River Site

Post-Construction Report (PCR) for Old F-Area Seepage Basin (Building 904-49G) (U)

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SRS

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LIST OF ACRONYMS AND ABBREVIATIONS

AAL	Acura Analytical Laboratory
ASTM	American Society for Testing and Materials
BOA	Basic Order Agreement
BSDT	benchscale design test
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLSM	Controlled Low-Strength Material
CMI/RDR/RAWP	Corrective Measures Implementation/Remedial Design Report/Remedial Action Work Plan
CMI/RDWP	Corrective Measures Implementation/Remedial Design Work Plan
CMS/FS	Corrective Measures Study/Feasibility Study
cm/sec	centimeter per second
CM	contaminant migration
cm^2	square centimeter
CMIR/FRR	Corrective Measures Implementation Report/Final Remediation Report
COC	constituent of concern
dpm	disintegrations per minute
ERD	Environmental Restoration Division
ESD	Explanation of Significant Difference
FFA	Federal Facility Agreement
gm	gram
G-M	Geiger-Mueller
GPS	global positioning system
H/C	hydraulic conductivity
IDW	Investigation-Derived Waste
LLW	low-level waste
LLWMDF	Low-Level Waste Management Disposal Facility
LOO	line of optimum
LUCIP	Land Use Controls Implementation Plan
MCL	maximum contaminant level
mm	millimeter
msl	mean sea level
MZCL	mixing zone concentration limit
NTS	Nuclear Technology Service
O&F	operation and function
O&M	operation and maintenance
OU	operable unit
OFASB	Old F-Area Seepage Basin
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PCR	Post-Construction Report
PVC	polyvinyl chloride
PPE	personal protective equipment
PSTP	pilot scale test program
psi	pounds per square inch
PWMO	production waste mixing operation

RAO	remedial action objectives
RCRA	Resource Conservation Recovery Act
RDWP	Remedial Design Work Plan
ROD	Record of Decision
SAM	single auger mixing
SP	superplasticizer
S/S	stabilization/solidification
SCDHEC	South Carolina Department of Health and Environmental Control
SRS	Savannah River Site
TCLP	Toxicity Characteristic Leaching Procedure
UCS	unconfined compressive strength
(u)	uranium
µg/gm	micrograms per gram
µg/L	micrograms per liter
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
VCP	vitrified clay pipe
Wet Socket	A column whose set is retarded or has more moisture mixed into it allowing remixing at a later time

1.0 SYNOPSIS OF COMPLETED CONSTRUCTION WORK

1.1 Purpose and Scope of Post-Construction Report

This Post-Construction Report (PCR) is prepared in accordance with the requirements for submittal of regulatory documents as identified in the Federal Facility Agreement (FFA). The purpose of the PCR is to document compliance with technical and statutory requirements and to provide a summary of the remedial activities completed during implementation of the selected corrective action for the Old F-Area Seepage Basin (OFASB) at the Savannah River Site (SRS). The selected action for the OFASB includes treatment of contaminated soils (potential groundwater contaminant source) and installation of wells to perform long-term monitoring to evaluate natural attenuation in accordance with a groundwater mixing zone (GWMZ) application. Although the source treatment has been completed and all wells are installed, the groundwater cleanup goals have not been achieved. Therefore, this PCR serves as an interim remedial action report pending completion of this objective. After the GWMZ is satisfied, a final Corrective Measures Implementation Report and Final Remediation Report (CMIR/FRR) will be submitted within 90 days. The USEPA and SCDHEC have performed a final inspection of the completed activities following notification of construction completion. This operable unit is ready to commence the operation and maintenance (O&M) phase (including groundwater monitoring) pending final approval of this document.

This PCR provides a summary of construction activities performed in accordance with the approved CMI/RDR/RAWP. This report includes the following items:

- A brief description of the OU background, including a brief statement on remedial action requirements and objectives

- A chronology of completed events related to remediation of the OU
- A summary of construction activities performed
- Deviations from the original design of the approved CMI/RDR/RAWP (WSRC 1999)
- Waste disposal
- Verification of construction completion and achievement of remedial action objectives
- As-built drawings
- Project costs (including remedial action (RA) capital costs incurred to date, forecast RA operating costs, post-RA annual operation and maintenance (O&M) costs, and total present worth costs)

1.2 Old F-Area Seepage Basin Background

The OFASB is a Resource Conservation Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) unit located within the SRS, approximately 600 feet north of F Area and 1 mile east of Road C.

The OFASB is approximately 200 by 300 feet in dimension and covers a total of 1.3 acres. The interior of the basin is divided by an earthen berm, which divides the basin into two compartments. The unit includes a process sewer line and an overflow ditchline. The ditchline is located at the northwest corner of the basin and leads toward Upper Three Runs Creek, which lies north of the basin. The process sewer line, which fed the basin at the southwest corner, has an average depth of 9 to 10 feet below existing grade.

Between 1954 and mid-May 1996, the OFASB served as an unlined seepage basin and received contaminated water for the purpose of reducing radioactive substance concentration.

Remedial Action Objectives

In March 1997, the Record of Decision (ROD) for this unit was approved by USEPA and the SCDHEC (WSRC 1997a). Based on risks posed by the radionuclides in OFASB soils and process sewer line sediment, the general remedial action objectives (RAOs) as identified in the ROD are as follows:

a) Eliminate the risk posed by direct external exposure to radiation, ingestion and inhalation of radionuclides, and prevent or mitigate the leaching and migration of contaminants of concern (COC) to the groundwater

b) Restore the aquifer through natural groundwater mixing processes and other processes (radioactive decay) to achieve MCLs throughout the groundwater plume

c) Achieve state of South Carolina groundwater mixing zone objectives

Overview of the Selected Remedy

In March 1998, the combined CMI/RDR/RAWP for the OFASB (904-49G) (WSRC 1999), which provided the design details of the remedial action for the OFASB, was approved by USEPA and SCDHEC. During the preparation of the CMI/RI/RAWP, SRS decided that contaminated wood chips could be placed within the basin instead of being sent to an offsite facility. With the concurrence of USEPA and SCDHEC, an Explanation of Significant Difference (ESD) was developed and approved (see Appendix E).

On September 10, 1998, construction activities for the remedial action at the OFASB were started. A copy of the DOE SRS correspondence for the start date is provided in Appendix D. In addition, a copy of the Fact Sheet was issued to the public (see Appendix C). The key elements of the selected remedial action and as identified in the ROD, and as amended by the ESD, are as follows:

- Placement of all contaminated soils from the unit in the bottom of the basin
- In situ stabilization/solidification (S/S) of the contaminated soil at the bottom of the basin
- Placement of contaminated wood chips over the first layer of the grading fill above the grouted mass
- Construction of an engineered low-permeability soil cover over the solidified/stabilized soil
- Implementation of a regulator-approved groundwater mixing zone application (WSRC 1997)
- Implementation of institutional controls to limit access to the site and associated pipelines and to restrict future use of this site to industrial application (See Attachment A for details)

The OFASB was remediated and closed in accordance with the applicable and relevant federal, state, and local environmental laws and statutes. The technology of choice for this remediation and closure was S/S using cost-effective grouting materials and admixtures.

1.3 Chronology of Events

Activities	Start Date
Mobilization activities for construction	8/03/98
RA start date	9/10/98
Soil characterization and benchscale design test	10/06/98
Excavation and relocation of contaminated soil to the basin	11/30/98
Pilot Scale Test Program (PSTP)	2/16/99
Grouting of manholes	3/25/99
Production Waste Mixing Operation (PWMO)	8/23/99
Well installation	11/29/99
Soil cover placement	1/18/00
Revegetation	5/30/00
Waste Disposal	11/01/00

The following sections summarize the major construction events for remedial action and closure of the OFASB.

2.0 MOBILIZATION AND CONSTRUCTION

Sevenson Environmental Services, Niagara Falls, New York, was selected to perform remediation and closure of the OFASB. The Sevenson team consisted of RECON/Terra Contractors, Denton, Texas; Accura Analytical Laboratory (AAL), Norcross, Georgia; VEETech, P.C., Aiken, South Carolina; and Nuclear Technology Service (NTS), a subcontractor to AAL providing nuclear chemistry analysis services. The grout mix development was performed by AAL under the supervision and guidance of Sevenson and VEETech.

The contractor mobilized project personnel during the summer of 1998 to initiate the development of key documents required to start field activities. In September 1998, the field offices were set up and the site was prepared for work. Areas were cleared, ground penetrating radar surveys were completed, initial radiological surveys were performed, office trailers were set up, a topographic survey was performed to verify the existing conditions (see Figure 1), SRS safety procedures were implemented, and the basin was prepared for future work.

The remainder of 1998 was used to mobilize the equipment needed for soil characterization, basin preparation, and benchscale testing.

Soil S/S activities commenced in 1999. To support these activities, the contractor erected batch plant equipment and mobilized and assembled the single-auger mixing (SAM) equipment. All equipment was delivered and ready for beginning S/S activities by March 1, 1999.

The following sections describe the activities that transpired during the remedial action performed at the OFASB.

2.1 Soil Characterization and Benchscale Design Test

Soil characterization of the basin was the first step in the development of a grout mix. The grout mix was required to achieve the following performance requirements when it is mixed with basin soils:

a) Compressive strength for the S/S mix should be equal or higher than 50 psi

b) Leached extraction for total uranium (U) in the S/S mix shall be performed in accordance with Toxicity Characteristic Leaching Procedure (TCLP) test requirements (EPA 1986). The threshold specified to the contractor for TCLP (U) was less than 20 μg/L

c) Hydraulic conductivity of S/S mix should be less than or equal to 1.0E-05 cm/sec

The above performance requirements were achieved during production waste mixing operation and results have been provided in Table 8 of this PCR.

To obtain materials for grout mix development, a sampling plan was developed based on historical information related to the operation of the basin and on past radiological surveys performed on the basin. Ten sampling locations were selected in the basin and the overflow ditchline (see Figure 2). At each of the ten locations, four soil samples were collected from each of the following regions of the basin: upper third, middle third, lower third, and a composite of the entire depth. In addition, one water sample was collected from standing water in the basin at the time of the initial sampling.

After the samples were collected, they were tested in accordance with the SRS approved Benchscale Design Test (BSDT) Plan. After reviewing the test results, a single "worst case" location was selected (XB-9, shown in Figure 2). The soils at the location of XB-9 were selected for the BSDT since soils at this location represent the highest level of the uranium concentration in the basin. It was assumed that any mix that can solidify/stabilize this soil and meet the acceptance criteria would be adequate for the rest of the basin. (See Table 1 for a summary of the highest level of uranium concentration detected in the basin). The levels of contamination (total uranium) encountered during the BSDT were consistent with the treatability study conducted for the OFASB. The highest level of total uranium present in TCLP leachates from untreated soil composites in this study was 913 µg/L.

Additional soil was collected at the XB-9 location to obtain a sufficient quantity of material for the BSDT process. Initial soil was collected in November 1998 to develop a suite of primary design mixes. After initial review of these mixes, it became apparent that improvement to the mix was needed to meet or exceed the hydraulic conductivity value specified in the CMI/RDR/RAWP. To accomplish this, the design team for the subcontractor determined bentonite provided the characteristics needed to improve the hydraulic conductivity value of the mix design. As a result, an additional BSDT was required to evaluate the effect of the addition of bentonite to the mix.

Table 1. Summary of Test Results for the Soils Collected at the XB Location

Sample & Date	Specific Gravity	USCS	% Moisture	% Finer than No. 4 Sieve	% Finer than No. 200 Sieve	% Finer than 0.005 mm	Atterberg Limits			Total Uranium (μg/gm)	TCLP Uranium (μg/L)	pH	Sulfate (SO4)	Sulfite (SO3)	Sulfide (S)	Nitrate/Nitrite (NO3/NO2)	Re-Dox (mV)	Boron (B)
							LL	PL	PI									
XB-9 11/11/98	2.59	SC	18.6	99.9	31	22	31	18	13	117	556	5.5	ND	ND	ND	ND	82	ND
XB-9 1/5/99	2.63	SC	18.7	100	22.9	15	NP	NP	NP	87.3	681	5.6	57	ND	12	0.3	304	ND

Notes:
NP = Nonplastic
ND Nondetect

This required a second collection of material at the designated location in January 1999. Table 1 summarizes the results of the soil tests used to develop the S/S mix(es).

Utilizing the collected soil from the worst-case area in the basin, the final BSDT was performed between January and March 1999. S/S Mix No. 3.1 was selected as the primary grout mix to start the in-basin PSTP. This mix design met or exceeded the required performance requirements. Table 2 shows the composition of S/S Mix No. 3.1.

Table 2. S/S Mix Design No. 3.1

Ingredient	S/S Mix No. 3.1	
	Weight/gms	%
Soil	1814	65.57%
Cement	364	12.95%
Fly Ash	91	3.24%
Water	450	16.02%
Bentonite	50	1.78%
Zeolite	40	1.42%

2.2 Excavation of Contaminated Soils and Relocation of Soils to the Basin

Excavation and relocation of contaminated soils to the basin was a multi-event task. The excavation was broken into two stages: excavation of soils from the basin side slopes onto the basin bottom and excavation of soils from the overflow ditchline.

2.2.1 Side-slope soil removal

The removal of the side-slope soil from the basin sidewall was performed in several phases as the areas to be excavated became accessible. The areas to be excavated were staked out to the proposed line and grade per the design with a minimum of 2 feet of soil excavated, verified by site survey, adjusted when necessary, and then resurveyed for final survey as-builts. The side-slope soils were placed at the basin bottom, then graded to promote site drainage.

2.2.2 Overflow Ditchline Soil Removal

The overflow ditchline was excavated in accordance with project requirements. The area was staked out to the proposed line and grade for control of excavation activities, excavated, verified by site survey, and adjusted where necessary. Following field verification that 2 feet of ditchline soils had been removed field screening was performed. Preliminary field screening of soil was performed via surface scanning with a Ludlum Model 3 portable instrument. The instrument was equipped with a 44-9 Geiger-Mueller (GM) pancake probe for beta-gamma detection and with a 43-5 scintillation probe for alpha detection. Detection limits used for this instrument were <5,000 dpm/100 cm2 beta-gamma and <500 dpm/100 cm^2 alpha. All materials screened below the instrument detection level. To verify removal of contaminated materials, three confirmation soil samples were collected from the ditchline. Soil samples from the excavated areas were analyzed at AAL for radiological contamination using the threshold values of 50 pCi/g for nonvolatile beta, 20 pCi/g for gross alpha, and speciate for Strontium-90, Technetium-99, and Iodine-129 to ensure that remaining soils were below threshold limits. All samples were below required limits and results are summarized in Table 3. All soils removed from the ditchline were hauled and placed in the basin bottom for subsequent S/S mixing (see Figure 3 for the as-built survey).

Table 3. **Results of Soil Analysis for the Ditchline**

Samples	Radionuclide	Activity (pCi/g)	Threshold Limits (pCi/g)
A	Gross Alpha	8.32E+00	2.0E+01
	Nonvolatile Beta	1.23E+01	5.0E+01
	Sr-90	1.50E+00	5.7E+01
	I-129	3.60E+00	1.3E+01
	Tc-99	4.36E+00	2.3E+03
B	Gross Alpha	1.35E+01	2.0E+01
	Nonvolatile Beta	1.61E+01	5.0E+01
	Sr-90	1.47E+00	5.7E+01
	I-129	1.93E+00	1.3E+01
	Tc-99	3.96E+00	2.3E+03
C	Gross Alpha	4.78E+00	2.0E+01
	Nonvolatile Beta	1.04E+01	5.0E+01
	Sr-90	1.19E+00	5.7E+01
	I-129	2.40E+00	1.3E+01
	Tc-99	5.35E+00	2.3E+03

2.3 Pilot-Scale Test Program Activities

PSTP activities were conducted in three stages: equipment shakedown, out-of-basin test columns, and in-basin mixing of contaminated soils.

Equipment Shakedown - The equipment shakedown consisted of a startup procedure for all of the equipment involved in the S/S mixing operation. This entailed running all pumps, batch mixers, silos, the mixing tool, and the crane. The shakedown showed that grout could be mixed in the batch plant, pumped to the mixing tool, and injected into the area to be mixed.

Out-of-Basin Test Columns - The out-of-basin test columns were mixed to demonstrate the effectiveness of the mixing tool in breaking up site soils and mixing the grout into the soil. An area north of the basin was selected to test the system. The grout was injected through the mixing tool into the soils and mixed completely. The final product was flowable and appeared to be well mixed.

In-Basin Mixing (Pilot Scale Test) - The in-basin mixing of the contaminated soils was performed in accordance with the project requirements and included the mixing of columns using the SAM equipment, sample retrieval methods, installation of temperature and strain gauges for monitoring the curing process, and general production grouting methodologies. The initial pilot scale test revealed that the soil type in the test area contained sufficient clay to impact the consistency of the S/S mix and production rate of the mixing. When mixed with the grout, the clay did not produce a grouted soil product similar to that seen in the BSDT and the out-of-basin test. The grouted soil, although well mixed, was thick, did not flow well, and reached initial set sooner. These attributes (called workability) made placement of the instruments and sample retrieval using polyvinyl chloride (PVC) sampling tubes difficult. To resolve these issues subsequent pilot scale-testing plans were developed.

An additional pilot scale test, called PSTP-1, was developed to address the concerns described above. For PSTP-1, it was determined that adjustment of S/S Mix No. 3.1 would be necessary to improve workability. Rheobuild 1000 superplasticizer (SP) was added to the 3.1 mix (20 oz per 100 lb of soil cement). The adjusted grout mix with superplasticizer (3.1SP) used during PSTP -1 mixing activities did demonstrate improved workability of the S/S mix. As a result of the PSTP validation process, S/S Mix No. 3.1SP was found to facilitate instrumentation and sampling tube installation in areas with high soil clay content.

Table 4 shows the composition of mix design 3.1, developed in the BSDT and used in the initial pilot-scale test, and the mix design with the addition of SP (3.1SP) used in PSTP-1.

Table 4. Compositions of Mix No. 3.1SP and 3.1

Ingredient		S/S Mix No. 3.1SP		S/S Mix No. 3.1	
		Weight/gm	%	Weight/gm s	%
1	Soil	1,814	64.46%	1,814	65.57%
2	Cement	364	12.94%	364	12.95%
3	Fly Ash	91	3.23%	91	3.24%
4	Water	450	16.00%	450	16.02%
5	Zeolite	40	1.42%	40	1.42%
6	Bentonite	50	1.77%	50	1.78%
7	Rheobuild 1000 Superplasticizer	5.1	0.180%	0	0%
	Total	2,814.1	100%	2,809	100%

During pilot scale testing, the S/S mix was injected through the SAM and mixed with the soils at a penetration rate of no greater than 3 minutes per foot. A 0.4-foot overlap was used for this area, and the auger was positioned with the use of site survey equipment. Field personnel positioned the instrumentation and sampling tubes over the mix area on a portable walkway. The instrumentation was placed on an instrument tree driven into the grouted soil by hand initially, then with the hydraulic excavator for final placement. The tubes and instrument trees were placed as soon as the column was mixed. (These activities were demonstrated in both the initial PSTP and improved in the subsequent PSTP-1 with the addition of the SP in mix design 3.1SP). Finally, "wet sockets" were placed around the grouted soil area for future tie-in with PWMO columns.

After the grouted soil had set, the contractor retrieved the PVC sample tubes from the test area and recorded the percent recovery of the sample. The percent recovery was not acceptable for all of the tubes. Because of this, the contractor investigated and demonstrated the use of a nominal 3-inch coring machine to retrieve samples from the grouted mass. Coring techniques were developed to retrieve samples cores that met the contract specification requirements and SRS approval. The coring machine became the sample retrieval method of choice and was used during the PWMO.

At the conclusion of PSTP-1, the contractor had demonstrated that S/S mixing methodologies with mix designs 3.1 or 3.1SP could be used for continued operation in the basin. Sample test results (reference Sect. 2.7) showed that both S/S mixes 3.1 and 3.1SP were effective at meeting the performance criteria of the design specifications.

2.4 Grouting of Manholes and Piping

The grouting of the manholes and piping associated with the project was performed in the spring of 1999 after the PSTP field activities were completed. The manholes were located, inspected, radiologically scanned, opened, and prepared for filling with grout. The manholes were filled with the 2,000 psi concrete with the exception of manhole No. 1. Excavation to expose the manhole cover No. 1 revealed that the manhole was covered with an electrical duct bank that carries electrical cables in conduit. Because the duct bank created a barrier over the manhole, the manhole was rendered inaccessible. SRS eliminated grouting of manhole No. 1 since the intent of this action is to provide access controls in addition to administrative controls to prevent potential exposure. Since the existing electrical duct bank limits access to manhole No. 1, the RAO will continue to be met even though the man way for this manhole was not grouted. Administrative controls will also be maintained for OFASB Areas. (See unit-specific Land Use Controls Implementation Plan (LUCIP) in Appendix A).

The process sewer line, which fed the basin at the southwest corner, is made of vitrified clay and located an average of 9 to 10 feet below the land surface. The pipeline that originated in F Area and ended in the OFASB is approximately 800 feet in length. The configuration of the pipeline is provided in Sheet 2 of Figure 7 of the PCR. As stated in the ROD, the length of operational history of the pipeline was less than 9 months of batch wastewater disposal through the pipeline. Evaluations using modeling in the Corrective Measures Study/Feasibility Study (CMS/FS) identified that pipeline soils did not pose a risk from direct exposure and that activity levels in the pipeline soils do not pose future impact to groundwater.

The section of the 15-inch vitrified clay pipe (VCP) that extended from the basin inlet to the basin boundary was removed. This section of pipe was broken up and mixed with the soil inside the basin for S/S. In the course of routine field monitoring with radiological screening instrumentation, it was discovered that the remainder of the inlet pipe (up to manhole No. 4) and the soil surrounding it were contaminated above background. As a result, remaining clay pipe (a total of 35 feet) from the basin boundary to the manhole and contaminated soil surrounding the pipe were removed and placed in the basin for stabilization. During this activity, an additional 15-inch vitrified clay "stub," 2 feet in length, was discovered. The "stub" exited manhole No. 4 in a northwesterly direction. Radiological surveys were conducted. Elevated readings indicated that waste materials existed in contact with the vitrified clay stub. Following this discovery, the 2-foot "stub" and soil surrounding the stub were removed and placed in the basin for stabilization. The remaining soils in the excavated areas that were outside of the S/S mix area were analyzed for radiological contamination using a threshold of 50 pCi/g nonvolatile beta and 20 pCi/g gross alpha. The results were below threshold. (See Figure 9 for the location VCP and soils which have been removed).

2.5 Production Waste Mixing Operation

The PWMO began in August 1999 after the results of the performance testing for the PSTP had been reviewed by SRS. Additionally, several mixed columns were excavated during the beginning of the PWMO to provide access for visual inspection to verify uniformity and homogeneity of the mix columns.

At the beginning, the PWMO was very slow. To achieve the expected production rates and to meet project completion schedule, the contractor proposed variations in mixing rates, mixing patterns, mix design, and mixing equipment. A review of these items indicated a need to change the mixing equipment and adjust the mix design. Part of the problem was attributed to the fact that the mixing equipment used at this time was undersized for the type of soil encountered in the basin. During September 1999, the contractor mobilized a higher torque mix platform and arranged for delivery of a 150-ton crane. The new mix platform and crane were placed in service October 20, 1999.

The mixes used in the PSTP (3.1 and 3.1SP) were further enhanced to improve the S/S mix workability and the mixing tool penetrating rate. A series of enhanced mixes were evaluated and field tested and one mix was selected. The composition of the "enhanced mix" is shown in Table 5.

Table 5. Enhanced Mix

Ingredient	Enhanced Mix
Soil (grams)	1814
Soil Cement (grams)	364
Fly ash (grams)	91
Water (milliliters)	518
Bentonite (grams)	22
Zeolite (grams)	40
Superplasticizer (grams)	0

The combination of the larger and higher torque equipment and the "enhanced mix" enabled the contractor to attain the original planned production rates without impacting quality.

The 3-bladed mixing head used in the PSTP was retained for use in the PWMO. However, during the production activities, the mixing tool struck a buried stone and was damaged. The stone was removed and placed with the S/S mix. The contractor was unable to repair or replace the tool with another since it had been constructed especially for this project. The contractor also had two 2-bladed mixing heads onsite. These were modified and reinforced, then tested and approved for use. A demonstration column was mixed using the 2-bladed mix head, then visually inspected for mixing uniformity and homogeneity prior to continued usage.

After sufficient S/S curing, core samples were obtained from the grouted mass for 14- and 28-day testing. The cores were obtained using the 3" core machine that had been demonstrated and approved in the PSTP. Cores were removed from the grouted mass, logged, cut to the appropriate sample length, photographed, packaged for shipment, and then shipped according to the approved work plans and site procedures. After samples had been obtained, the resulting voids were sealed with bentonite or grout mix.

Approximately 10,154 yd^3 of contaminated soil was treated in the combined pilot and production grouting operations. Approximately 1,664,545 gallons of grout mix were added to this soil to complete the S/S mix operation. Reference Section 2.7 for summary of S/S mix test results.

2.6 PWMO Performance Test Deviation

Performance deviations were encountered with the Toxicity Characteristic Leaching Procedure (TCLP) for uranium (u) analysis. A number of samples exceed the performance requirement of 20 μg/L for uranium leached. Previous TCLP test results for uranium had been very low; typically, less than 1 μg/L. In March 2000, TCLP (u) testing generated data that frequently exceeded the 20 μg/L performance requirement. A group of 25 samples exceeded the performance requirement while there were no PWMO TCLP (u) failures prior to March. TCLP (u) analysis was placed on hold until the reason for the failures could be identified and evaluated.

SRS personnel carefully reviewed the failed sample population to determine if any field variables could be a potential cause. There was no definable pattern of failure in the location of the samples, and field activities and mix parameters had been monitored and remained the same. As a result, laboratory test procedures and processes were investigated as a step in determining a cause to the issue.

The two laboratories involved in the TCLP (u) testing, AAL and NTS, were audited by SRS and the contractor to determine if the sample preparation and/or analytical methodology was responsible for the escalation of TCLP test results. It was determined that the TCLP samples were biased with fine particles. As a result, the sample preparation technique was corrected and the TCLP (u) samples retested. No further TCLP (u) failures were identified in the retest program. TCLP (u) analysis for the remaining samples were performed using corrected sample preparation techniques, and no other failures were identified.

2.7 Summary of S/S Mix Test Results

The primary test parameters to evaluate the S/S grout performance were unconfined compressive strength (UCS), hydraulic conductivity (H/C), and

TCLP (u). Variations of these tests included immersion and acute radiation exposure. For immersion, test samples were immersed in water for 90 days after the initial specified curing period. For radiation exposure testing, acute radiation doses of 10E+4 rad were applied to samples after the specified initial curing period. These test variations were utilized to evaluate potential impacts of S/S media exposure and have been included in this section. Other geotechnical and chemical tests shown in the approved CMI/RDR/RAWP were performed throughout the development and production grouting process. During these tests, the S/S mix met or exceeded the performance criteria. These supplementary tests provided no indication of negative impact to the quality of the completed S/S mix and, therefore, have not been shown in this section.

The following sections summarize the test data for the key performance parameters for each of three phases required in the completion of the remedial action S/S process: benchscale development, in-basin pilot scale activities, and production grouting.

2.7.1 Benchscale Design Test Results

The benchscale testing of the approved mix designs was completed in three parts: BSDT, BSDT-Rerun, and BSDT-1. The BSDT results are for mix design 3.1 that was utilized in the initial in-basin pilot test PSTP. BSDT-Rerun was a limited second round of geotechnical tests performed on mix design 3.1. BSDT-1 results are for mix design 3.1SP utilized in the in-basin pilot test PSTP-1. BSDT-1 was performed in parallel with the PSTP when it became apparent that workability of the initial mix was needed to implement fieldwork. This part of the test included a suite of tests limited to the key performance indictors. Table 6 provides the results of these tests.

Table 6. Benchscale Design Test Summary Results

Bench Scale Test			BSDT	BSDT	BSDT	BSDT-	BSDT-	BSDT-	BSDT-1	BSDT-1	BSDT-1	
						Rerun	Rerun	Rerun				
Design Mix			3.1	3.1	3.1	3.1	3.1	3.1	3.1SP	3.1SP	3.1SP	
			Min	Max	Average	Min	Max	Average	Min	Max	Average	Acceptance
Cure Time	Test	Sample	Value	Value	Value	Value	Value	Value	Value	Value	Value	Criteria
Unconfined Compressive Strength (UCS) Testing (psi)												
14-Day	UCS	Soil/Grout	140	162	151	271	302	290	466	533	507	>50
14-Day Rad	UCS	Soil/Grout	153	175	169	-	-	-	-	-	-	>50
14-Day Imm	UCS	Soil/Grout	231	494	353	-	-	-	-	-	-	>100
28-Day	UCS	Soil/Grout	186	222	208	358	465	411	605	652	634	>100
28-Day Rad	UCS	Soil/Grout	200	315	252	-	-	-	-	-	-	>100
28-Day Imm	UCS	Soil/Grout	263	305	289	-	-	-	-	-	-	>100
Hydraulic Conductivity (H/C) Testing (10E-07 cm/sec)												
28-Day	H/C	Soil/Grout	0.84	0.84	0.84	-	-	-	0.1	0.17	0.14	<1x10E-07
28-Day Rad	H/C	Soil/Grout	0.66	1.5	0.92	0.24	0.4	0.32	0.072	0.14	0.01	<1x10E-07
28-Day Imm	H/C	Soil/Grout	0.29	0.7	0.53	-	-	-	-	-	-	<1x10E-07
TCPL (u) Testing (μg/L)												
14-Day	TCLP	Soil/Grout	0.129	1.2	0.545	-	-	-	-	-	-	<20
14-Day Rad	TCLP	Soil/Grout	0.222	0.554	0.328	-	-	-	-	-	-	<20
28-Day	TCLP	Soil/Grout	0.0564	0.172	0.108	-			0.0328	0.189	0.0965	<20
28-Day Rad	TCLP	Soil/Grout	0.3200	0.9490	0.6120	-	-	-	-	-	-	<20
28-Day Imm	TCLP	Soil/Grout	0.207	0.387	0.207	-	-	-	-	-	-	<20
Day = Expected days of cure*												
Day Rad = Days of cure and acute radiation dose exposure.												
Day Imm = Days of cure and 90 days of water immersion.												

* Some variation in cured days documented (e.g., 14-Day UCS tested at 18 days of cure time.)

The results of the three tests indicated that mix design 3.1 (BSDT, BSDT-Rerun) and 3.1SP (BSDT-1) met or exceeded the performance criteria with the exception of one H/C value. The H/C value for one mix 3.1 sample was 1.5 x 10E-7 cm/sec. This result was reviewed by SRS technical personnel and determined to be isolated in frequency and below the minimum value required in the field. Mix design 3.1 was authorized by SRS for use in the pilot scale program.

2.7.2 Pilot Scale Test Results

The in-basin pilot scale program was performed in two stages: the initial test (PSTP) utilizing mix design 3.1 and a second test (PSTP-1) utilizing mix 3.1SP to improve S/S mix workability. Table 7 provides a summary of the key test results.

The results of the PSTP indicated that UCS results were all acceptable. The H/C test failures noted were analyzed by the project and were determined to be caused by the test recovery method used during the initial pilot program. The use of PVC tubes for sample removal was constructed with screws penetrating the bottom section of the tube. These screws were intended to ensure a complete section of material was removed with the tube when it was retrieved after initial S/S curing. Although the screws did hold the material in the tubes, they also caused a vertical indication in the sample that caused the tests to fail. Additional testing for H/C testing was performed in PSTP-1. The failure of TCLP (u) tests in the initial PSTP was considered isolated, and additional testing was evaluated in PSTP-1.

The results of PSTP-1 testing revealed that all but one test specimen passed the acceptance criteria. The one failure, H/C, was considered isolated. A significant number of acceptable test results were obtained and evaluated to allow S/S mixing operations to continue.

Table 7. Pilot Scale Test Summary Results

Pilot Test			PSTP	PSTP	PSTP	PSTP	PSTP	PSTP-1	PSTP-1	PSTP-1	PSTP-1	PSTP-1	
Design Mix			3.1	3.1	3.1	3.1	3.1	3.1SP	3.1SP	3.1SP	3.1SP	3.1SP	
					Min	Max	Average			Min	Max	Average	Acceptance
Cure Time	Test	Sample	Tested	Failures	Value	Value	Value	Tested	Failures	Value	Value	Value	Criteria
Unconfined Compressive Strength (UCS) Testing (psi)													
14-Day	UCS	Soil/Grout	6	0	138	976	485	11	0	140	553	301	>50
14-Day Rad	UCS	Soil/Grout	6	0	118	749	444	2	0	252	385	319	>50
14-Day Imm	UCS	Soil/Grout	6	0	328	589	443	0	0	0	0	0	>100
28-Day	UCS	Soil/Grout	11	0	159	1155	454	6	0	244	527	349	>100
28-Day Rad	UCS	Soil/Grout	6	0	181	1150	584	1	0	574	574	574	>100
28-Day Imm	UCS	Soil/Grout	9	0	212	1290	597	1	0	199	199	199	>100
Subtotal			44	0				21	0				
Hydraulic Conductivity (H/C) Testing (10E-06 cm/sec)													
14-Day	H/C	Soil/Grout						11	1	0.0011	1.3	0.209	<10E-06
28-Day	H/C	Soil/Grout	11	1	0.017	1.5	0.424						<10E-06
28-Day Rad	H/C	Soil/Grout	8	4	0.018	35	5.514	6	0	0.0013	0.33	0.1523	<10E-06
28-Day Imm	H/C	Soil/Grout	9	2	0.015	8	1.678	1	0	0.0024	0.0024	0.0024	<10E-06
Subtotal			28	7				7	0				
TCPL (u) Testing (µg/L)													
28-Day	TCLP	Soil/Grout	9	1	0.0103	260	29.282	1	0	0.4640	0.464	0.464	<20
28-Day Rad	TCLP	Soil/Grout	7	0	0.0000	0.5360	0.2601	1	0	0.0562	0.0562	0.0562	<20
28-Day Imm	TCLP	Soil/Grout	9	1	0.0268	47.5	5.5726	1	0	0.0244	0.0244	0.0244	<20
Subtotal			25	2				3	0				
Day = Expected days of cure*													
Day Rad = Days of cure and acute radiation dose exposure.													
Day Imm = Days of cure and 90 days of water immersion.													

* Some variation in cured days documented (e.g., 14-Day UCS tested at 18 days of cure time.)

2.7.3 Production Waste Mixing Operation Results

The production waste mixing operation was performed with two mix designs: 3.1SP and the "Enhanced" mix design created during the production operation to further improve mix workability. For additional quality control purposes batch plant testing of the grout mix prior to mixing was also completed. Table 8 provides a summary of the key test results of the S/S mixes and the batch plant grout.

The results of the production mixing operations revealed most key test parameters achieved acceptable results with the exception of TCLP (u). The results of TCLP (u) are shown both with and without the suspect TCLP (u) results explained in section 2.6. When TCLP (u) results are reviewed without the influence of the suspect results, they significantly pass the acceptance criteria for most of the tests performed. Other results that did not meet the acceptance criteria (a total of 9 in 753 S/S mix tests shown in Table 8 excluding suspect TCLP (u) and batch plant grout samples) were individually reviewed and/or retested with additional samples in the same region. There was no established trend in any test parameter to create a concern for total compliance in the S/S mix quality. All batch plant grout tests exceeded the acceptance criteria.

Table 8. Production Waste Mixing Operation Summary Results

Mix Design			3.1SP	3.1SP	3.1SP	3.1SP	3.1SP	Enhanced	Enhanced	Enhanced	Enhanced	Enhanced	Enhanced
					Min	Max	Average			Min	Max	Average	Acceptance
Cure Time	Test	Sample	Tested	Failures	Value	Value	Value	Tested	Failures	Value	Value	Value	Criteria
Unconfined Compressive Strength (UCS) Testing (psi)													
14-Day	UCS	Soil/Grout	16	1	46	888	534	74	0	58	706	362	>50
14-Day Rad	UCS	Soil/Grout	15	0	216	1075	728	59	0	122	828	408	>50
14-Day Imm	UCS	Soil/Grout	15	0	146	1292	661	50	1	85	756	429	>100
28-Day	UCS	Soil/Grout	14	0	438	857	673	52	0	154	956	451	>100
28-Day Rad	UCS	Soil/Grout	14	0	223	1108	764	47	0	132	1106	527	>100
28-Day Imm	UCS	Soil/Grout	14	0	304	1550	866	41	0	112	936	491	>100
Subtotal			88	1				323	1				
Hydraulic Conductivity (H/C) Testing (10E-06 cm/sec)													
28-Day	H/C	Soil/Grout	15	1	0.0028	1.5	0.1127	74	2	0.0028	3.4000	0.01828	<1x10E-06
28-Day Rad	H/C	Soil/Grout	15	0	0.0014	0.4300	0.0428	47	2	0.0029	2.2000	0.1809	<1x10E-06
28-Day Imm	H/C	Soil/Grout	15	2	0.0014	1.2	0.1762	34	0	0.0007	0.1400	0.0245	<1x10E-06
Subtotal			45	3				155	4				
TCPL (u) Testing (µg/L) with Suspect Test Data													
28-Day	TCLP	Soil/Grout	14	2	0.0000	48.7	6.4555	82	5	0	334.0000	11.3357	<20
28-Day Rad	TCLP	Soil/Grout	11	2	0.0000	259.0	27.6787	38	14	0.0111	404.0000	85.2275	<20
28-Day Imm	TCLP	Soil/Grout	8	2	0.0897	395	64.9172	16	0	0.0133	0.291	0.1062	<20
Subtotal			33	6				136	19				
TCPL (u) Testing (µg/L) without Suspect Test Data													
28-Day	TCLP	Soil/Grout	12	0	0.0000	12.1	1.3481	75	0	0	14.2000	0.7444	<20
28-Day Rad	TCLP	Soil/Grout	9	0	0.0000	4.5	0.8740	24	0	0.0111	12.4000	1.1894	<20
28-Day Imm	TCLP	Soil/Grout	6	0	0.0897	19.4	5.2063	16	0	0.0133	0.291	0.1062	<20
Subtotal			27	0				115	0				
Batch Plant Grout Testing (UCS psi, H/C 10E-6 cm/sec)													
14-Day	UCS	Grout	31	0	371	1411	706.2	66	0	124	472	262.2	>100
28-Day	UCS	Grout	27	0	768	1565	989.5	62	0	151	631	401.6	>100
28-Day	H/C	Grout	31	0	0.0022	0.024	0.0089	62	0	0.013	0.62	0.1113	<1x10E-06
Subtotal			89					190					
Day = Expected days to cure*													
Day Rad = Days of cure and acute radiation dose exposure.													
Day Imm = Days of cure and 90 days of water immersion.													

* Some variation in cured days documented (e.g., 14-Day UCS tested at 18 days of cure time.)

2.8 Soil Cover Placement

Placement of the soil cover began after production grouting areas had been successfully accepted and the as-built survey from S/S material had been obtained (see Figure 4 for final as-built survey). The cover over the basin is composed of three layers: a grading layer including common fill and soil/chips layers (the soil/chips is a blend of approximately 15% wood chips and 85% common fill); a minimum 2-foot low permeability soil layer; and a 18-inch vegetation layer that includes a 6-inch mix of topsoil and common fill at the top.

Before the common fill was placed, the 4-inch diameter steel pipe, which was removed from southwest corner of the basin and filled with the grout to stabilize potential contamination, was placed on the stabilized mass in the basin. After the first lift of common fill was placed over the stabilized mass, approximately 280 yds^3 of wooden chips blended with additional soil were spread over the compacted lift (WSRC 1998). (The wooden chips for this layer had been stored under a geotextile cover for protection. During the move, the cover tore and the pieces were mixed with the chips. To avert the potential for creating voids in the layer and because of the difficulty of decontaminating the material, the geotextile pieces were separated from the chips and laid flat over the blended wood chip/soil layer.) Before the additional grading fill material was placed, the blended material was compacted by five passes of a vibratory roller having a dynamic force of 30,000 lb per drum.

Common fill material was excavated and hauled from the Central Shops Borrow Area for use as grading fill and as part of the vegetative layer (see figures for top of grading fill). Low permeability soil was obtained from a stockpile of soil from B Area and prequalified for a hydraulic conductivity value of less than or equal to 1.0E-5 cm/sec prior to placement (see Figure 6 for top of low-perm soil). To determine the acceptability of the soil obtained from stockpile, nine bulk samples were taken from the available stockpile for laboratory testing. From the nine bulk samples, three large composite samples were formed and tested for the following:

- Soil Particle Size Analysis – American Society for Testing Materials (ASTM) D422
- Moisture Content – ASTM D2216 or D4643
- Liquid Limit, Plastic limit, and Plasticity Index – ASTM D4318

Next, the following tests were performed in triplicate for each of the composite samples above (nine compaction tests):

- Laboratory compaction characteristics – ASTM D422
- Laboratory compaction characteristics – ASTM D2216 or D4643
- Laboratory compaction characteristics – ASTM D698 (reduced proctor applying 15 blows per layer)

Once the compaction characteristics from the above tests were determined, three samples were remolded from the remaining three composite samples (three tests were performed) for determining hydraulic conductivity. Based above Proctor data, remolding was performed at approximately 95% compaction with a moisture content above the 2.5% optimum moisture content. These samples are tested in accordance with the following standard:

- Hydraulic Conductivity – ASTM D5084

The Proctor compaction results were used to construct a moisture-density curve, which forms a line of optimum (LOO) compaction characteristics. The LOO is used as a quality control measure in the field during the placement and compaction of low permeability layers.

During the backfill operation, materials for the low permeability layer were tested in situ for hydraulic conductivity in accordance with ASTMD 5084. All results met the performance requirement (1.0E-5 cm/sec) except one hydraulic conductivity (H/C) sample, which marginally exceeded the requirement (*1.9 E-05 cm/sec). This one H/C deviation was reviewed against all other test parameters and determined to be an isolated condition that was deemed acceptable. See below the summary of these tests.

Table 9. Summary of Low Permeability Soil Tests (H/C, cm/sec)

No. of Samples	Min Value	Max Value	Average	Acceptance Criteria
21	0.0064 E-05	*1.9 E-05	0.12 E-05	<1.0E-05

Topsoil was obtained from an offsite source.

The soils were placed in lifts, compacted, tested, and surveyed upon completion. Quality control testing was performed for the soils placed throughout the project in accordance with project specification. Tests included gradation, moisture content, in-place density, plasticity index, and hydraulic conductivity (WSRC 1999).

Areas that did not meet the criteria established in the project specifications were reworked by the contractor until the criteria were met.

The cover system was completed in accordance with the design requirements and met all acceptance criteria. The following volumes of soils were used during installation of the cover system:

Soil	Volume (Yd^3)
Grading Layer	7,380
Low Permeability Layer	5,770
Vegetative Layer	3,134
Topsoil (Cap Area)	928
Total	17,212

None of the materials used for the soil cover were excavated from areas used for any industrial facility. A review of historical data at SRS indicates these areas were not contaminated.

2.9 Revegetation

After placement of the revegetation soil layer, the revegetation activities started with application of lime to the topsoil. The lime was applied uniformly over the scarified topsoil area. The soil was moistened, and the lime was mixed with the topsoil using a farm tractor and rake. Commercial 10-10-10 fertilizer was applied in accordance with the specifications. The specified seed mix was applied at the following rate: Brown Top Millet at 15 lb/acre, Common (unhulled) Bermuda at 40 lb/acre and Centipede at 15 lb/acre. Mulch was blown onto all seeded areas immediately after the seed was broadcast. Moist conditions were maintained for all seeded areas. Site restoration was completed in accordance with project specifications, and repairs were made to all areas disturbed during the course of the construction.

2.10 Well Installation and Monitoring

To supplement the existing well network and to fulfill the requirements of the monitoring well approval and the groundwater mixing zone application (WSRC 1997, SCDHEC 1999), seven new monitoring wells, three intermediate wells, and four compliance boundary wells were installed in the lower zone of the Upper Three Runs Aquifer.

The groundwater mixing zone application (WSRC 1997) and the CMI/RDR/RAWP (WSRC 1999) invoked a naming convention for the new wells that did not comply with SRS alphanumeric standards for groundwater wells. Therefore, the well names were changed to comply with SRS standards and to match the identifiers for existing wells in the OFASB network. Table 10 lists the old well identifiers and the corresponding new well names and identifies each new well as either an intermediate well or a compliance boundary well.

Table 10. Well Identifiers

Old Identifier	New Name	Purpose
SCPW-1	FNB-9	Intermediate Well
SCPW-2	FNB-10	Intermediate Well
SCPW-3	FNB-11	Intermediate Well
SCCW-1	FNB-12	Compliance Boundary Well
SCCW-2	FNB-13	Compliance Boundary Well
SCCW-3	FNB-14	Compliance Boundary Well
SCCW-4	FNB-15	Compliance Boundary Well

The three intermediate wells were installed in the area between the existing plume wells (FNB-2, FNB-3, and FNB-5) and the compliance boundary. The four compliance boundary wells were installed near the downgradient edge of the contaminant plume. The new wells were completed during the period from November 29, 1999, through January 3, 2000.

Table 11 presents well installation and construction details for the OFASB new monitoring wells.

The new wells and the existing plume wells (FNB-2, FNB-3, and FNB-5) will be monitored according to the requirements of the CMI/RDR/RAWP (WSRC 1999) and the groundwater mixing zone application (WSRC 1997).

Table 11. New Well Installation and Construction Details

Well	UTM East	UTM North	Screen Zone Top (feet mean sea level [ft msl])	Screen Zone Bottom (ft msl)	Target Aquifer	Installation Date
FNB-9	436520	3683775	188.25	158.3	lower Upper Three Runs	12/99
FNB-10	436621.9	3683866	200.2	170.2	lower Upper Three Runs	12/99
FNB-11	436761.3	3683847	191.19	161.2	lower Upper Three Runs	12/99
FNB-12	436559.9	3684000	194.55	164.6	lower Upper Three Runs	11/99
FNB-13	436618.8	3684087	197.24	167.2	lower Upper Three Runs	12/99
FNB-14	436675.4	3684091	202.49	172.5	lower Upper Three Runs	12/99
FNB-15	436776.8	3684097	179.42	149.4	lower Upper Three Runs	12/99

3.0 DEVIATIONS FROM ORIGINAL DESIGN

The project successfully completed the remedial action at the OFASB (904-49G) to control the contaminated waste in accordance with the CMI/RDR/RAWP (WSRC 1999). No major configuration changes were required during construction. The preferred alternative identified in the ROD was completed with no deviation, except for the subsequently approved ESD as stated in Section 1.2. A copy of this ESD has been provided in Appendix E. Several minor design and construction changes were implemented during the remedial action process. All changes were reviewed by SRS technical personnel prior to implementation to ensure contract specification and regulatory compliance. No changes were made that impacted final project quality. In many cases, notification was provided to the regulators prior to implementation. The following is a summary of these changes:

Item	Change	Reason
1	Modified hydraulic conductivity in BSDT from 10 E-8 cm/sec to 10 E-7	The hydraulic conductivity value of < 10 E-7 cm/sec is acceptable as a BSDT performance requirement. This will set the target laboratory parameters for the BSDT with regard to permeability measurement at about one order of magnitude less than what is expected in the field.
2	Added plasticizer to S/S Mix 3.1 and enhanced mix 3.1SP	Improve workability of the S/S mix. (See Section 2.3 and 2.5 for details.)
3	Reduced mixing column overlaps from 0.8 ft to 0.4 ft	To reduce the overlaps, thus reducing the remixing of the columns grouted previously. Reduction of the overlap was accomplished using the revised SAM pattern, which provides a minimum of 0.4 ft overlap on all adjoining columns. Use and accuracy of a Trimble 4800 GPS Total station survey instrument to locate the center of the columns assures the minimum overlap of the columns and S/S of all the soil/waste in the basin. Subcontractor's quality controls in place, with regard to survey technique, alignment of mixing tool, and placement of the mixing head were observed and monitored in the field during mixing operation.
4	The CMI/RDR/RAWP required the minimum frequency for confirmation sampling of the stabilized waste to be the greater of one full-length core sample per day or a minimum of one full-length core sample per every 500-ft^2. Sample retrieval rate for PWMO sample collection is based on the average of one per 500 ft^2.	Revision of sampling requirements for coring to represent daily production during periods of low production will create numerous extra samples collected in 500 ft^2.

Item	Change	Reason
5	Geotextile material that covered the wood chips pile was placed over the grading fill below the soil cover.	During the construction activity (production grouting operations), the wood chip pile stored in the basin was moved from one area of the basin to the other. During the move, the geotextile cover was torn and mixed with the wood chip pile itself. Under the circumstances, it was difficult to decontaminate the geotextile cover for clean disposal. Therefore, SRS segregated the geotextile pieces (approximately 833 yd^2) from the wood chips and placed this material in a single layer on top of the last grading fill layer. (See Section 2.8 for details.)
6	Removal of additional clay pipe and placement in the basin	Construction activities at the southwest corner of OFASB entailed removal of a section of VCP. During the course of the activity, it was discovered that the remainder of the inlet pipe from the boundary of the basin sidewall to manhole #4, as well as the soil surrounding the pipe, was contaminated. In addition, a 15-inch pipe "stub" that extruded from manhole #4 was discovered during waste excavation activities. (See Section 2.4 for details.)
7	Replacement of the crane	The original crane was replaced with a 150-ton, high torque crane to achieve the planned production rate. (See Section 2.5 for details.)
8	Discharge of rainwater from the basin to the ground	Due to heavy rain during construction, the OFASB collected rainwater that required disposition so that construction activity could continue. Basin water was pumped into a temporary storage tank. This tank was lined with a bladder that could be disposed of as radioactive waste if necessary. Some of the water was recycled in the grout mixing process. Excess water not used in grout mix was sampled and compared with the limits identified in IDW Management Plan, Rev. 2, Appendix A (WSRC 1994) (gross beta-gamma, 50 pCi/L; gross alpha, 15 pCi/L; Cs-137, 119 pCi/L; and mercury, .0002 mg/L). Since the results were well below these limits, the excess water was discharged onto the ground. Notification of results and quantities of rainwater were provided to the regulators prior to discharge.

Item	Change	Reason
9	Eliminate grouting manhole No. 1.	Existing approximately 1 foot H x 5 feet W concrete duct bank with multiple embedded rigid electrical conduits running over the manhole No. 1 making it inaccessible (See Section 2.4 for details).
10	Dispositioning of the remaining secondary waste at unit in a trench adjacent to the basin closure instead of off-unit.	Consistent with the decision made by the three parties, USEPA, SCDHEC and SRS, at the July 19, 2000 meeting, SRS placed the secondary remediation waste in a trench to be constructed outside but adjacent to the stabilized mass at the basin southern end. (See Section 3.2 for details).

3.1 Monitoring Well Construction

All new wells were constructed according to the design requirements of Monitoring Well Approval #SF-99-044 (SCDHEC 1999) and were within allowable tolerances for location and screen zone placement. The location originally selected for well FNB-12 was changed to avoid placement in an area of wetland vegetation near Upper Three Runs Creek. The as-built location of well FNB-12 is approximately 67 feet site east and 47 feet site south of the location originally proposed (as SCCW-1) in the CMI/RDR/RAWP (WSRC 1999). Refer to Table 10 and Figure 8 for the as-built conditions and location of the new wells.

Note: The table in the CMI/RDR/RAWP (WSRC 1999) lists approximate site coordinates and elevations for the seven new wells. Although the coordinates and elevations were correct estimates, the column headings for site north and site east were transposed. Column two should have read "SRS East"; column three should have read "SRS North."

3.2 Waste Disposal

Waste management (handling, disposal, and transportation of construction-generated wastes) and dewatering met the requirements of applicable SRS manuals and procedures (e.g., WSRC 3Q Manual, *Environmental Compliance Manual;* WSRC 1S Manual, *Waste Acceptance Criteria;* WSRC C1 Manual, *Environmental Restoration Administrative Procedures*). Primary remediation waste was stabilized by grouting. Aqueous secondary remediation waste, which includes decontamination rinsates and the excess water from dewatering of the basin, was incorporated into the S/S process when practicable. Excess (unused) rainwater was sampled, analyzed, and compared to the *Investigation-Derived Waste Management Plan,* Rev. 2, Appendix A (WSRC 1994) limits. The contamination in the water was below those limits and water was discharged on the ground.

Non-aqueous (solids) secondary remediation waste that could not be grouted in the basin due to the timing of its generation was considered low-level radioactive waste. This waste consists of such items as the final core samples from the grouted basin (returned from the laboratories), contaminated silt-fencing materials, hoses, and miscellaneous job control waste, which falls into the same category of waste as the others. It also includes items such as electrical cords and small tools like shovels and hammers, metal pieces used during construction, miscellaneous wood scraps, items not practicable to decontaminate for subsequent reuse, and materials used by Radcon to control contamination such as plastic, rope, and barricades.. The total volume of the secondary waste is approximately 39 cubic yards. This includes approximately 30 cubic yards of personal protective equipment (PPE) and 9 cubic yards of construction debris.

The secondary waste was placed in a trench constructed outside of the grouted material but adjacent to the basin. Fieldwork for this task began November 1, 2000. The following activities were performed to complete the task:

- SRS surveyors delineated the excavation limits prior to commencement of construction. Safety, erosion control, and Radcon barricades were set up around the work area, allowing sufficient room to excavate the trench.

- A trench was excavated outside but adjacent to the stabilized mass at the basin's southern end as shown on Figure 9. To safely excavate the trench and to ensure that the cap could be properly keyed into the existing cap, a step slope was created at the upper section of the trench.

- The waste trench was surveyed before the controlled low strength material (CLMS) was placed within the trench.

- A minimum 6 inches of CLMS was placed at the bottom of the waste trench and allowed to cure for 24 hours before the secondary waste was placed over it.

- To minimize personnel handling of the waste, incompressible secondary waste, which was contained in four B-12's and one B-25, was placed in the east end of the trench area. CLSM was added to the containers' contents and the trench to ensure thorough mixing and encapsulation. Secondary waste (PPE) bags from B-25 container were placed in the west end of the trench on top of the cured 6-inch layer of CLMS. To ensure internal material was thoroughly blended with CLSM, a backhoe was used to open the bags and blend with fluid CLSM. After this activity, the trench was filled with CLSM up to 6 inches minimum above the CLSM/waste mix. A 6-inch minimum buffer zone of CLSM was maintained between the waste (and container) and the trench sides.

- The soil cover was placed over the trench after the waste/CLSM had sufficiently cured. The cover over the trench comprises three layers: a grading fill; a minimum 2-foot low permeability soil layer with a hydraulic conductivity value of less than or equal to 1.0E-5 cm/sec; and a minimum 18-inch vegetation layer that includes a 6-inch mix of topsoil and common fill at the top (see Section A of Figure 9). During the backfill operation, soils were placed in lifts and compacted and tested. Materials for the low permeability layer were tested in situ for hydraulic conductivity in accordance with ASTMD 5084. All the results met the performance requirement (1.0E-5 cm/sec). (See Table 12 below for low permeability soil test results.)

- The trench construction area was restored, fertilized, seeded, and mulched in accordance with the project specifications. Both rye grass and unhulled Bermuda grass seed were applied to provide both immediate erosion control and long-term ground cover.

- Construction of the secondary waste trench was completed on November 17, 2001.

Table 12. Summary of Low Permeability Soil Tests (H/C, cm/sec)

No. of Samples	Min Value	Max Value	Average	Acceptance Criteria
3	0.038E-05	0.92E-05	0.48E-05	<1.0 E-05

4.0 CERTIFICATION OF ACHIEVEMENT OF REMEDIAL ACTION OBJECTIVES

The selected remedial action (RA) and RAOs (see Section 1.2) are documented in the ROD (WSRC 1997a). The acceptance criteria for various components of the RA (i.e., removal and consolidation of contaminated OFASB pipelines and soils, the final in situ stabilized/solidified waste in the OFASB and the low permeability soil cover) were developed based on the functional requirements/objectives for those components. These criteria as well as the detailed field implementation plan are reported in the approved Remedial Design Work Plan (RDWP) (WSRC 1997b) and the approved CMI/RDR/RAWP (WSRC 1999). If the implementation plan is executed in a manner that meets the acceptance criteria, the remedial action will reduce the risks posed by external exposure to radiation, inhalation and ingestion of radionuclides and will minimize migration of COCs to the unit groundwater.

Field implementation of the remedial action was performed in accordance with the aforementioned CMI/RDR/RAWP, which was strategically developed for the successful accomplishment of the RAOs. Pertinent sections of this PCR summarized the field implementation process. The results of inspections, verification sampling, analysis and testing of the multiple components of this RA implementation indicate that the results satisfactorily met or exceeded the established acceptance criteria. Those results also indicate that any observed deviations from the original design had no significant adverse effect on the functional quality and integrity of the closed unit.

The project was executed under the direction of an SRS Subcontract Technical Representative who was regularly assisted by a project team consisting of representatives from the SRS-ER engineering, construction, quality assurance, and project management functional areas. The project team performed regular reviews of the test results and conducted field observations of the subcontractor's work during the project. The reviews and the rationale stated above provides verification that the completed portions of the OFASB remedial action were conducted within the project specifications and have achieved the performance goals and remedial objectives as stated in the ROD and as amended by the ESD. Achieving the groundwater remedial objectives stated in the ROD will require long-term monitoring and will be documented as part of the CMIR/FRR.

The RAOs listed in the ROD are as follows:

- Prevent external exposure to radiological constituents
- Prevent inhalation of radiological constituents
- Prevent ingestion of soil or produce grown in soil with radiological constituents
- Prevent or mitigate the release of constituents of concern to the groundwater
- Prevent or mitigate the impact to the nearest groundwater receptor located at the upper Three Runs Creek
- Restore the aquifer through natural groundwater mixing processes and other processes (radioactive decay) to achieve MCLs throughout the groundwater plume (groundwater mixing zone application modeling estimates that MCLs throughout the entire groundwater aquifer will be achieved in approximately 200 years)
- Achieve State of South Carolina groundwater mixing zone objectives

  a) control source to minimize addition of contaminants to the groundwater,

  b) establish plume monitoring and compliance wells to ensure compliance with mixing zone application, and

  c) monitor to ensure contaminated groundwater remains on SRS until MCLs achieved throughout the plume and to ensure groundwater area or plume is decreasing concentrations.

5.0 VERIFICATION OF OFASB CLOSURE

The OFASB project was completed June 9, 2000, in accordance with the performance requirements and project specifications. All monitoring wells were constructed. SRS and USEPA representatives conducted a walkdown of the OFASB and monitoring wells in June 2000. On January 23, 2001, the following personnel, T. Johnson, USDOE; K. Feely, USEPA; K. McSwain, USEPA; M. McRae, USEPA (Parallax), and K. Davis, USEPA (Parallax) M. T. Kasraii, WSRC; B. K. Davis, WSRC; G. F. Stejskal, WSRC; participated in a second walkdown of the OFASB. During this walkdown, WSRC provided a history of the unit, explained the remedial action taken, showing as-built drawings, and the locations of the monitoring and point-of-compliance wells.

USEPA and SCDHEC stated that they had no disagreements with the actions taken at the OFASB but did have two concerns. The concerns and the SRS response are as follows:

1. The vegetative cover is brown and there are some bare spots existing on the cover. What are SRS's plans to assure that a vegetative cover is maintained?

SRS Response:

At the time of the inspection, the secondary waste trench area had been seeded with rye grass (winter grass) to allow the permanent grass a chance to get established. As a result at the time of inspection, the area over the waste trench appeared green (winter grass) while the other areas of the cap, planted with permanent grass, appeared brown. The OFASB has been scheduled for reseeding. This will eliminate any bare spots and increase the grass density. For maintenance of the vegetation cover, see Section 6 of this PCR.

2. Why was a fence not constructed around the unit?

SRS Response:

Installation of a fence around the OFASB soil cover has the potential to create obstruction for proper maintenance of the cover. In addition, installation of a fence is not necessary since the following elements have been considered as part of "institutional controls" for this unit.

- Installation of warning signs, as required by design per the approved CMI/RDR/RAWP
- Use of existing SRS access controls (including security gates, guards, and the site use/site clearance program)
- Periodic inspection and maintenance as required design per the approved CMI/RDR/RAWP
- Compliance with long-term institutional control requirements per Section 120(h) of CERCLA, as described in the approved CMI/RDR/RAWP (Section 13.1.2) and Appendix A of this document

Therefore, the design documents (CMI/RDWP and CMI/RDR/RAWP), did not consider installation of a fence as part of RA.

6.0 POST-CONSTRUCTION ACTIVITIES

The SRS Environmental Restoration Division (ERD) Operations Department will assume custodianship of the OFASB and begin regular monthly monitoring inspections for the first 2 years after the PCR approval. Inspections after 2 years will be performed semiannually per the checklist provided in Attachment A. Using a formal inspection process, trained personnel will perform routine inspections to assess the condition of the soil cover. Maintenance of the soil cover (e.g., repair as a result of erosion, subsidence, burrowing animals, vehicular activity, etc.) will be coordinated by ERD Operations. Until the PCR is approved, ERD Operations will continue inspections and maintenance as required by the Stormwater Management and Sediment Control Plan/Pollution Prevention Plan for the OFASB until permanent vegetation is established.

The selected remedial action also includes groundwater monitoring at the OFASB. The objective of monitoring is to demonstrate compliance with MCLs at the compliance boundary wells and compliance with the MZCLs at the plume wells as required by the groundwater mixing zone application. A detailed description of groundwater monitoring and reporting activities are provided in Section 6.3 of CMI/RDR/RAWP (WSRC 1999) and Groundwater Mixing Zone Application (WSRC 1997). Routine groundwater monitoring will start within 90 days of PCR approval.

7.0 PROJECT COSTS

The OFASB project was contracted under an SRS Basic Ordering Agreement (BOA) fixed price subcontract. The BOA consists of companies that have been pre-qualified to perform environmental remediation activities at SRS. The scope of work for this project was competitively bid amongst multiple BOA companies. The low cost bidder was selected to perform the work. The ROD total present worth estimate for the remedial action was $ 2.8 M; the BOA fixed price contract and estimated present worth O&M costs total was $ 5.2 M. The table below compares the summary of remedial action project costs to the original remedial action cost estimates. Detailed breakdowns of costs compared to the CMS/FS and ROD are included in Appendix F.

Cost Item	Original Estimate (ROD)	Remedial Action (RA) Cost
O&M cost basis	30 years	30 years
Direct Capitol Cost-Closure	1,342,800	3,806,559
Direct Capitol Cost-Groundwater	215,000	207,704
Present worth O&M Cost-Closure	389,506	389,506
Present worth O&M Cost-Groundwater	846,157	846,157
Total Present Worth	**2,793,463**	**5,249,926**
Difference between total remedial action cost and ROD estimate	**+$ 2,456,463 or +88%**	

The project costs were approximately 88% greater than the CMS/FS and ROD cost estimate. This increase was largely a result of under estimating the cost to perform in-situ grouting. The original estimated cost to grout the material was $422k. The RA cost was $2,807k, including approximately $400k of raw material costs alone, for completing the task. Based on the competitive process for awarding the contract, the RA cost incurred is reasonable and appropriate for a project of this nature.

8.0 AS-BUILT SURVEY DRAWINGS (See Appendix B)

Figure 1. Pre-Construction Survey of OFASB

Figure 2. Basin Characterization Soil Sample Locations

Figure 3. Pre-Treatment Survey of the OFASB (After Placing Contaminated Soils in the Basin Before Stabilization)

Figure 4. Topographic Survey of the Basin After Completion of Stabilization/ Solidification (Top of Solidified Mass)

Figure 5. Topographic Survey after Placing Grading Fill

Figure 6. Topographic Survey After Placing Low Perm Soil (Top of Low-Perm Fill)

Figure 7. Final Site As-Built Survey

Figure 8. As-Built Location of Seven New Monitoring Wells

Figure 9. Final Site and As-Built Locations of Secondary Waste Trench and Miscellaneous VC Pipe

9.0 REFERENCES

SCDHEC 1999. Monitoring Well Approval #SF-99-044, October 5, 1999, South Carolina Department of Health and Environmental Control, Columbia, SC

WSRC 1994. *Investigation-Derived Waste Management Plan (U),* WSRC-RP-94-1227, Rev. 2, Westinghouse Savannah River Company Savannah River Site, Aiken, SC

WSRC 1997. *Groundwater Mixing Zone Application for the Old F-Area Seepage Basin (U),* WSRC-RP-97-39, Rev. 1, Westinghouse Savannah River Company, Aiken, SC

WSRC 1997a. *Record of Decision, Remedial Alternative Selection for the Old F-Area Seepage Basin (U),* WSRC-RP-96-872, Rev. 1, Westinghouse Savannah River Company, Aiken, SC

WSRC 1997b. *Corrective Measures Implementation/Remedial Design Work Plan for the Old F-Area Seepage Basin (U),* WSRC-RP-97-160, Rev. 1, Westinghouse Savannah River Company, Aiken, SC

WSRC 1998. *Explanation of Significant Differences to the Rev. 1.1 Record of Decision for the Old F-Area Seepage Basin (U)*, WSRC-RP-98-4123, Rev. 1, Westinghouse Savannah River Company, Aiken, SC

WSRC 1999. *Corrective Measures Implementation/Remedial Design Report/Remedial Action Work Plan for Old F-Area Seepage Basin (904-49G) (U)*, WSRC-RP-97-854, Rev. 1.2, Westinghouse Savannah River Company, Aiken, SC

APPENDIX A

Unit-Specific LUCIP for Old F-Area Seepage Basin (Bldg. 904-40G) (U)

LAND USE CONTROL IMPLEMENTATION PLAN (LUCIP)

The Old F-Area Seepage Basin (OFASB) (Bldg. 904-49G) LUCIP will be appended to the Savannah River Site (SRS) Land Use Control Assurance Plan (LUCAP), which has been approved by the United States Department of Energy (USDOE), United States Environmental Protection Agency (USEPA), and South Carolina Department of Health and Environmental Control (SCDHEC).

1.0 REMEDY SELECTION

The OFASB is a Resource Conservation Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) unit located within the SRS, approximately 600 feet north of F Area and 1 mile east of Road C. The Upper Three Runs Creek is located to the north of the basin. The water table is approximately 75 feet below ground surface in the area of the OFASB. Surface drainage is to the north toward Upper Three Runs Creek, which is 155 feet below the basin elevation.

The OFASB covers a total of 1.3 acres and is approximately 200 by 300 feet in dimension. An earthen berm in the interior divides the basin into two compartments. This unit also includes one effluent ditch line, which is located to the northwest corner of the basin leading toward Upper Three Runs Creek, and one process sewer line, which fed the basin at the southwest corner. The sewer line has an average depth of 9 to 10 feet below the land surface and is approximately 800 feet in length.

Between 1954 and mid-May 1955, approximately 9 to 14 million gallons of wastewater was discharged to the basin. The basin served as an unlined seepage basin for the purpose of reducing radioactive substance concentrations. Since 1955, the OFASB has received occasional discharges of cooling water and rainfall runoff. During a three-month period in 1969, spent nitric acid solution used to etch depleted uranium (from Building 303-M Operations) was discharged to the basin. Wastewater disposal was discontinued after the 1969 discharge.

The operable unit includes a source unit and a groundwater unit. The source unit comprises the basin and associated soil and vegetation, an adjacent ditch line and the sewer line.

The OFASB characterization revealed that surface and subsurface soils within the unit contained the highest concentrations of contaminants as well as contaminants with the highest potential risk. The remedial action selected in the OFASB Record of Decision (ROD) consisted of removal of contaminated vegetation; removal of the top 2 feet of soil from the effluent ditch line and placement into the basin; in situ grouting of the top 2 feet of the basin bottom, and placement of the soils in the basin. The OFASB was then backfilled and compacted. A low permeability engineered soil cover was then constructed over the basin area to eliminate radiation exposure and minimize potential future impacts to the groundwater beneath the OFASB.

Institutional controls will be used as the selected remedy for the waste process sewer line and the surrounding soils. These controls will restrict future use of this land to industrial applications and limit access to the soils. The selected remedy for groundwater is to maintain existing institutional controls and monitor the extent of the groundwater contaminant plume. The RAOs for this remedy are to achieve mixing zone contaminant limits (MZCLs) throughout the groundwater aquifer and not to exceed maximum contaminant levels (MCLs) at the compliance point as described in the approved groundwater mixing zone application. To implement the groundwater mixing zone demonstration, four compliance boundary wells, three intermediate wells, and the three existing MZCL wells have been utilized.

2.0 LAND USE CONTROL

For the OFASB, the following land use control (LUC) objective is necessary to ensure protectiveness of the remedy:

- Controlled access to the OFASB unit in accordance with the current site use/site clearance programs, including access controls to the sewer line by grouting the manholes and posting signs in the area to indicate that the sewer line and soil beneath the unit has been contaminated with radionuclides.

The elements of the institutional control corrective action, which consists of land restrictions without any engineering controls, are composed of deed notifications when the parcel is transferred from federal ownership (Section 2.1) and access controls comprising posting identification signs (Section 2.2) and field walkdowns and maintenance for general site conditions (Section 2.3). These LUCs will be implemented in perpetuity for this operable unit.

Each element of the institutional controls corrective action is discussed below.

2.1 Deed Notification

A deed notification shall be filed in the appropriate county records in accordance with CERCLA 120(h), which requires the government to create a deed when land on which any hazardous substance was stored, released, or disposed of is transferred to non-federal ownership. In the event the property is transferred, a deed notification will be filed with Aiken County. Per CERCLA 120(h)(3)(A), the deed shall contain, to the extent practical, such information as is available based on the complete search of agency files, including the following:

- A notice of the type and quantity of such hazardous substances
- Notice of the time at which such storage, release, or disposal took place
- A description of the remedial action taken, if any

Per CERCLA 120(h)(3)(B), the deed shall also contain a covenant warranting that

- All remedial action necessary to protect human health and the environment with respect to any such substance remaining on the property has been taken before the date of such transfer.
- Any additional remedial action found to be necessary after the date of such transfer would be conducted by the United States Government.

2.2 Access Controls

2.2.1 On-Site Workers

In accordance with WSRC ID, *Site Infrastructure and Services Manual,* Procedure 3.02, "Site Real Property Configuration Control," use of all lands and waters at SRS shall be coordinated via the Site Use Program. No use of land (i.e., excavation or any other land use) shall be undertaken without prior approval documented by a Site Use Permit. Also, in accordance with Procedure 3.02, all work at SRS that adds to or modifies features or facilities portrayed on SRS development maps (i.e., plot plans of facilities/utilities at SRS) will be authorized by a Site Clearance Permit before excavation activities take place. All Site Clearance Requests are reviewed to verify that either an approved Site Use Permit has been obtained or that an existing Site Use Permit has sanctioned the request.

Verification of US DOE approval for intended land use must be obtained before a Site Clearance Permit is issued. The site use and site clearance processes are applicable to all activities and personnel on site (including subcontractors). The processes are controlled within the SRS Quality Assurance Program.

SRS identifies all buildings and facilities on maps used in the Site Use/Site Clearance Program and requires a 200-foot buffer zone around each facility. This waste unit is identified on these maps as a CERCLA facility.

All work in these areas will be strictly controlled, and workers will be appropriately trained and briefed about health and safety requirements if work is deemed necessary for maintenance. Any changes in the use or disturbance of the OFASB will be cleared with the USEPA and SCDHEC before disturbance occurs. To prevent unknowing entry and to ensure that unrestricted use of the waste unit does not occur while under ownership of the government, identification signs have been posted at the unit. The signs are legible from a distance of 25 feet and located approximately every 100 feet along the process sewer line and at each manhole and each side of the basin in the area as shown in Figure 7, sheet 1 and 2. The signs read as follows:

Old F-Area Seepage Basin

"DANGER"
UNAUTHORIZED PERSONNEL KEEP OUT.
THIS UNIT WAS USED TO MANAGE HAZARDOUS SUBSTANCES. DO NOT DIG OR EXCAVATE. DO NOT ENTER WITHOUT CONTACTING THE WASTE SITE CUSTODIAN.
CUSTODIAN: MANAGER, POST-CLOSURE MAINTENANCE
PHONE: (803) 952-6882

Old F-Area Seepage Basin Process Piping

"DANGER"
UNAUTHORIZED PERSONNEL KEEP OUT.
THIS SUBSURFACE PIPING SYSTEM WAS USED TO CONVEY HAZARDOUS SUBSTANCES. DO NOT DIG OR EXCAVATE WITHOUT CONTACTING THE WASTE SITE CUSTODIAN.

CUSTODIAN: MANAGER POST-CLOSURE MAINTENANCE
PHONE: (803) 952-6882

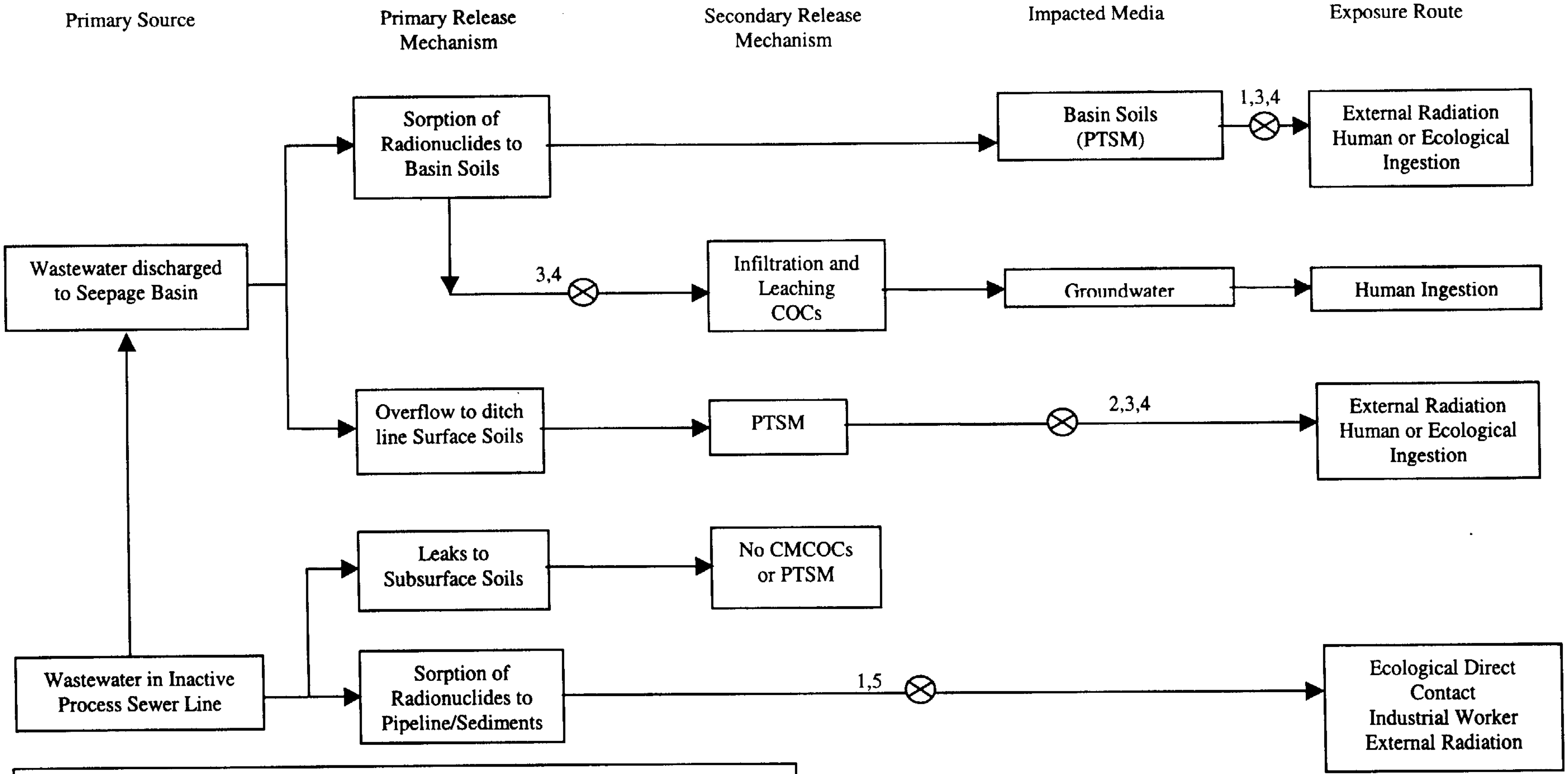
2.2.2 Trespassers

Additionally, while under the ownership of USDOE, access control of the entire SRS will continue to be maintained in accordance with the 1992 RCRA Part B Permit Renewal Application, Volume I, Section F.1. To comply with the security requirements for a RCRA-permitted facility, this section describes the 24-hour surveillance system (R.61-79.264.14(b)(1)), artificial or natural barriers (R.61-79.264.14(b)(2)(i)), control entry systems (R.61-79.264.14(b)(2)(ii)), and warning signs (R.61-79.264.14(c)) in place at the SRS boundary.

2.3 Field Walkdowns and Maintenance for Institutional Controls

Monitoring will be performed to verify that LUCIP requirements have been met. Semi-annual monitoring of the OFASB OU, 904-49G, will be conducted for accuracy and legibility of signs, visible subsidence or erosion of the waste unit, proper vegetative growth, burrowing animals, proper access to the facility, mowing, etc. Subsidence or erosion will be corrected by backfilling the affected area with clean soil and seeding the area to prevent further erosion. USEPA and SCDHEC will be notified of the results of any inspection, event, and/or action that indicates a potential compromise of institutional controls within 30 days of identification. The notification and the reason for the notification will be documented in the Federal Facility Agreement Annual Progress Report. All other routine maintenance activities (i.e., mowing, etc.) will be documented, and the documentation will be maintained in files that are subject to USEPA and SCDHEC review and audit. A copy of the completed inspection form will be maintained in Environmental Restoration Division administrative record files.

Inspections at the OFASB will be performed to ensure that institutional controls remain protective and consistent with all RAOs. Monthly inspections will be performed for the first 2 years and until permanent vegetation is established. After that time, inspections will be performed semi-annually per the inspection checklist.



LEGEND
→ = Pathways – past, current and hypothetical future
1. = Institutional Controls
2. = Consolidation of Soils into Basin
3. = In Situ Stabilization
4. = Low-permeability Soil Cover
5. = Grouting of manholes
⊗ = Remedy breaks this pathway

Notes: In Situ stabilization meets CERCLA preference for treatment and provides qualitative reduction in leachability.

PTSM = principal threat source material
COC = contaminant of concern
CMCOC = contaminant migration contaminant of concern

Figure A-1. Conceptual Site Model (CSM) for the Old F-Area Seepage Basin Post Remedial Action

APPENDIX A

ER INSPECTION CHECKLIST FOR OLD F-AREA SEEPAGE BASIN

Waste Site: ____________________ A = Satisfactory X = Unsatisfactory (Comments required)	A or X	Comments or Corrective Action Taken (See Maintenance Register for Corrected Items)
Check to see if the site needs mowing.		
Verify that the basin and roads are accessible.		
Check for potential encroachments. (Ensure that there is no building on the site.)		
Verify all signs are intact, in good condition, and legible from a distance of at least 25 feet.		
Visually check vegetative cover for grass density. There should be no woody vegetation or shrubs growing on the cover. The height of the vegetative growth should not impair the visual inspection of the site.		
Check the integrity of drainage ditches (if any) for presence of excessive erosion, sediment buildup, and any debris restricting water flow.		
Visually inspect the concrete markers at four corners of the basin to ensure their integrity. The concrete should be visible and free of damage.		
Visually check the basin cover for signs of erosion subsidence and/or depressions.		
Verify that conditions of the roads to the well sites are adequate.		
Inspect the grounds surrounding well sites for vegetation overgrowth, debris, and existence and/or development of erosion features.		

APPENDIX A

ER INSPECTION CHECKLIST FOR OLD F-AREA SEEPAGE BASIN (Cont'd.)

Waste Site: ____________ **A = Satisfactory** **X = Unsatisfactory (Comments required)**	**A or X**	**Comments or Corrective Action Taken (See Maintenance Register for Corrected Items)**
Verify that the well posts and protective covers are in place.		
Verify the well is properly identified per R.61-71.6H (South Carolina well standards and regulations).		
Verify the wells' casings are properly locked per R.61-71.11.C.6 (South Carolina well standards and regulations).		
Verify that the previous "Quarterly Monitoring Well Inspection Summary Report" has been sent to ERD Records Interim Storage. This report can be obtained from ERD Waste Treatment.		
Other		
Comments:		

Inspected By:________________ / ________________ Date:_______ Time:_______
(Print Name) (Signature)

Reviewed By:________________ / ________________ Date:_______ Time:_______
PM or Designee (Print Name) (Signature)

Note: USEPA and SCDHEC must be notified within 30 days of identification of any area where any breach or compromise of restrictions placed on this institutional control operable unit has occurred.

APPENDIX B

FIGURES

:OPY
;/CS

Figure 1

ROLINA
IZATION

SOUTH CAROLINA
REGISTERED
LAND
SURVEYOR
9049
TOMMIE M. DONALDSON, JR.

20 40 60

GRAPHIC SCALE IN FEET
1 inch = 20 ft.

AREA SEEPAGE BASIN
CONSTRUCTION SURVEY

PROJECT PE113607
CONTRACT NO. QB00229K

PREPARED FOR
VIRONMENTAL SERVICES, INC.
OF ENERGY – SAVANNAH RIVER SITE
SOUTH CAROLINA

DONALDSON, GARRETT & ASSOCIATES, INC.

4875 RIVERSIDE DR. MACON, GA. 31210
(912)474-5350 FAX:(912)477-2534

-D1	SHEET 1 OF 1
N	

F90EXA.DWG/20 PLOT DATE: 03/15/2000 BY: Jay

QB00229K-020-C-SE10

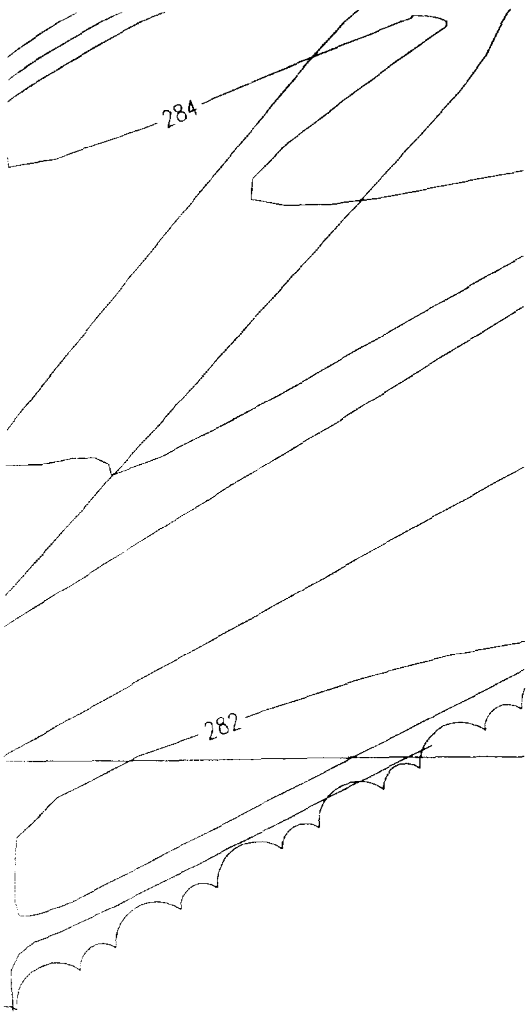


FIGURE 2

OLD F-AREA SEEPAGE BASIN
CLOSURE
BASIN CHARACTERIZATION
SAMPLE LOCATIONS

MLF6479

QB00229K-23-C

UNCONTROLLED COPY
ISSUED BY DCC/CS

Figure 3

20 0 20 40 80

GRAPHIC SCALE IN FEET
1 inch = 20 ft.

OLD F-AREA SEEPAGE BASIN
PRE-TREATMENT SURVEY

PROJECT PE113607
SRS SUBCONTRACT NO. QB00229K

PREPARED FOR
SEVENSON ENVIRONMENTAL SERVICES, INC.

U.S. DEPARTMENT OF ENERGY – SAVANNAH RIVER SITE
AIKEN COUNTY SOUTH CAROLINA

.S. NO. N/A	DSGN: N/A	DONALDSON, GARRETT & ASSOCIATES, INC.
AWING NO. 447-00-E	DRWN: JN	4875 RIVERSIDE DR. MACON, GA. 31210
	CHKD: JN	(912)474-5350 FAX: (912)477-2534
	APVD:	
TE: MARCH 20, 2000	PROJ. NO.: 5500-004-D1	SHEET 1 OF 1
ALE: 1" = 20'	FIELD BOOK: EDC/PSION	

QB00229K-023-C-SE10 F90ASB1A.DWG/20 PLOT DATE: 05/09/2000 BY: jay

1 of 7

Figure 4

20 0 20 40 60

GRAPHIC SCALE IN FEET
1 inch = 20 ft.

QB00229K-42-A

OLD F-AREA SEEPAGE BASIN
TOP OF SOLIDIFIED MASS

PROJECT PE113607
SRS SUBCONTRACT NO. QB00229K

PREPARED FOR
SEVENSON ENVIRONMENTAL SERVICES, INC.

U.S. DEPARTMENT OF ENERGY - SAVANNAH RIVER SITE
AIKEN COUNTY SOUTH CAROLINA

.L.S. NO. N/A RAWING NO. 453-00-E	DSGN: N/A DRWN: JN CHKD: JN APVD:	DONALDSON, GARRETT & ASSOCIATES, INC. 4875 RIVERSIDE DR. MACON, GA. 31210 (912)474-5350 FAX:(912)477-2534
ATE: APRIL 21, 2000	PROJ. NO.: 5500-004-D1	SHEET 1 OF 1
CALE: 1" = 20'	FIELD BOOK: EDC/PSION	

F90ASB2A.DWG/20 PLOT DATE: 05/09/2000 BY: joy

QB00229K-42-A

Figure 5

20 40 60

GRAPHIC SCALE IN FEET
1 inch = 20 ft.

-AREA SEEPAGE BASIN
TOP OF COMMON FILL (GRADING FILL) 5-22-02
PROJECT PE113607
UBCONTRACT NO. QB00229K

PREPARED FOR
NVIRONMENTAL SERVICES, INC.
OF ENERGY – SAVANNAH RIVER SITE
SOUTH CAROLINA

DONALDSON, GARRETT & ASSOCIATES, INC.
4875 RIVERSIDE DR. MACON, GA. 31210
(912)474–5350 FAX:(912)477–2534

4--D1
SION

SHEET 1 OF 1

F90ASB3A.DWG/20 PLOT DATE: 05/09/2000 BY: jay

ORIGINAL

20 40 60

GRAPHIC SCALE IN FEET
1 inch = 20 ft.

AREA SEEPAGE BASIN
OF OF LOW-PERM FILL

PROJECT PE113607
BCONTRACT NO. QB00229K

PREPARED FOR
NVIRONMENTAL SERVICES, INC.

OF ENERGY – SAVANNAH RIVER SITE
SOUTH CAROLINA

DONALDSON, GARRETT & ASSOCIATES, INC.

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–D1

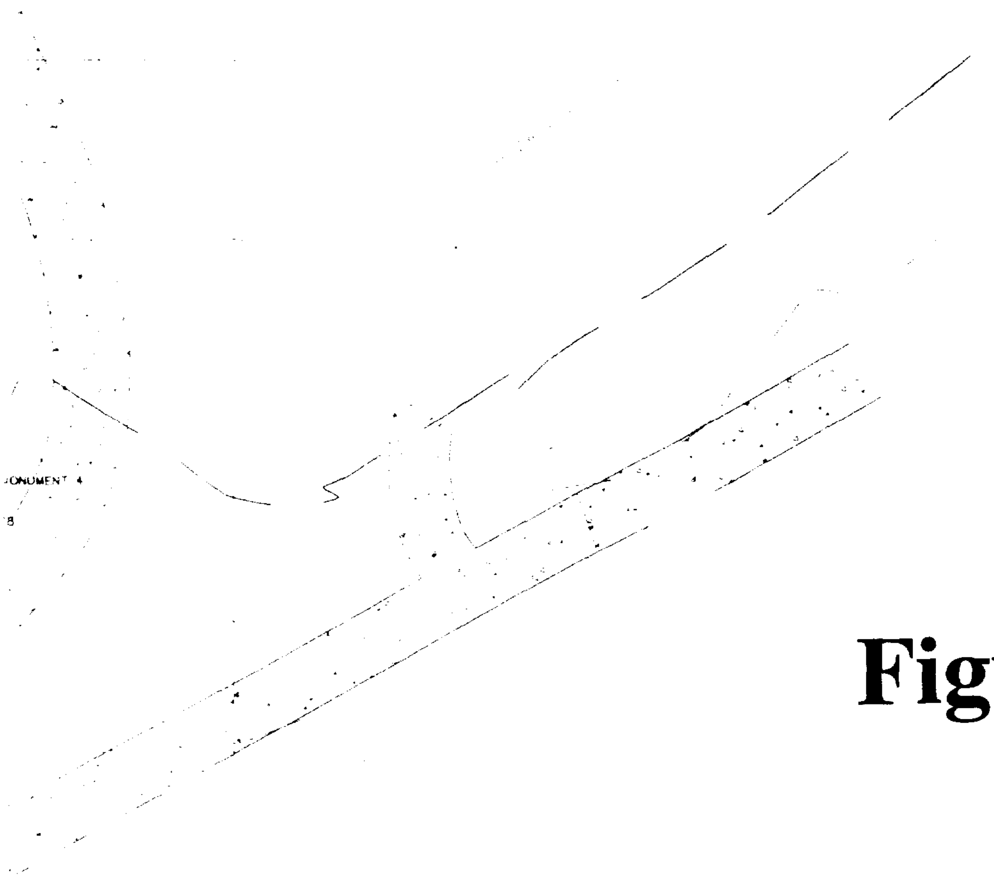
ON

SHEET 1 OF 1

F90ASB4.DWG/20 PLOT DATE: 05/25/2000 BY: joy

Figure 6

MONUMENT
SILT FENCE
MANHOLE
GRADE CONTROL POINT



CONTROL POINT 1
N=80369.56
E=54599.05
ELEV=282.46

Figure 7

20 0 20 40 60
GRAPHIC SCALE IN FEET

OLD F-AREA SEEPAGE BASIN
FINAL SITE AS-BUILT SURVEY

PROJECT PE113607
SRS SUBCONTRACT NO. QB00229K

PREPARED FOR
SEVENSON ENVIRONMENTAL SERVICES, INC.

U.S. DEPARTMENT OF ENERGY - SAVANNAH RIVER SITE
AIKEN COUNTY SOUTH CAROLINA

R.L.S. NO. N/A DRAWING NO. 457-00-E	DSGN: N/A DRWN: RAW CHKD: JN APVD:	DONALDSON, GARRETT & ASSOCIATES, INC. 4875 RIVERSIDE DR. MACON, GA. 31210 (912)474-5350 FAX:(912)477-2534
DATE: 06/14/ 2000	PROJ. NO.: 5500-004-D1	SHEET 1 OF 2
SCALE: 1" = 20'	FIELD BOOK: EDC/PSION	

F90ASB5.DWG/20 PLOT DATE: 08/02/2000 BY: joy

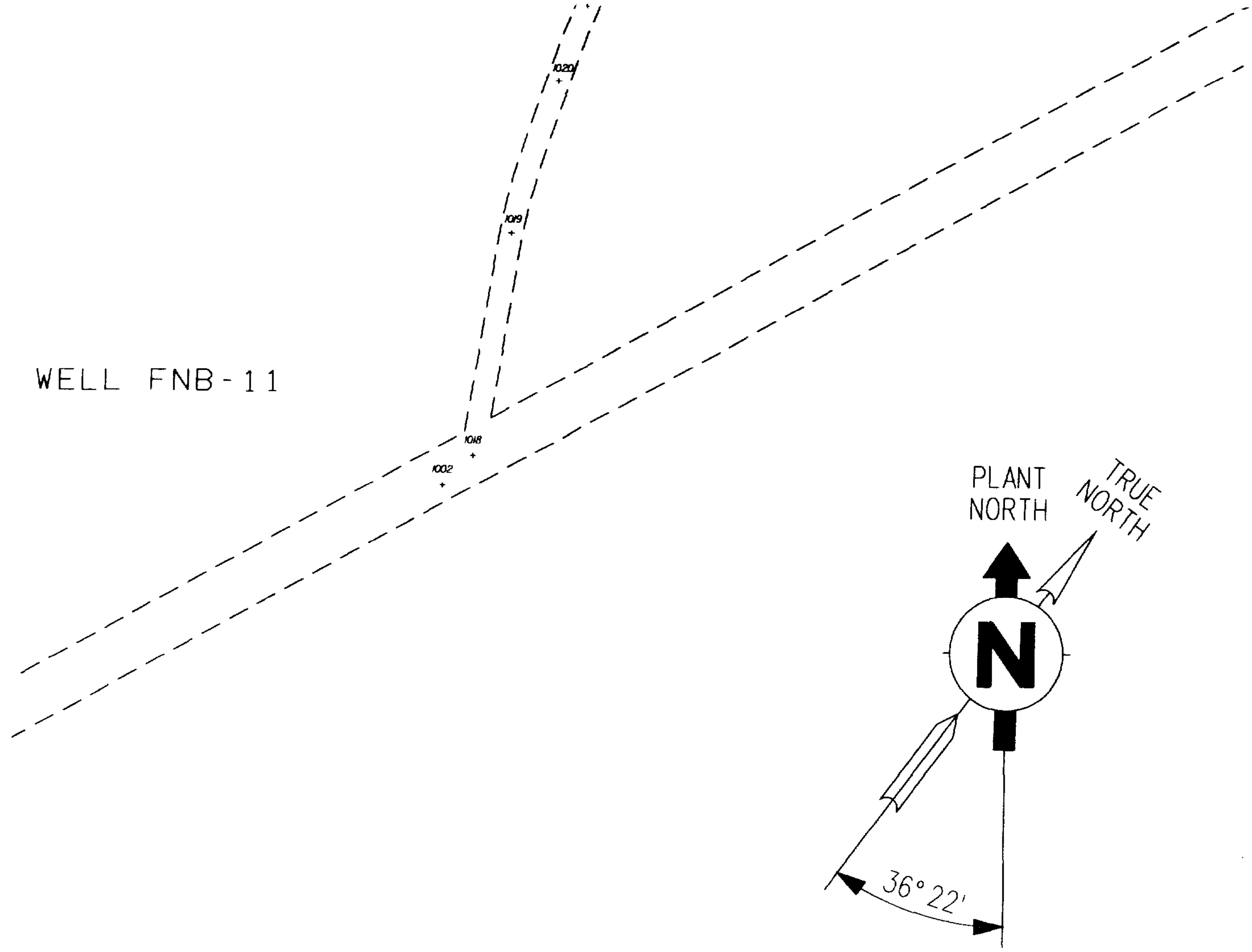


Figure 8

ATIONS OF SEVEN NEW MONITORING WELLS

T OF OLD F-AREA SEEPAGE BASIN

MLF648Ø

FROM F AREA

DETAIL 1

NOT TO SCALE

P Q R S T U V W X Y

'E:

·BUILT TOPOGRAPHIC INFORMATION SHOWN ON THIS FIGURE IS COMPILED FROM THE SEVENSON ENVIRONMENTAL
ℝVICES, INC FINAL SITE AS-BUILT SURVEY AND BSRI FIELD SURVEY DATA AND DRAWINGS.

FIGURE 9

IS DRAWING HAS BEEN FURNISHED BY THE SAVANNAH RIVER SITE. E INFORMATION AND KNOW HOW THEREON MAY NOT BE USED NOR THE AWING REPRODUCED WITHOUT WRITTEN PERMISSION OF THE PRIME NTRACTOR. ALL REPRODUCTIONS IN WHOLE OR IN PART, INCLUDING NDOR'S SHOP DRAWINGS, SHALL BEAR OR REFER TO THIS STAMP.

REFERENCE DRAWINGS

REFERENCE STANDARDS

UNITED STATES DEPARTMENT OF ENERGY

SAVANNAH RIVER SITE

BLDG. NO.	SITE CLEARANCE NO.	DESIGN AREA NO.	DESIGN GROUP
			PE&CD/ER

TITLE

OLD F AREA SEEPAGE BASIN CLOSURE

FINAL SITE AND AS BUILT LOCATION OF SECONDARY WASTE TRENCH AND MISCELLANEOUS VC PIPE (U)

SCALE	SRP DRAWING NO.	SHEET NO.	LATEST REVISION
AS NOTED	SK-C-5371	1 OF 1	0

555556666 567890123 PSC- PLOT DATE 4/25/01 TIME DRAWN BY (ORIG): W.R.BROWN DATE: LAST CADD REV. BY:

Scale shown on this drawing is only applicable when plotted at 30"x42" (actual drawing size)

008004

APPENDIX C

FACT SHEET

Old F-Area Seepage Basin (904-49G)
Pre-construction CERCLA Briefing Fact Sheet (U)

Objective

This fact sheet describes the Old F-Area Seepage Basin (OFASB) at SRS (Savannah River Site) and the actions that will be taken to remediate the basin. The fact sheet has been issued to the public to meet the regulatory requirements of the National Contingency Plan (NCP), which requires "the lead agency to issue a fact sheet and provide, as appropriate, a public briefing prior to the initiation of the remedial action" (300.435 (c) (3).

Location of the Facility

The OFASB is a Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act (RCRA/CERCLA) unit. The basin is located within SRS, approximately 600 feet north of F-Area and 1 mile east of Road C. Upper Three Runs Creek lies to the north of the basin.

The OFASB covers a total of 1.3 acres and is approximately 200 by 300 feet in dimension. An earthen berm in the interior divides the basin into two compartments. The basin unit also includes an overflow ditchline and a process sewer line. The ditchline is located at the northwest corner of the basin and leads toward Upper Three Runs Creek. The process sewer line, which fed the basin at the southwest corner, has an average depth of 9 to 10 feet below the land surface and is approximately 800 feet in length.

History

The OFASB served as an unlined seepage basin for the purpose of reducing radioactive substance concentrations. Between 1954 and mid-May 1955, approximately 9- to 14-million gallons of wastewater were discharged to the basin. Since 1955, the basin has received occasional discharges of cooling water and rainfall runoff. During a three-month period in 1969, spent nitric acid solution, used to etch depleted uranium, was discharged from Building 303-M Operations to the basin. Wastewater disposal to the basin was discontinued after the 1969 discharge.

Radioactive releases during operation of the basin are estimated at 1.8 curies (Ci) although due to natural radioactive decay, the present inventory is estimated at less than 0.8 Ci. Analytical data indicates that both radiological and non-radiological contaminants have had an impact on the soil media associated with the OFASB.

Remedial Action Description

The remedial actions for the OFASB unit will address three areas: the basin, the process sewer line, and the groundwater. In addition to the specific remedies selected for each area, institutional controls will be implemented. These controls will restrict future use of this land to industrial applications, as necessary, and limit access to the unit.

Basin

The remedial action selected in the Record of Decision (ROD) for the OFASB entails removal of contaminated, chipped vegetation from the site; removal of the top 2 feet of soil from the effluent ditchline and basin sidewall and placement in the basin; in-situ grouting of the top 2 feet of the basin bottom and the soils placed in the basin. Once in situ grouting has been completed, the chipped vegetation will be placed over the grouted soils, on top of the first clean, compacted, soil-fill layer. The OFASB will be backfilled and compacted to grade. A low permeability engineered soil cover will be constructed over the basin area to eliminate the risk of radiation exposure and minimize potential future impacts to the groundwater beneath the basin.

Process sewer line

Institutional controls and grouting will be used as selected remedies for the waste process sewer line. Institutional controls will consist of site-use and site-clearance permits as well as access controls to the pipeline and associated manholes. Signs will be posted at the waste unit to indicate that the area was used to dispose of waste material and contains buried waste. The pipeline manholes will be grouted to restrict access and eliminate the risk of exposure.

Groundwater

To effect adequate protection of the groundwater, the selected remedy for groundwater is installation of monitoring well network between the basin and the down gradient steam and initiation of groundwater sampling. An application for a groundwater mixing zone has been approved by the regulatory agencies.

Health Hazards Exposure to Off-Site Communities

There will be no health hazards posed to off-site communities as result of this remedial action.

APPENDIX D

DOE-SRS CORRESPONDENCE FOR THE START DATE

Department of Energy
Savannah River Operations Office
P.O. Box A
Aiken, South Carolina 29802

SEP 14 1998

Mr. K. A. Collinsworth, Manager
Federal Facility Agreement Section
Division of Site Assessment and Remediation
Bureau of Land and Waste Management
South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201

Mr. J. L. Crane
SRS Remedial Project Manager
Waste Management Division
Environmental Protection Agency, Region IV
61 Forsyth Street, SW
Atlanta, GA 30303

Dear Mr. Collinsworth and Mr. Crane:

SUBJECT: Notification of the Remedial Action Start for the Old F-Area Seepage Basin/ (904-49G)

This letter is to inform your agencies that the United States Department of Energy (US DOE) initiated the remedial action at the Old F-Area Seepage Basin (OFASB) on September 10, 1998. The Federal Facility Agreement Appendix D milestone for the remedial action start is September 19, 1998.

As of September 10, 1998, US DOE has been maintaining a continuous presence and ongoing actions at the OFASB. Currently, preparations for the actual remediation of the OFASB have been initiated as described in the Revision.1.1 Corrective Measures Implementation/Remedial Design Report/ Remedial Action Work Plan (CMI/RDR/RAWP). These actions include site preparation, staging of material and equipment, obtaining samples for the bench scale testing and preparations to conduct the field demonstration at the OFASB.

SEP 14 1998

As previously discussed and outlined in the Revision.1.1 CMI/RDR/RAWP, the actual stabilization of the OFASB will not proceed until your agencies have approved the Revision.1.2 CMI/RDR/RAWP.

US DOE will keep your agencies informed of the progress at the OFASB. We welcome and encourage you to visit the OFASB during this remedial action. The US DOE appreciates your cooperation in helping us achieve this remedial action start.

If you or your staff have any questions, please call me at (803) 725-7032.

Sincerely,

Brian T. Hennessey
Environmental Restoration Division
SRS Remedial Project Manager

BTH/HMH:ed
OD-98-455

c: A. B. Gould, DOE-ECD, 703-A
C. V. Anderson, DOE-ERD, 703-A
C. B. Warren, EPA-IV
J. L. Corkran, EPA-IV
S. A. Holt, Dynamac*
J. K. Lindler, SCDHEC-Columbia
J. T. Litton, SCDHEC-Columbia
G. K. Taylor, SCDHEC-Columbia
M. D. Sherritt, SCDHEC-Columbia
SRS Administrative Record Files (Palmer, 730-2B)*
*w/enclosures

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bc: T. F. Heenan, 703-A
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S. J. Carroll, 730-2B
G. H. Golshir, 730-2B
B. G. Schappell, 730-2B
J. M. Clark, 730-2B
B. K. Davis, 730-2B
M. T. Kasarii, 730-2B
J. A. Adams, 730-2B
L. H. Wells, 730-2B
G. F. Stejskal, 730-2B
T. W. Mickley, 730-2B
D. R. Earnhart, 730-2B
J. W. Cook, 742-A
M. P. Wilson, 742-A
EPD Files, 742-A (A. Odum)
ERD Files, 730-2B, Rm. 1000

APPENDIX E

EXPLANATION OF SIGNIFICANT DIFFERENCE FOR THE OLD F-AREA SEEPAGE BASIN

**EXPLANATION OF SIGNIFICANT DIFFERENCES
TO THE REVISION.1.1 RECORD OF DECISION
FOR
THE OLD F-AREA SEEPAGE BASIN**

Introduction

This Explanation of Significant Differences (ESD) is being issued by the Department of Energy (DOE), the lead agency for the Savannah River Site, with concurrence by the Environmental Protection Agency-Region IV (EPA) and South Carolina Department of Health and Environmental Control (SCDHEC) to announce changes in the remedial decision selected for the Old F-Area Seepage Basin (OFASB) waste unit. The waste unit is located northwest of the center of the Savannah River Site (SRS), in Aiken, South Carolina. The original remedy includes removal of contaminated vegetation from the basin and overflow ditchline, chipping the vegetation, and transporting the chipped vegetation off-unit for disposal. This ESD provides the rationale for disposing of the chipped vegetation on-unit. The result of this remedy change would: (1) reduce the overall cost of the remedial action by eliminating the costs for additional vegetation handling, transportation and disposal off-unit; (2) eliminate the unnecessary exposure risk to the workers handling, transporting, and unloading the vegetation for disposal at the off-unit facility, and; (3) preserve all remedial action objectives and remedial actions identified in the originally selected remedy.

The SRS is required by CERCLA Section 117 (c) to publish an ESD whenever there is a significant change to a component of the remedy identified in the Record of Decision (ROD). Section 300.435 (c)(2)(I) of the National Oil and Hazardous Substances Pollution Contingency Plan requires the lead agency to provide an explanation of the differences and to make the information available to the public in the Administrative Record and information repository. This ESD is available for public review during normal business hours at the following information repositories:

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

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

Summary of Site History, Contamination Problems, and Selected Remedy

The OFASB, which served as an unlined seepage basin, received 9 to 14 million gallons of low radioactive activity wastewater between November 1954 and mid-May 1955. Wastewater included overhead condensates from evaporates, laundry wastewater, non-reactor cooling water from F and H Areas, and possibly other chemicals.

Since 1955, the OFASB received occasional discharges of cooling waters and rainfall runoff. During a three-month period in 1969, spent nitric acid solutions used to etch depleted uranium (M Area operations) were discharged (via tanker truck) to the basin. Wastewater disposal was discontinued after the 1969 discharge. An estimated 1.8 curies (Ci) of radioactive activity was released to the basin during its use. Due to natural radioactive decay an estimated inventory of less than 0.8 curies remains. Releases to the basin of various non-radioactive chemicals also occurred during basin use. The inactive basin is currently fenced and open. Standing water is present during wet seasons. The trees and vegetation from the basin and overflow ditchline have been removed and chipped. The chipped vegetation is being stored on-unit at the OFASB in accordance with established SRS requirements.

Analytical data pertaining to OFASB indicates that radionuclide contaminated soils associated with OFASB are the principal threat wastes which pose risk to both the future resident and industrial worker.

These radionuclide risks are primarily associated with external radiation from the top two feet of the OFASB soils. Major contaminants include Cesium-137 and Mercury. Fifty-three percent (53%) of the Cesium –137 is found in the top two feet of soils and 97% of the Mercury is found in the top two feet of soil.

The groundwater monitoring data has also revealed that Iodine-129, Nitrate, Strontium-90, and Tritium are present in the groundwater above maximum contaminant levels (MCLs). Uranium has been detected above proposed MCLs. Although radium has been decreasing over time, it has also exceeded MCLs. The groundwater plume has been detected in eight local wells associated with the OFASB. The groundwater plume in the water table aquifer has migrated beyond the surface boundaries of the OFASB by more than 200 feet toward the Upper Three Runs Creek which is more than 2500 feet to the north of the OFASB.

Based on the risk analysis, the OFASB soils pose a significant risk to human health. Significant carcinogenic risk to the potential future resident and worker are driven by exposure from direct radiation from the basin soils contaminated with Cesium-137 to a depth of 0 to 2 feet (4,500 cubic yards) and overflow ditchline soils to a depth of 0 to 2 feet (167 cubic yards). Significant carcinogenic risks to the potential future resident are also driven by exposure from ingestion of groundwater contaminated with Iodine-129, Tritium, Strontium-90 and Radium-228 in the water table aquifer.

The approved remedy as stated in the Revision 1.1 ROD (March 1997) consists of: (1) off-unit disposal of vegetation removed and chipped from the basin and overflow ditchline; (2) in-situ grouting of basin and overflow ditchline soils and installation of a low permeability engineered soil cap; (3) groundwater controls using alternate concentration limits/mixing zone for remediation of the OFASB groundwater, and; (4) institutional control for the OFASB influent pipeline and pipeline soils.

The primary remedial action objectives (RAOs) for the OFASB operable unit that have a potential to be influenced by the disposition of chipped vegetation on-unit are as follows:

- Prevent external exposure to radiological constituents,
- Prevent inhalation of radiological constituents, and to
- Prevent or mitigate the release of constituents of concern to the groundwater.

Description of Significant Differences and the Basis for those Differences

Remedial Strategy:

The change in the originally approved remedy is to dispose of the vegetation from the basin and overflow ditchline on-unit in lieu of off-unit. All other remedial action remedies remain unchanged. The chipped vegetation is currently stored on-unit. Prior to and during production grouting of the basin soils the chipped vegetation will be handled and stored in accordance with established SRS requirements. After completion of grouting, the chipped vegetation will be placed on top of the first clean, compacted, soil fill layer placed over the in-situ grouted soils. The chipped vegetation (approximately 285 cubic yards) will be blended into the second lift of grading fill. The volume of the chips will be limited to approximately 15% of soil volume and will be uniformly spread over the compacted lift of grading fill. The blended material will be compacted prior to placement of additional fill material. Clean fill material will continue to be compacted in-place until the proper grade for a low permeability cap has been obtained. A low permeability engineered soil cap would then be constructed over the basin area to minimize surface infiltration and reduce the potential for contamination migration. This method of chip disposal will minimize potential of settlement especially uneven settlement that could result in cracking of the soil cover system. Attachment A shows a typical cross section of the disposed chips and associated constructed layers required to complete the basin closure.

Cost Effectiveness:

The following estimates have been made for the chipped vegetation disposal methods:

Original Remedy	Modified Remedy
Off-unit disposition of chipped vegetation at SRS E-Area Low Level Disposal Facility $ 123,000.	On-unit disposition of chipped vegetation $ 23,000.

The proposed remedy for disposition of chipped vegetation on-unit is cost effective. The original remedy considered several off-unit disposal options. All of the options for off-unit disposal require packaging, transportation, and off-loading of the chips at a SRS disposal facility. The review of these options has been on going since the vegetation has been chipped. Additionally, on-unit storage and handling costs have been expended during the investigation of viable off-unit disposal options. The extended period of time (approximately 12 months) involved in this determination negated any savings previously forecast for reducing handling and storage costs planned by immediate off-unit disposal. Regardless, the on-unit disposal method described in the Remedial Strategy section costs significantly less than the proposed off-unit option.

Prevention to Exposure or Inhalation of Radiological Constituents:

The on-unit disposal of chipped vegetation will be constructed to have approximately four (4) feet of clean soil over the top of the blended vegetation\soil compacted mixture. An analysis was performed to calculate the shielding effect of soil cover against Cesium -137, a source for gamma radiation, for H-Retention Basin (ECSD-SGS-95-0317, dated July 13, 1995). The calculations show that a 2 to 3 ft soil cover provides adequate safeguard against any external exposure from the gamma radiation source. For the OFASB, the major contaminants include Cesium-137 and Mercury. Cesium concentrations in the soil at OFASB are considerably less than the value analyzed for H-Retention Basin (1,345 pCi/g vs. 33,000 pCi/g). The radiological contamination identified in the chipped vegetation (e.g. Cesium 2.89 pCi/g) is much lower than the contamination levels detected in the OFASB soils. Hence, the proposed remedy for the disposition of chipped vegetation placed over the grouted matrix in a soil mixture will be effective in eliminating the direct radiation exposure hazards associated with the on-unit worker.

Prevent or Mitigate the Release of Constituents of Concern to Groundwater:

A low permeability engineered soil cap with a minimum thickness of 2 feet of compacted low-hydraulic conductivity soil (in-place saturated hydraulic conductivity of 1×10^{-5} cm/sec or less) is installed over the vegetation/soil mixture and compacted clean fill material. The cap will also have an upper surface with a slope to promote surface runoff and minimize surface erosion. A vegetative soil layer will be placed over the low permeability layer to support grass growth and will have the ability to survive and function with little or no maintenance. The surface slope will also promote runoff and minimize surface erosion. The design of this cap both reduces the risks associated with direct radiation exposure and minimizes future potential migration of contaminants to the groundwater.

To further analyze the potential impact of adding the chipped vegetation under the engineered cap, transport and risk modeling was performed using a computer-based program called RESRAD. The program calculated groundwater concentrations for specified times in the future based on various hydrogeologic properties of the unsaturated and saturated zones. The estimated groundwater concentrations were compared to appropriate maximum contaminant levels (MCLs). Only three constituents were estimated to appear in groundwater within 1,000 years: Carbon-14, Iodine-129, and Technetium -99. None of these constituents had estimated groundwater concentrations exceeding their MCLs, or if MCLs were not available, their risk-based activities (RBAs). Therefore the addition of the chipped vegetation in the proposed configuration meets the RAO to prevent or mitigate the release of constituents of concern to the groundwater.

Conclusion:

Disposing of the chipped vegetation on-unit will not reduce the overall effectiveness of the selected remedy. Rather, the selected change in the ROD to dispose of contaminated vegetation on-unit will: (1) reduce the overall cost of the remedial action; (2) eliminate the unnecessary exposure risk to the workers handling, transporting, and unloading the vegetation for disposal at the off-unit facility, and; (3) preserve all applicable RAO and remedial actions identified in the original ROD.

Support Agency Comments

Comments were received from USEPA, Letter to Mr. Brian Hennessey, FFA Project Manager, from Julie L. Corkran, RPM, USEPA, dated August 13, 1998. The primary comments from USEPA were to provide additional information to clarify the basis for the remedy change and the cost and implementability differences, establish that the change does not impact the protectiveness of the remedy, and respond to any contradictory positions previously taken by DOE.

The comments were reviewed and incorporated as appropriate in this Explanation of Significant Differences to the Revision 1.1 Record of Decision.

Affirmation of the Statutory Determinations:

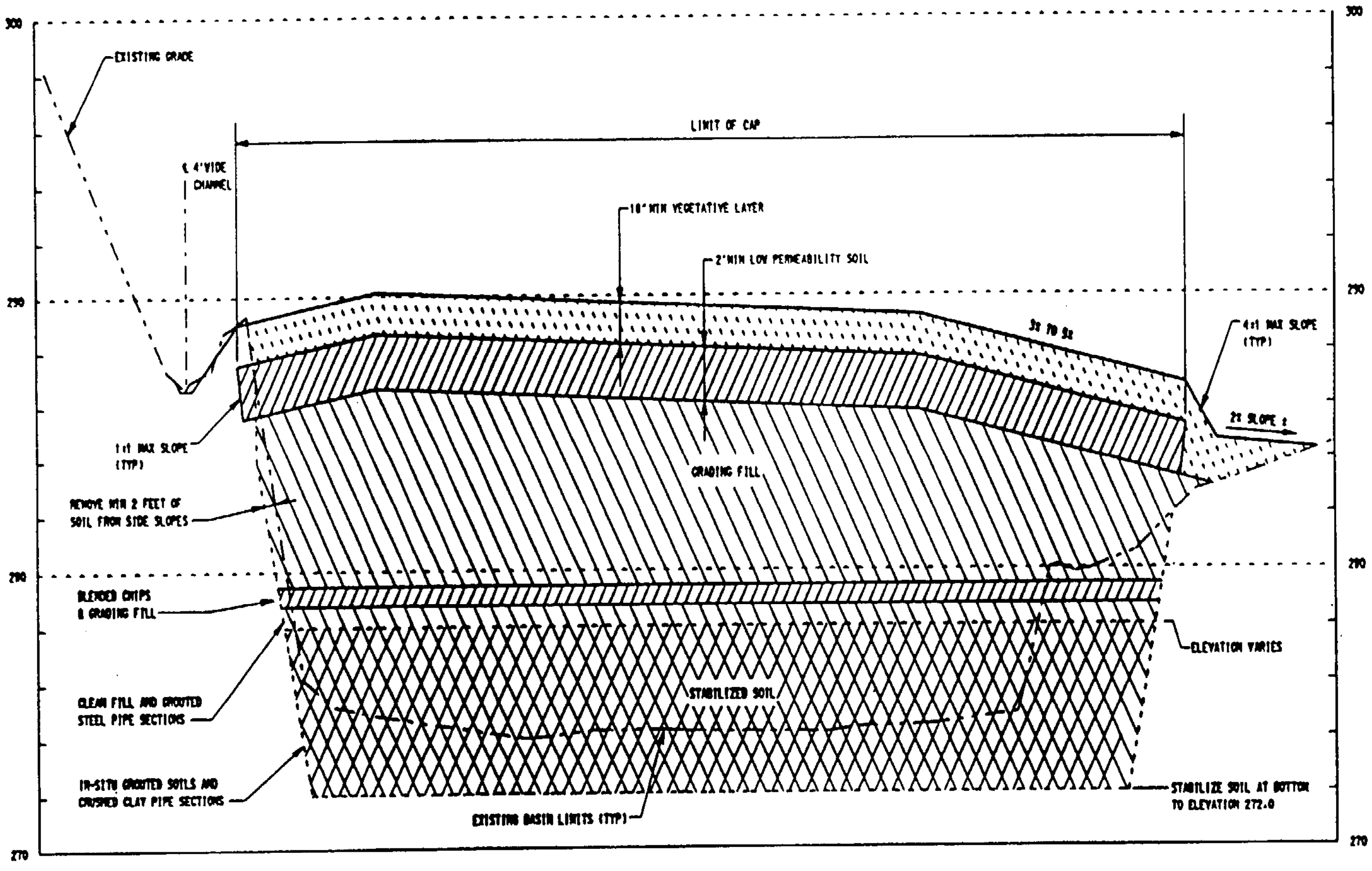
Considering the information that has been provided, DOE believes the changes that have been made to the selected remedy remains protective of human health and the environment, complies with federal and state requirements that were identified in the Revision 1.1 ROD and this ESD as applicable or relevant and appropriate to this remedial action, and is cost effective.

Public Participation Activities

The public will be informed of the changes in the selected remedy as specified in this document through public notices in the *Barnwell People Sentinel/Allendale Citizen Leader, Aiken Standard, Augusta Chronicle, and The State.*

ATTACHMENT A
SKETCH SHOWING THE CROSS-SECTION OF THE COVER SYSTEM OVER OFASB

008004



TYPICAL SECTION

APPENDIX F

PROJECT COST

Table F1. Old F-Area Seepage Basin Excavation, In-Situ Grouting, Vegetation Disposition, and Capping CMS/FS vs. Actual and Forecast To-go Cost Comparison

	CMS/FS[1] Costs ($)	RA[2] Costs ($)
Direct Capital Costs:		
Site Work		
Work Plan(s)	20,000	149,737
Mobilization/Demobilization	20,000	129,738
Decon	20,000	----
Excavation-Effluent Ditchline soils	3,000	112,816
Gamma Scan	1,000	----
In-Situ Grouting		
Labor & Materials	425,000	2,807,261
Capping (Low Permeability Soil Cover) Basin	730,800	584,008
Vegetation Disposal (ESD)	123,000	23,000
Estimated/Actual Direct Capital Costs	**1,342,800**	**3,806,560**
Annual O&M Cost:		
Cover System		
Inspection	6,000	6,000
Subsidence Monitoring	1,000	----
Mowing	6,000	6,000
Cover Repair	1,000	2,000
Estimate Annual Operating and Maintenance Cost	14,000	14,000
Present Worth O&M Cost (30Yrs., i=7%) Present Worth Factor 12.409	173,726	173,726
Present Worth Remedy Review Cost (Table 3)	215,780	215,780
Total O&M Cost	**389,506**	**389,506**
Total Present Worth Cost	**1,732,306**	**4,194,065**

1. Estimated costs obtained from Corrective Measures Study/Feasibility Study Report (CMS/FS) WSRC-RP-95-385, Rev. 1. Discount rate was changed from i=5% to i=7%. Vegetation disposition estimate is from the ESD for the Rev.1.1 ROD for the OFASB WSRC-RP-98-4123 Revision 1, September 1998.
2. Remedial action (RA) contract costs incurred and estimated annual O&M costs. Total direct contract costs of $3,806,559 were awarded as a fixed price. Distribution of costs are based on a SRS approved contractor spend plan. Costs do not include pending or future subcontractor claims for work completed. All claims are negotiated to conclusion.

Table F2. Old F-Area Seepage Basin Groundwater Mixing Zone – CMS/FS vs. Actual and Forecast To-Go Cost Comparison

Item	CMS/FS[1] Costs ($)	RA[2] Costs ($)
Direct Capital Costs:		
Site Work		
Work Plan(s)	20,000	18,000
Mobilization/Demobilization	10,000	----
Decon	5,000	----
Modeling	100,000	100,000
Well Installation	80,000	89,704
Estimated/Actual Direct Capital Costs	**215,000**	**207,704**
Annual O&M Cost:		
Capping		
Analysis	19,200	19,200
Sampling	1,600	1,600
Quarterly Report	3,000	30,000
Estimate Annual Operating and Maintenance Cost	50,800	50,800
Present Worth O&M Cost (30Yrs., i=7%) Present Worth Factor 12.409	630,377	630,377
Present Worth Remedy Review Cost (Table F3)	215,780	215,780
Total O&M Cost	846,157	846,157
Total Present Worth Cost	**1,061,157**	**1,053,861**

1. Estimated costs obtained from Corrective Measures Study/Feasibility Study Report (CMS/FS) WSRC-RP-95-385, Rev. 1. Discount rate was changed from i=5% to i=7%.
2. Remedial action (RA) work plan(s) and well installation are direct costs incurred. Modeling activities are pending and remains as an estimate. Annual O&M costs are estimates.

Table F3. Remedy Review Cost (Every 5-Years)

Remedy Review			CMS/FS Costs ($)	RA Costs ($)
Agency Reporting Every 5 years, $100,000				
	Year	PWF (7%)		
	5	0.7131		
	10	0.5083		
	15	0.3625		
	20	0.2584		
	25	0.1842		
	30	0.1314		
		2.1578		
Remedy Review Present Worth Cost 30 years, i=7%			**215,780**	**215,780**