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FEASIBILITY STUDY/CORRECTIVE MEASURES STUDY FOR SITE 1 INCINERATOR LANDFILL AND SITE 41 FORMER INCINERATOR UNIT MCRD PARRIS ISLAND SC
1/11/2002
TETRA TECH NUS

Feasibility Study/ Corrective Measures Study

for

Site/SWMU 1 - Incinerator Landfill and SWMU 41 - Former Incincerator Unit

Marine Corps Recruit Depot

Parris Island, South Carolina

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

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FEASIBILITY STUDY/ CORRECTIVE MEASURES STUDY FOR SITE/SWMU 1 - INCINERATOR LANDFILL AND SWMU 41 - FORMER INCINERATOR UNIT

MARINE CORPS RECRUIT DEPOT PARRIS ISLAND, SOUTH CAROLINA

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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ACRONYM LIST

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
ARAR	Applicable or Relevant and Appropriate Requirement
AWQC	Ambient Water Quality Criteria
BAP	benzo(a)pyrene
bgs	below ground surface
CAA	Clean Air Act
CAMU	Corrective Action Management Unit
CAOs	Corrective Action Objectives
CCME	Canadian Council of Ministers of the Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
cm/sec	centimeters per second
CMS	Corrective Measures Study
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CTO	Contract Task Order
CWA	Clean Water Act
DDD	p,p'-dichlorodiphenyl dichloroethane
DDE	p,p'-dichlorodiphenyl dichloroethylene
DDT	p,p'-dichlorodiphenyl trichloroethane
DDTR	The sum of DDD, DDE, and DDT
DOD	Department of Defense
DOT	Department of Transportation
E.O.	Executive Order
ERA	ecological risk assessment
ER-L	Effects Range-Low
ER-M	Effects Range-Medium
ESVs	Ecological Screening Values
FDEP	Florida Department of Environmental Protection
FS	Feasibility Study
GRAs	general response actions
HHRA	human health risk assessment
HQ	Hazard Quotient

HSWA	Hazardous and Solid Waste Amendments of 1984
IAS	Initial Assessment Study
ILCR	incremental lifetime cancer risk
IR	Installation Restoration
LDRs	Land Disposal Restrictions
LLDPE	linear low-density polyethylene
LUCs	Land Use Controls
LUCAP	Land Use Control Assurance Plan
LUCIP	Land Use Control Implementation Plan
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MCRD	Marine Corps Recruit Depot
mg/kg	milligrams per kilogram
MHSPE	Ministry of Housing, Spatial Planning, and Environment
msl	mean sea level
MSWLF	Municipal Solid Waste Landfill
NAAQS	National Ambient Air Quality Standards
NAVFAC	Naval Facilities Engineering Command
Navy	United States Navy
NCP	National Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutant
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observed adverse effect level
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standards
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PAHs	polynuclear aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PELs	Probable Effects Levels
PPE	personal protective equipment
ppm	parts per million
PRG	Preliminary Remediation Goal
PVC	polyvinyl chloride
R.	regulation

RAOs	Remedial Action Objectives
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RGO	Remedial Goal Options
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SDWA	Safe Drinking Water Act
SMCL	Secondary Maximum Contaminant Level
SOUTHDIV	Southern Division
SOUTHNAVFAC	Southern Division Naval Facilities
SSLs	Soil Screening Levels
SVOCs	semivolatile organic compounds
SWDA	Solid Waste Disposal Act
SWMU	Solid Waste Management Unit
TBC	to be considered
TDS	total dissolved solids
TEF	toxicity equivalent factors
TELs	Threshold Effects Levels
TSCA	Toxic Substance Control Act
TSD	treatment, storage, and disposal
TtNUS	Tetra Tech NUS, Inc.
U.S. EPA	United States Environmental Protection Agency
U.S.C.	United States Code
USFWS	United States Fish and Wildlife Service
UST	underground storage tank
UXO	unexploded ordnance
VOCs	volatile organic compounds
yd^3	cubic yard

RESPONSE TO REGULATORY COMMENTS TO THE DRAFT FS/CMS FOR SITE/SWMU 1 AND SWMU 41

USEPA COMMENTS ON DRAFT FEASIBILITY STUDY/CORRECTIVE MEASURES STUDY SITE/SWMU 1 - INCINERATOR LANDFILL AND SWMU 41 FORMER INCINERATOR MARINE CORPS RECRUIT DEPOT PARRIS ISLAND, SOUTH CAROLINA EPA ID#: SC6170022767

Specific Comments:

1. **Comment:** Page 1_1, Section 1.2, 1st Paragraph, 1st and 2nd Sentences. The CERCLA/SARA regulatory framework is generally referred to being applicable to past releases of hazardous substances, in part to distinguish this program from RCRA requirements for hazardous waste. Please rephrase this text to clarify this distinction.

Response: Agreed. The phrase ..."past hazardous waste operations and past hazardous materials spills"... will be revised to ..." release of hazardous substances"....

2. **Comment:** Page 2_2, Section 2.2, 1st Paragraph, 1st Sentence. Specify that the borings installed during the RI/RFI were around the perimeter of the site. This will help clarify the approximate depths on the cross_sections.

Response: Agreed. The following will be added at the second sentence. " These wells and boring were installed around the perimeter of the site."

3. **Comment:** Page 2_3, Section 2.2, 1st Paragraph, 3rd Sentence. Please clarify that the topographic low areas are the surrounding tidal creeks.

Response: Agreed. The sentence will be modified as follows. ... toward the topographical low areas "(surrounding tidal streams)"....

4. **Comment:** Page 2_3, Section 2.2, 3rd Paragraph. Add a statement to this paragraph that the Floridian Aquifer generally flows toward the coast, and that there are no private or municipal groundwater wells between Site 1 and the coast.

Response: There is insufficient information on the properties of the Floridan Aquifer in this area to make this statement. The Master Work Plan for the site indicates that the Floridan Aquifer from this area may flow toward the southeast to southwest, but the flow direction may be influenced by a significant user to the south.

5. **Comment:** Page 3_11, Section 3.2.3. Add the CERCLA Off Site Rule to the Action_Specific ARARs for off site disposal of CERCLA waste.

Response: The following statement will be added to the first bullet on Page 3-12. "In addition, the offsite landfill must be in compliance with it's permit (CERCLA Offsite Rule)."

6. **Comment:** Pages 3_19 through 3_22, Section 3.4. The discussion presented for the media of concern is presented relative to implementation of a containment alternative. Selection of the appropriate response action has not taken place. The relative impact of the no action and removal alternatives should be presented for the media of concern as well, or the text revised not to discuss response actions. Pathways and interactions between media should be discussed further.

Response: The discussion of the presumptive remedy in this section is presented to clarify site characterization data that is or is not available and is included in response to previous team comments. The discussion does not presume that a response action has been selected. The discussion on the impact of the alternatives is presented in Section 5.0 of the report.

7. **Comment:** Page 3_23, Section 3.5, 1st Paragraph, 1st Sentence. The rationale for not identifying COCs in surface water should be presented (e.g., none were present, a transient media that will be addressed through the sediment. response action, etc.).

Response: The following statement will be added. As discussed in Section 3.4, because of the transient nature and presence of only minor contamination, surface water and groundwater COCs will be addressed via soil and sediment actions.

8. **Comment:** Page 3_23, Section 3.5.1, 2nd Paragraph. Please include/cite the reference used for TEFs. The same comment applies to the soil COCs.

Response: The following reference will be added to these two paragraphs.

U.S. EPA (United States Environmental Protection Agency). 1995. Supplemental Region 4 Guidance to RAGS: Human Health Risk Assessment. Atlanta, GA, November.

9. **Comment:** Pages 3_24 and 3_25, Section 3.5.2. Clarify whether references in the text to sediment exposure and sediment COCs are intended to refer to soil.

Response: Agreed. The two references to sediment will be changed to soil.

10. **Comment:** Page 3_26, Section 3.7, 1st Paragraph, 1st Sentence. Present the rationale for selecting sediment and soil media for development of RGOs (i.e., the primary impacted media requiring a response action, and the response action is considered to be protective of pathway media as well).

Response: Agreed. The first sentence will be revised as follows. "As discussed in Section 3.4, RGO were selected to aid in assessing impacted soils and sediments. These two media are the most impacted at the site, and addressing these will address other potentially impacted media including surface water and groundwater."

11. **Comment:** Page 3_26, Section 3.7, 2nd Paragraph, 3rd and 4th Sentences. Elaborate how HHRA risk drivers were identified and why these were the only COCs selected for RGOs. Also, clarify the process that may subsequently identify additional COCs. Generally, the COCs and related risks requiring action are established in the FS, and are not subject to further revision.

Response: Agreed. The second half of the 3rd sentence and the 4th sentence will be deleted. The COC presented are the final COCs.

12. **Comment:** Page 4_2, Section 4.2.1, 1st Paragraph. To be consistent with subsequent sections, it should be stated that no action does not reduce the volume, mobility or toxicity of the contaminants and may eventually result in a larger area becoming contaminated through mass wasting processes.

Response: The following sentence will be added. "The no action alternative does not reduce toxicity, mobility, or volume. However, in the long term, contaminants may detoxify, become immobilized, migrate, and/or impact additional media in the future. Associated risks would be unknown."

13. **Comment:** Page 4_2, Section 4.2.3, 1st Paragraph, 2nd Sentence. Tidal/wave action should be added to the list of primary transport mechanisms.

Response: Tidal/wave action is considered in the surface water and erosion mechanisms, but as requested will also be listed separately.

14. **Comment:** Page 4_6, Section 4.5.1.2, 4th Paragraph. Discussion should be added regarding in perpetuity costs associated with this technology. Since Site 1 includes COCs with slow natural degradation rates, the necessary duration for implementing this technology is long. While it is recognized that present worth is the cost basis used for the FS, making costs beyond 30 years relatively insignificant, recent analysis by the General Accounting Office (http://www.gpo .ucop.edu/cgi_bin/gpogate? waisdoc= 1&doctype=TEXT&docid= ::::0+ 83099+/diskb/wais/data/gao /d01441.txt&server=gao/ wais.access.gpo.gov) suggests these costs may be a significant consideration for the lead agency.

Response: This type of discussion is too detailed for this section of the FS, especially since the costs are only listed as low, medium, or high. Rather, this type of discussion will be added as a new uncertainty discussion presented under Section 6.2.9 and include the following.

"The cost estimates presented in this section are based on several assumptions and include the following.

The estimate for leaving waste on site assumes that operation and maintenance costs remain constant for 30 years. Actual costs may be higher or lower based on the results of the groundwater monitoring, effectiveness of the cap in containing wastes, and the long term degradation and/or stability of the contaminants present. In addition, MCRD Parris Island will be responsible for maintaining the integrity of the landfill beyond 30 years. Costs beyond 30 years are not factored into Feasibility Studies.

The cost estimate for off site disposal assumes that 1% of the waste materials will need to be segregated and treated prior to disposal. The actual percentage of waste requiring treatment prior to disposal may be higher or lower.

The cost estimate for off site disposal assumes that the MCRD Parris Island will have no future liability for wastes taken off site. In the event that the private offsite landfill is not ability to maintain the integrity of the landfill, MCRD Parris Island may be required to again address these wastes, as well as potentially wastes disposed of by other generators."

15. **Comment:** Page 4_7, Section 4.5.1.3.1, 2nd Paragraph. The duration of the multilayer cap relative to the persistence of the COCs should be considered as part of the effectiveness evaluation.

Response: Reliable information on this concept is not available and as a result no changes are planned for the FS. The toxicity of most of the contaminants would be expected to dissipate with 20 to 200 years. The covered synthetic liners and clay are expected to be stable for longer periods of time. However, this issue is the same for all alternatives considered, including on site and off site landfills.

16. **Comment:** Page 4_7, Section 4.5.1.3.1, 4th Paragraph. As stated in Specific Comment 14, additional discussion of the long_term costs should be added.

Response: This type of discussion is too detailed for this section of the FS, especially since the costs are only listed as low, medium, or high. Rather, this type of discussion will be added as a new uncertainty discussion presented under Section 6.2.9.

17. **Comment:** Page 4_8, Section 4.5.1.3.2, 1st Paragraph. The expected or required duration for containment requiring slope stabilization and erosion control measures should be presented. Based on this, a design storm event return period can be established. The necessary elevation and extent of erosion control measures can then be established.

Response: The necessary elevation and extent of erosion control measures will be developed in the Remedial Design. Site 1 is located within the 100 year flood plan, but is not identified in an area of “flood with velocity (wave action)”. See page 2-23 of the Master Work Plan, Volume 1.

18. **Comment:** Page 4_11, Section 4.5.1.4.2, 1st Paragraph. Add text stating that current off site facility approval for CERCLA waste disposal also is required.

Response: Agreed.

19. **Comment:** Page 4_11, Section 4.5.1.4.2, 2nd through 4th Paragraphs. Additional specificity regarding the local availability of appropriate disposal facilities, the distance(s), and tipping fees should be included to fully evaluate the viability of this technology.

Response: The availability of local off site landfills is a cost issue and is addressed in more detail in Sections 5.0 and 6.0. For Section 4.0, and the type of cost evaluation presented, (i.e. low, medium, and high), this level of detail is not required. One local landfill (less than 50 miles) and several regional landfills (less than 500 miles) have been identified.

20. **Comment:** Page 4_13, Section 4.5.2.2, 5th Paragraph. As noted in Specific Comment 14, additional discussion of the significance of long term_costs should be added.

Response: For an FS, the cost issues are generally limited to 30 years. The cost for monitoring and maintenance beyond 30 years is uncertain, and when evaluated using a present worth consideration, relatively insignificant.

21. **Comment:** Page 4_16, Section 4.5.2.5.1, 3rd Paragraph, 5th Sentence. Delete the word "Potentially" from this statement; land use controls would be required.

Response: Agreed.

22. **Comment:** Page 4_17, Section 4.5.2.5.2, 2nd through 4th Paragraphs. See specific Comment 19.

Response: The availability of local off site landfills is a cost issue and is addressed in more detail in Sections 5.0 and 6.0. For Section 4.0, and the type of cost evaluation presented, (i.e. low, medium, and high), this level of detail is not required.

23. **Comment:** Page 4_20, Section 4.7.2, 2nd Bullet. Reword this statement to clarify it is monitored natural attenuation, and that it also applies to Arsenic contaminated sediments.

Response: The statement will be reworded to indicate that the remedy is “monitored natural attenuation for PAHs”.

Arsenic is not generally subject to natural attenuation processes, and monitoring is not being proposed for this area. The arsenic contaminated sediments were not found to present a current risk to human health or ecological receptors. The only identified concern with this area would be in the event that housing units were constructed in the marsh area and people lived in close contact with the sediment for long periods of time.

24. **Comment** Page 5_2, Section 5.1.2, 2nd Bullet. See Specific Comment [33].

Response: The statement will be reworded to indicate that the remedy is “monitored natural attenuation for PAHs”.

Arsenic is not generally subject to natural attenuation processes, and monitoring is not being proposed for this area. The arsenic contaminated sediments were not found to present a current risk to human health or ecological receptors. The only identified concern with this area would be in the event that housing units were constructed in the marsh area and people lived in close contact with the sediment for long periods of time.

25. **Comment:** Page 5_4, Section 5.1.2, 2nd Paragraph. Please specify that a monitoring plan will be submitted as part of the Remedial Action Report.

Response: The following sentence will be added to the paragraph. "Additional details would be developed during the remedial design and remedial action."

26. **Comment:** Page 5_5, Section 5.1.2, 4th Paragraph, 2nd Sentence. Clarify what groundwater monitoring program is being referred to since this would be a pre_construction decision.

Response: The decision would be a post construction decision, and based on the results of the groundwater monitoring program.

27. **Comment:** Page 5_6, Section 5.1.2, 3rd Paragraph. As stated in Specific Comment 17, the design storm event should be established in order to determine the type and extent of slope stabilization and erosion control necessary.

Response: The design storm event is determined during the remedial design phase.

28. **Comment:** Page 5_6, Section 5.1.2, 4th Paragraph. Please add text indicating that sinuous drainage ways will be included in the final grading plan for denuded sediment excavation areas.

Response: The type and number of drainage ways will be defined in the remedial design.

29. **Comment:** Page 5_7, Section 5.1.2, 1st and 3rd Paragraphs. Clarify that the frequency for long_term monitoring of groundwater and sediment is expected to be annual after the first year. Also, clarify the inspection and monitoring frequency anticipated for the landfill cap. It would be expected that inspections would be conducted following major storm events and quarterly for at least the first five years.

Response: The wording presented in the FS is intentionally vague. The monitoring and frequency requirements will be determined during preparation of the long term monitoring work

plan. The intent of the FS is to only provide general guidelines, and to present the basis for the cost estimate.

30. **Comment:** Pages 5_10 through 5_12, Section 5.1.3. Specific Comments 26 through 29 also are applicable to the corresponding elements of Alternative 2b.

Response: Acknowledged. Responses will be similarly incorporated.

31. **Comment:** Page 5_14, Section 5.1.4, 4th Paragraph, 6th Sentence. It is recognized that including 10 percent hazardous waste in the disposal volume is a contingency planning measure, but this may be overly conservative. If this volume of hazardous waste were present, the RI would have had more indication of its presence. One percent may be more realistic since any potentially hazardous waste would likely be segregated prior to disposal. Changing this assumption would save approximately $1,000,000 on the cost estimate for this alternative.

Response: The estimate provided is somewhat conservative based on limited characterization of the waste material at the site. The actual percentage of waste that would be classified as hazardous would only be determined during an excavation.

Although, as evidenced by the lack of significant groundwater contamination and the length of time that materials have been present and subject to weathering, it is likely that any excavated wastes excavated would not be classified as hazardous waste. As such, the estimate will be revised to reflect a 1% assumption for the percentage of hazardous waste. However, because of the uncertainty, the estimate assuming 10% hazardous waste will remain in the Appendix and also be referenced in footnote to the cost summary table. Please note that costs at offsite landfills vary significantly over time based on availability and regulatory requirements.

32. **Comment:** Page 5_14, Section 5.1.4, 5th Paragraph. See Specific Comment 28 regarding the installation of sinuous drainage ways in the denuded excavation areas.

Response: The type and number of drainage ways will be defined in the remedial design.

33. **Comment:** Page 5_18, Section 5.2.5.5, 1st Paragraph, 4th Sentence. Use of a 30_year basis for calculation of present worth costs is an acceptable approach. In addition to this the FS should specify the design life of the containment system based on the expected duration of COC degradation to acceptable concentrations (i.e., 50 years versus 500 years). This information will

allow the lead agency to better evaluate real long_term costs and restrictions of the containment alternatives.

Response: Acceptable concentrations in media are based on matrix, pathway, stability, toxicity, and dose. Because the wastes are isolated from the receptors, once the wastes are contained within the landfill, the waste constituents meet acceptable concentrations. Since the primary COCs are inorganic, they are not subject to degradation like the organics. However, inorganics may naturally stabilize to less toxic or bioavailable forms. However, the bioavailability of chemicals are not normally addressed in risk assessments. The current risk assessment assumes that the contaminants are 100% bioavailable.

Also, because the waste materials, as well as the cap design are relatively inert and stable (e.g mineral clays and rock), the landfill is expected to remain effective indefinitely. Although, the Navy acknowledges that maintenance of the landfill beyond 30 years may be required.

34. **Comment:** Page 5_22, Section 5.3.2.1, 3rd Paragraph. Clarify that monitored natural attenuation also is the planned component of this alternative for sediment with Arsenic contamination above human health RGOs.

Response: The referenced alternative does not consider monitored natural attenuation of the arsenic. Insoluble arsenic, being a metal, is not normally considered subject to monitored natural attenuation. The arsenic contamination will be addressed through land use controls, that will prohibit residential development in the salt water marsh. Site specific human health risk calculations indicate that under current and future expected scenarios, adverse risk to human health is not present.

35. **Comment:** Page 5_22, Section 5.3.2.2, 1st Paragraph, 2nd Sentence. Specify what the surface water exceedances are.

Response: Agreed. The following contaminants will be added to the referenced sentence.

“bis(2-ethylhexyl) phthalate, chrysene, pentachlorophenol, arsenic, copper, lead, mercury, and zinc”

36. **Comment:** Page 5_22, Section 5.3.2.2, 1st Paragraph, 5th and 7th Sentences. Please clarify the expected timeframes over which the cleanup standards will be attained for each media (e.g., 5_10 years, 10_20 years, 20_50 years, etc.).

Response: An accurate range for achieving these goals cannot be determined for these media, and as such was not presented. Once the wastes are isolated from the environment, continuing impact from them would end almost immediately, whereas chemical imput from groundwater will likely continue for a few years. Also, further complicating this estimate would be the fact that these constituents are present in the surface water upstream of Parris Island and the quality of this water is not within control of the base.

37. **Comment:** Page 5_23, Section 5.3.2.5, 1st Paragraph, 1st Sentence. As stated in Specific Comment 36, clarify how long before this alternative would be expected to be fully effective.

Response: An accurate range for achieving these goals cannot be determined for these media, and as such was not presented. Once the wastes are isolated from the environment, continuing impact from them would end almost immediately, whereas chemical imput from groundwater will likely continue for a few years. Also, further complicating this estimate would be the fact that these constituents are present in the surface water upstream of Parris Island and the quality of this water is not within control of the base.

38. **Comment:** Page 5_23, Section 5.3.2.5, 1st Paragraph, 3rd Sentence. Please add or may fail completely to the end of this sentence. Eventual failure is the design endpoint for all containment systems.

Response: The text will be added as indicated. However, please note that the containment system is being designed not to fail, and that long term maintenance will be required to continue the effectiveness of the cap.

39. **Comment:** Page 5_23, Section 5.3.2.5, 2nd Paragraph. The extent of necessary repairs is highly dependent on the design life and the time necessary for the wastes to degrade to below action levels. The likelihood of a hurricane event producing a significant storm surge topped by heavy waves that could severely damage or destroy unprotected portions of the landfill, releasing COCs to the environment, increases with this duration. For this reason, periodic inspections should include after severe storms. This uncertainty should be reflected in either conservative design assumptions (e.g., rip rap up to the 100 year storm event) or more conservative O&M assumptions (e.g., major repairs required every 50 years) in the cost estimate.

Response: The need for inspection after storm events will be added to the report in several locations. The assumptions for the design of the rip rap will be addressed during the remedial

design. Cost assumptions beyond the 30 year period is not included in the FS estimates and even if it was, because of the factor used in estimating future costs, the estimate would have a negligible impact on the cost estimate. Note that Site 1 is outside the area identified as being subject to wave action during storm events.

40. **Comment:** Page 5_25, Section 5.3.2.5, 6th Paragraph. The O&M costs appear to be somewhat underestimated. Based on an increased inspection frequency and a larger allowance for repair of storm damage, please provide a revised O&M cost estimate.

Response: The Navy will use existing base personnel for the inspection. Since this effort will be incremental for existing base personnel, added costs would be minimal.

Costs associated with potential storm damage are difficult to predict. The values presented are expected to be higher in some years and lower in other years. Also note that the landfill is being designed to minimize the need for long term maintenance, through vegetation, slope design, and erosion control measures.

41. **Comment:** Pages 5_26 through 5_29, Section 5.3.3. Specific Comments 36 through 40 also are applicable to the corresponding elements of Alternative 2b.

Response: Acknowledged. The responses will be incorporated as indicated.

42. **Comment:** Page 5_30, Section 5.3.4.4, 1st Paragraph, 3rd Sentence. See Specific Comment 31.

Response: Acknowledged. The responses will be incorporated as indicated.

43. **Comment:** Page 5_32, Section 5.3.4.5, 1st Paragraph. Based on a revised percentage of hazardous waste, please provide a revised cost estimate for the removal alternative.

Response: Agreed.

44. **Comment:** Page 6_3, Section 6.2.5, 2nd Paragraph, 4th Sentence. The acceptability of alternative 2a will, in part, rely on the estimate of the time required to attain cleanup goals using monitored natural attenuation.

Response: Acknowledged.

45. **Comment:** Page 6_4, Section 6.2.6, 1st Paragraph, 4th and 6th Sentences. The apparent discrepancy in waste volumes between alternatives 2b and 3 appears to be attributable to inclusion of a "buffer area outside waste limits" in alternative 3. It is unclear why this is included in the estimated excavation volume as it appears to be related to subitem 1.6 for clearing vegetation in a border area, presumably for equipment access, not to a contingency waste volume. Please clarify.

Response: The difference is volume estimates is based on the practical ability to excavate wastes and is commonly referred to “over excavation” to ensure that all waste materials are removed. Over excavation typically requires that one to two of additional vertical excavation be conducted to ensure that all of the waste has been removed and that the confirmatory samples are clean.

46. **Comment:** Page 6_4, Section 6.2.7, 2nd Paragraph. It should be noted that implementation of alternative 3 would restore 5 to 7 acres salt marsh.

Response: Agreed. The following statement will be added. “Under Alternative, approximately 5 to 7 acres of salt water marsh will be added to the approximately 4000 acres of salt water marsh currently at MCRD Parris Island.

47. **Comment:** Page 6_5, Section 6.2.9. The cost comparison should be based on the revised assumptions discussed above. Additionally, the position of the lead agency relative to the real long_term costs for long term monitoring and O&M should be evaluated.

Response: The cost estimates will be revised as indicated above. The Navy, as the lead agency, assumes the burden for these costs.

48. **Comment:** Page 6_7, Table 6_1, 3rd column, 6th row. In the text of the FS monitored natural attenuation is presented as a treatment technology, and this should be reflected in the table.

Response: Agreed. “No treatment” will be replaced with “No enhanced treatment other than natural biological degradation.

48. **Comment:** Appendix B. The assumptions and engineering approach reflected in the cost estimates are internally consistent, thorough, and reasonable. Based on the revised assumptions presented in the comments above, it would be expected that the estimated costs for alternatives

2a and 2b would increase slightly and for alternative 3, decrease moderately. Despite these changes, the present worth cost for removal and off site disposal would still exceed the containment alternatives.

Response: Acknowledged.

SCDHEC COMMENT ON DRAFT FEASIBILITY STUDY / CORRECTIVE MEASURES STUDY SITE/SWMU 1 – INCINERATOR LANDFILL (7/01), MARINE CORP RECRUIT DEPOT, PARRIS ISLAND, SC6 170 022 762

ENGINEERING COMMENTS, JULY 31, 2001

1. **Comment:** General. In accordance with RCRA guidance concerning the development of a Corrective Measures Study, this document should discuss viable remedial alternatives and propose a corrective measure most appropriate for this SWMU. The Department is aware that this varies from the CERCLA guidance pertaining to the development of a Feasibility Study. Therefore, the proposed corrective measure may be discussed in the cover letter for this document.

Response: Acknowledged. The recommended remedy for this site has been discussed in several partnering team meetings. As previously discussed, the recommended alternative will be provided in a transmittal letter in the future.

2. **Comment:** General. The Department's preferred alternative is what may best be described as a modified Alternative 2a. The Department maintains that alternative 2a with the addition of the excavation of the PAH contaminated area is most appropriate for this site. The consolidation of the PAH contaminated sediments would result in more timely remediation of the sediments rather than relying on a lengthy natural attenuation process which has not been demonstrated to be occurring at this site. Furthermore, it does not appear as though site-specific modeling has been conducted to establish the length of time required for contaminant concentrations to decrease to RGOs. Consequently, please modify the document to include a modified 2a remedial alternative.

Response: The Navy acknowledges SCDHECs preference for the selected remedy. However, the Navy would prefer to maintain the FS in its current format and not create additional alternatives. As long as the relevant issues are addressed, the Proposed Plan and ROD can, and commonly does, select a remedy that is not separately detailed in an FS.

3. **Comment:** General. The use of a CAMU is inappropriate for this site. The purpose of the CAMU is to treat, store, or dispose of hazardous remediation waste without triggering Land Disposal Restrictions (LDR). Data should be compiled, if it exists, or collected to determine if these sediments are considered characteristically hazardous (i.e., TCLP data). If the results demonstrate that the sediments are not hazardous, then LDRs do not apply, and activities may proceed as planned without the use of a CAMU. Should the sediments prove to be hazardous,

then the Navy must comply with LDRs and may want to consider another course of action since the Department can not approved the use of a CAMU without a permit, corrective action order, or other enforceable mechanism in place.

Response: The CAMU was considered primarily as a relevant and appropriate ARAR under CERCLA, and presented in the event that some of the materials be classified as hazardous, and the action of consolidation triggers the definition of disposal. As requested, the use of a CAMU under South Carolina LDRs will be eliminated from the FS. Compliance with LDRs will be addressed during the remedial design.

4. **Comment:** Section 4.5.1.2, Institutional Controls (Land Use Controls) and Monitoring, Page 4-6. This section states that the cost for land use controls are low, when in fact, the cost of land use controls are considerably high over the long term. The land use controls are to remain in effect in perpetuity or until such time as residential standards are met. This should be reflected in the cost discussion. Furthermore, Land Use Controls should not be evaluated as a technology in the remediation of contaminated sites. They are to be implemented in conjunction with a selected corrective action in cases where residential standards are not met and are not intended to be a stand-alone remedy. Consequently, this discussion should be removed from the document.

Response: The cost of land use controls are low relative to other technologies considered, such as excavation, containment, and incineration. The Navy acknowledges that land use control costs will continue to be incurred indefinitely.

In accordance with EPA guidance, Land Use Controls are specifically addressed as an institutional control. The Navy considers Land Use Controls to be an important part of any remedy that leaves waste on site. However, because of site conditions, the Conclusion statement for Institutional Controls “as a stand-alone option” will be deleted.

5. **Comment:** Section 4.5.1.2, Institutional Controls and Monitoring, Page 4-13. See comment #4.

Response: The cost of land use controls are low relative to other technologies considered, such as excavation, containment, and incineration. The Navy acknowledges that land use control costs will continue to be incurred indefinitely.

In accordance with EPA guidance, Land Use Controls are specifically addressed as an institutional control. The Navy considers Land Use Controls to be an important part of any

remedy that leaves waste on site. However, because of site conditions, the Conclusion statement for Institutional Controls "as a stand-alone option" will be deleted.

6. **Comment:** Section 4.6, Page 4-18; Table 4-1 and 4-2. See comment #4

Response: The cost of land use controls are low relative to other technologies considered, such as excavation, containment, and incineration. The Navy acknowledges that land use control costs will continue to be incurred indefinitely.

In accordance with EPA guidance, Land Use Controls are specifically addressed as an institutional control. The Navy considers Land Use Controls to be an important part of any remedy that leaves waste on site.

7. **Comment:** Section 5.1.2, Component 2, Page 5-4. This section should be modified to reflect the modified 2a approach which would include the excavation of the PAH contaminated sediments.

Response: The FS was developed to provide a range of alternatives. The Proposed Plan and ROD will select a final remedy based on one or more of the alternatives. As such, the Navy is not planning on revising the FS.

8. **Comment:** Section 5.1.2, Component 4, 4th paragraph, Page 5-5. This section discusses installing sumps within the interior of the landfill, if necessary, to control the migration of contaminated ground water. Such contingency may negatively impact the effectiveness of the low permeability cap. If such action is necessary, the Navy must ensure that a preferential pathway for infiltration through the cap is not created. Upon the completion of the contingency measure, if necessary, a demonstration must be made to the Department that the effectiveness if the cap is maintained.

Response: The installation of the sumps is a contingency remedy in the event that groundwater continues to be adversely impacted. The sumps would only be installed after the cap has been in place and long term monitoring demonstrates the need for further addressing the groundwater. If implemented, standard engineering practices would be used to reseal the cap.

9. **Comment:** Section 5.1.2, Component 6, Page 5-6. Upon completion of the sediment excavation, the Department recommends re-grading the area to prevent the creation of a "moat" adjacent to the landfill. Furthermore, this section states that remaining sediment contamination may be covered by soils. Given the dynamic nature of the site, the soils used as a cover may

only be temporary as they may be eroded away with tidal fluctuations. As such, the Navy should make all reasonable efforts to ensure that sediment contamination does not remain in place upon completion of the excavation activities.

Response: The description of the drainage channel around the landfill as a "moat" during the partnering team meeting was not accurate. In practice drainage channels would be established around the landfill and fill added as needed to establish a viable wetland.

The Navy concurs that all reasonable efforts will be taken to ensure that sediment contamination is placed within the clay capped area. The covering of residual sediments with soil is only presented as a contingency, in the event that excavation become impractical.

10a. **Comment:** Section 5.1.2, Component 7, 2nd paragraph, Page 5-7. This section states that after the first year of quarterly ground water monitoring, the frequency will be reduced to annual monitoring. It is inappropriate to make this determination at this point in time. This section should be revised to state that after the first year of sampling, the data will be evaluated to determine an appropriate monitoring frequency. A change in frequency may be proposed by the Navy in the form of an annual report submitted to the regulatory agencies for review and concurrence.

Response: The actual frequency of groundwater monitoring will be developed in the Groundwater Monitoring Plan. The description presented is only for the cost estimate. The working will be revised as follows.

After the first year, "the groundwater data will be evaluated. This evaluation will consider seasonal variability in results, positive detections relative to groundwater and surface water criteria, and any data trends. Based on this evaluation, the need and frequency for continuing long groundwater monitoring will be determined. For the purposes of the CMS cost estimate, annual monitoring beyond the first year is assumed. "

10b. **Comment:** The discussion relating to the natural attenuation of the PAHs should be removed in accordance with the modified 2a approach.

Response: The FS was developed to provide a range of alternatives. The Proposed Plan and ROD will select a final remedy based on one or more of the alternatives. As such, the Navy is not planning on revising the FS.

10c. **Comment:** The 3rd paragraph should state that unrestricted reuse of this property would be ensured via the Land Use Control Assurance Plan (LUCAP) and the Base Master Work Plan.

Response: Agreed. The first sentence will be revised as follows.

... unrestricted reuse of the site would not be allowed "via Land Use Control Assurance Plan (LUCAP) and the Base Master Plan."

11. **Comment:** Section 5.1.3, Component 2; Section 5.1.2, Component 3. Section 5.1.2 pertains to alternative 2a which involves excavating the pesticides and inorganic sediment contamination; whereas, Section 5.1.3 pertains to alternative 2b which involves the excavation of pesticide, inorganic, and PAH sediment contamination. One would expect the volume of excavated material to be greater for alternative 2b since the PAH contamination would also be excavated. However, alternative 2a states that 11,600 cubic yards of sediment/waste will be excavated while alternative 2b states that 9,000 cubic yards will be excavated. This is contrary to what one would expect based on the target contaminants for excavation.

Response: The volumes estimates are accurate as presented. Under Alternative 2b, the landfill will be larger than under Alternative 2a, and therefore less of the waste surrounding the landfill will have to be moved. Please note that Alternative 2b also includes 6,500 cubic yards of sediment addressed under Component 1. Therefore the total estimated volume for consolidation is actually; Alternative 2a: 11,600 cubic yards and Alternative 2b: 14,500 cubic yards.

12. **Comment:** Section 5.1.3, Component 3, 4th paragraph, Page 5-10. See Comment #8

Response: The installation of the sumps is a contingency remedy in the event that groundwater continues to be adversely impacted. The sumps would only be installed after the cap has been in place and long term monitoring demonstrates the need for further addressing the groundwater. If implemented, standard engineering practices would be used to reseal the cap.

13. **Comment:** Section 5.1.3, Component 5, Page 5-11. See Comment # 9

Response: The description of the drainage channel around the landfill as a "moat" during the partnering team meeting was not accurate. In practice drainage channels would be established around the landfill and fill added as needed to establish a viable wetland.

The Navy concurs that all reasonable efforts will be taken to ensure that sediment contamination is placed within the clay capped area. The covering of residual sediments with soil is only presented as a contingency, in the event that excavation become impractical.

14. **Comment:** Section 5.1.3, Component 6, Pages 5-11 and 5-12. See Comment # 10 with the exception of the PAH comment.

Response: The actual frequency of groundwater monitoring will be developed in the Groundwater Monitoring Plan. The description presented is only for the cost estimate.

Agreed. The first sentence will be revised as follows.

... unrestricted reuse of the site would not be allowed "via Land Use Control Assurance Plan (LUCAP) and the Base Master Plan."

15. **Comment:** Section 5.1.4, Component 4. See Comment # 9.

Response: The description of the drainage channel around the landfill as a "moat" during the partnering team meeting was not accurate. In practice drainage channels would be established around the landfill.

The Navy concurs that all reasonable efforts will be taken to ensure that sediment contamination is placed within the clay capped area. The covering of residual sediments with soil is only presented as a contingency, in the event that excavation become impractical.

16. **Comment:** Section 5.3.2.1, Page 5-22. The discussion of the natural attenuation of the PAH area should be removed in accordance with the modified alternative 2a.

Response: The FS was developed to provide a range of alternatives. The Proposed Plan and ROD will select a final remedy based on one or more of the alternatives. As such, the Navy is not planning on revising the FS.

17. **Comment:** Section 6.0. This section should be modified to be consistent with the modified 2a alternative.

Response: The FS was developed to provide a range of alternatives. The Proposed Plan and ROD will select a final remedy based on one or more of the alternatives. As such, the Navy is not planning on revising the FS.

18. **Comment:** Section 6.2.9, Page 6-5. The 30-year present worth of alternative 2a is $2,000 less than the capital cost; whereas, the 30-year present worth of alternative 2b is $316,000 greater than the capital cost. Please verify the cost estimates.

Response: Acknowledged. The cost estimates were revised just prior to the report being issued and the correct cost estimates were not consistently presented in the report. The cost estimates are being revised and will be presented in the final report.

DCH, 30 JULY 2001

1. **Comment:** Title: The title of this document should include SWMU 41. Please revise accordingly.

   Response: Agreed. The title will be revised to include SWMU 41.

2. **Comment:** Section 2.2, Site-Specific Geology And Hydrogeology: This section specifies the top and bottom of the waste was delineated using soil borings. The figures in this CMS state that the depth of the waste was estimated using aerial photographs. It is unclear how aerial photographs can be utilized to determine waste thickness since the difference in elevation would be insignificant when photographed from an altitude of 20,000 feet. Additionally, it has not been shown that aerial photographs exist that show this area prior to the addition of waste at SWMU 1. Either the text or the figures should be revised to reflect the method(s) used to calculate waste thickness. If aerial photographs were, in fact, used, please describe the methodology for these calculations.

   Response: The section states that the top and bottom of waste were approximately using several factors including soil borings. Soil borings were not the only data used in estimating waste thickness.

   The figures will be revised to delete reference to aerial photographs. Also, the following text will be added to the report.

   "The estimated bottom of the waste assumes that the tidal mud flat that is present on either side of the site and that stretches for several miles in either direction, remains flat through the site. The estimate also assumes that waste materials have not migrated much beyond the surface of the underlying sediments. These assumptions are supported by the soil boring data around the edge of the landfill and historical aerial photographs that do not indicate the presence of any significant depressions in this area."

   Note that based on a 1945 aerial photograph, a small tidal stream did run through the site.

3. **Comment:** Table 2-1, Results of April 2001 Sediment Investigation: The abbreviation "NR" used for the arsenic-Eco PRG is not defined. Please revise the table.

   Response: Since arsenic is not an ecological PRG, the NR will be replaced with a "--". However, the "--" will be defined as "No ecological preliminary remediation goals."

4. **Comment:** Figure 2-1, Site Layout: This figure shows a single location for SWMU 41. The conclusions drawn in the RI/RFI report for SWMUs 1 and 41 do not surmise that only the northern-most location be addressed in the future. Included below is part of an aerial photograph from 1955 that shows an incinerator with a smokestack at the southern location. This location must be included in all the figures in this CMS.

[Photo enclosed in original]

Response: The possible southern location for SWMU 41 was specifically addressed in the RCRA Facility Investigation. The conclusion was "either incineration never occurred in this area or that potential impacts from historical operation have been remediated. "

The purpose of the CMS is to develop options for remediating contaminated areas. Since this area was not found to be contaminated, it is not addressed in the FS. The Site ROD will document the absence of environmental impact at this location.

5. **Comment:** Figures 2-3 through 2-7, Cross Sections: Comment #2 applies to these figures.

Response: The figures will be revised to delete reference to aerial photographs.

6. **Comment:** Figure 3-2, Contaminated Sediment Delineation Map: The arsenic result for PAI-01-SD-021-01 should be marked with an "H". Please revise the figure accordingly.

Response: Agreed. Please note that during validation of the data, it was discovered that the arsenic results for SD21 and SD22 were reversed. The figure will be revised.

7. **Comment:** Section 4.4, identification And Screening Of Technologies And Process Options: Institutional Controls should not be included as a separate remedial measure. Institutional Controls should be evaluated as PART OF a remedy, but not as a stand-alone remedy. Please revise the text accordingly. This comment applies to all subsequent sections of this CMS which list Institutional Controls as a stand-alone remedy.

Response: The Navy disagrees. In accordance with EPA guidance, institutional controls are considered as both stand alone technologies and as part of remedies as needed.

8. **Comment:** Section 5.1.2, Component 7 – Implementation of land use controls, long-term monitoring, 5-year reviews, and operation and maintenance: It is not appropriate to specify quarterly monitoring

for one year only. Automatic reductions in groundwater monitoring frequency is not prudent. The text should be revised to say that quarterly monitoring will continue until such a time that the State and EPA approve a reduction in monitoring frequency.

Response: The actual monitoring frequency will be determined during the development of the groundwater monitoring plan. The discussion in the FS is presented as the basis of the cost estimates only. To address this comment, the text will be revised as follows (Sections 5.1.2 and 5.1.3).

After the first year, "the groundwater data will be evaluated. This evaluation will consider seasonal variability in results, positive detections relative to groundwater and surface water criteria, and any data trends. Based on this evaluation, the need and frequency for continuing long groundwater monitoring will be determined. For the purposes of the CMS cost estimate, annual monitoring beyond the first year is assumed. "

SCDNR COMMENTS ON FS/CMS FOR SITE/SWMU 1 – INCINERATOR LANDFILL, MCRD PARRIS ISLAND; BEAUFORT COUNTY, SC JULY 31, 2001

1. **Comment:** The Feasibility Study/Corrective Measures Study (FS/CMS) uses the results of the Remedial Investigation/RCRA Facility Investigation (RI/RFI) to evaluate four potential remedial alternatives for addressing risks to human health and the environment at Site/SWMU 1. This site is a 7-acre landfill at the tip of Horse Island, which extends approximately 670 feet into the marsh toward Archer Creek. It is estimated that 56,000 cubic yards of soil, fill, and waste material were disposed in the landfill from 1921 to 1965. Waste materials included combustion residues (ash) from the coal-fired incinerator at SWMU 41, as well as other non-hazardous and hazardous waste. Results of the ecological risk assessment performed as part of the RI/RFI for Site 1 indicated that pesticides, PAHs, and several heavy metals in sediments and soils posed an unacceptable risk to aquatic and terrestrial ecological receptors.

As stated in the FS/CMS, Alternative 1 (No Action) was developed to provide a baseline for comparison to the other alternatives, but would not be protective of human health or the environment. This alternative would not be acceptable to the SCDNR as a remedial action alternative. At the opposite end of the spectrum, Alternative 3 (Excavation and Off-Site Disposal of Waste and Sediment) would remove all waste material and sediments with contaminant concentrations in excess of Remedial Goal Options (RGOs). This alternative would be the most protective of any of the alternatives considered, and would be acceptable to the SCDNR provided all excavated areas were actively restored (regraded and replanted) to provide functional saltmarsh habitat. Implementation of this alternative would also obviate the need for land-use controls, maintenance of a cap, or long-term monitoring of contaminant migration from the site.

The other two alternatives presented (Alternative 2A and 2B) are premised on the applicability of the "presumptive remedy" of containment of waste materials, surface soils, and contaminated sediments on-site. Both alternatives involve the installation of a low-permeability cap system over the consolidated and regraded waste, soils, and sediment (which will be excavated from the surrounding marsh and placed within the upland boundary of the existing landfill). The two alternatives differ in that Alternative 2A would involve the excavation of *only* those sediments with concentrations of pesticides and metals that exceed the RGOs for ecological receptors; whereas, Alternative 2B would remove *all* contaminated sediments with concentrations of pesticides, metals, *and PAHs* above the RGOs for the protection of both ecological *and human* receptors. This latter alternative would include the removal of sediments from an area east of the landfill (Area III) where total PAH concentrations exceeded ecological RGOs by an order of magnitude (29,455 ug/kg). In Alternative 2A, these sediments would be addressed solely through natural attenuation and long-term monitoring.

Alternative 2B would also remove sediments from an area north of the landfill (Area II) where arsenic concentrations exceed human health RGOs, but are generally comparable to background concentrations. The SCDNR defers to SCDHEC on the adequacy of Alternative 2A for the protection of human health, but does not believe that natural attenuation of PAH-contaminated sediments in Area III is sufficiently protective of ecological receptors. Therefore, we recommend that, at a minimum, the sediments in Area III be removed, either as proposed in Alternative 2B or in Alternative 3. The SCDNR concurs with SCDHEC's comment (see letter dated 7/31/01) that the Navy should make all reasonable efforts to ensure that sediment contamination does not remain in place upon completion of the excavation activities. In order to protect ecological receptors such as fiddler crabs, which can burrow to depths of up to 3 feet, verification sampling should be performed at least to this depth to ensure that ecological RGOs are met throughout the upper three feet of surficial sediments. Finally, since Area III is somewhat removed from the landfill itself, and, therefore, from any potentially continuing sources of contaminant migration, opportunities for habitat restoration and enhancement in this area should be actively explored by the Parris Island Partnering Team during the Remedial Design phase.

In summary, the SCDNR believes that Alternative 3 (Excavation and Off-Site Disposal of Waste and Sediment) would be acceptable, provided all excavated areas were actively restored (regraded and replanted) to provide functional saltmarsh habitat, comparable in quality to that of the adjacent unimpacted marsh. Alternative 2B would also be acceptable, provided the proposed cap was constructed to eliminate any migration of contaminants to adjacent surface waters or sediments, either from erosion of contaminated soils or from discharge of contaminated groundwater. The limited groundwater sampling conducted to date does not indicate that groundwater contamination currently poses a substantial risk to ecological receptors; however, the elevated salinity in those groundwater samples does indicate that there is an interconnection between tidal surface waters and shallow groundwater that will not be addressed by the cap proposed under either Alternatives 2A or 2B. Therefore, the SCDNR recommends the inclusion of a detailed monitoring and contingency plan as part of any remedy selected for this site, in order to evaluate the effectiveness of the cap in preventing future migration of contaminants from the landfill to adjacent sediments and surface waters. Finally, the SCDNR recommends that all intertidal areas impacted by excavation be actively restored to functional saltmarsh habitat, comparable in quality to nearby unimpacted saltmarsh or tidal creek habitat. In this regard, the Natural Resource Trustees are anxious to work with the other team members to seek innovative, cost-effective remedies that, not only minimize exposure to contaminants, but also enhance habitat restoration and value.

Response: The Navy acknowledges SCDNR's comments and concurs with all its concerns. The Navy is pursuing a Modified Alternative 2a that targets excavation of the PAH contamination and allows the arsenic impacted area to remain.

The landfill cap is being designed to minimize the migration of COCs from waste materials to adjacent groundwater, surface water, and sediments. This includes a cap that will minimize precipitation infiltration and therefore vertical migration of contaminants to the underlying groundwater.

As noted in the RI report under current site conditions, ground water/surface water tidally cycles through at least a portion of the waste, near the edge of the landfill. However, only relatively minor exceedances of ecological criteria for these media were noted in the current uncontrolled condition and these exceedances were generally within a factor of two or three times the conservative criteria. Therefore, to remove the wastes from the active surface water flushing would significantly decrease the migration of these contaminants. In addition, the preliminary cap design under Alternatives 2a and 2b will involve providing a soil/cap buffer of approximately 20 horizontal feet between waste materials and surface water; and therefore reduce the impact even further. In addition, these alternatives include groundwater monitoring wells that would be used to track the migration of soluble contamination. In the event that excessive contaminant migration is occurring, then the contingency includes provisions for addressing leachate collection via sumps or wells.

The Navy also concurs with the restoration of impacted sediment areas to enhance habitat restoration and value. Restoration details will be developed during the Site 1 Remedial Design. Primary issues to be addressed are site grading, filling/capping, and re-vegetation requirements.

NOAA COMMENTS ON FEASIBILITY STUDY/CORRECTIVE MEASURES STUDY FOR SITE/SWMU 1 – INCINERATOR LANDFILL, MARINE CORPS RECRUIT DEPORT, PARRIS ISLAND, SOUTH CAROLINA, DATED AUGUST 13, 2001

1. **Comment:** The subject document presents four remedial alternatives.

a. Alternative 1 - No action

b. Alternative 2a – Removal of sediments that exceed ecological RGOs for pesticides and inorganics to an on-site cap. Sediments exceeding ecological and human health RGOs for PAH would be monitored for natural attenuation.

c. Alternative 2b - Removal and placement under an on-site cap of all sediments exceeding ecological and human health RGOs for pesticides, inorganics and PAH.

d. Alternative 3 - Removal and off-site disposal of sediments exceeding ecological and human health RGOs for pesticides, inorganics and PAH.

NOAA concurs with recommendations by the South Carolina Department of Health and Environmental Control as well as the South Carolina Department of Natural Resources. That is, the most appropriate remedial solution for Site 1 is a modified Alternative 2a. The modification includes the removal of PAH-contaminated sediments in a small (≈1/2 acre) area west of the upland portion of Site 1 (see Figure 3-2).

The report's proposal to monitor natural attenuation of PAH-contaminated sediments was not accompanied by any modeling that established the nature and duration of expected attenuation of petroleum compounds to ecological and human health RGOs.

Response: The Navy concurs with NOAA's comments.

2. **Comment:** The proposed cap/enclosure remedial solution should be designed and constructed to eliminate migration of contaminants to adjacent surface waters or sediments either by erosion or by the discharge of ground water. To that end, long-term monitoring and a contingency plan should be part of the selected remedy for Site 1. It is premature to specify the exact timing and frequency of monitoring.

Response: The Navy concurs with NOAA's comment. The frequency of monitoring will be developed in a long term monitoring plan. The values presented in the report are for information only and serve as the basis for the cost estimate.

3. **Comment:** NOAA concurs with comments by South Carolina personnel that areas impacted by sediment excavation should be actively restored to functioning saltmarsh habitat. NOAA is anxious to work with other members of the Parris Island MCRD Partnering Team to identify innovative, cost-effective remedial solutions that minimize chemical risks and enhance habitat restoration.

Response: The Navy concurs with NOAA's comment. The details for returning the area to a functioning salt water marsh will be established during the design activities.

US FISH AND WILDLIFE SERVICE COMMENTS ON 1 DRAFT FEASIBILITY STUDY/CORRECTIVE MEASURES STUDY FOR SITE/SWMU 1 - INCINERATOR LANDFILL MARINE CORPS RECRUIT DEPOT PARRIS ISLAND, SOUTH CAROLINA EPA ID#: SC6170022767, DATED AUGUST 24, 2001

The U. S. Fish and Wildlife Service (Service) has reviewed the above-referenced document and offers the following comments for your consideration.

1. **Comment:** Site/SWMU 1 is a 7-acre incinerator landfill at the tip of Horse Island which extends approximately 670 feet into the marsh toward Archer Creek and is approximately 400 feet in width; an extensive saltmarsh is located along the northern, eastern, and western portions of the peninsula on which Site 1 and SWMU 41 (former incinerator) are located. It is estimated that 56,000 cubic yards of soil, fill, and waste material were disposed of in the landfill from 1921 to 1965; wastes were piled on the land or placed in trenches into the marsh, extending the edge of the landfill farther into the marsh. Fill dirt was also used to build up the land at the edge of the marsh, and the landfill progressively extended farther into the marsh as wastes were dumped on the edge of the fill. Waste materials included combustion residues (ash) from the coal-fired incinerator at SWMU 41; noncombustible wastes such as cans, bottles, and construction debris; and hazardous wastes such as paint thinners, diesel fuels, kerosene, and strippers. Results of the ecological risk assessment performed as part of the RI/RFI for Site 1 indicated that pesticides, PAHs, and several heavy metals in sediments and soils pose an unacceptable risk to aquatic and terrestrial ecological receptors.

The Feasibility Study/Corrective Measures Study (FS/CMS) develops Remedial Action Objectives (RAOs) and Remedial Goal Options (RGOs) for Site/SWMU 1 and evaluates four potential remedial alternatives for addressing risks to human health and the environment at the site:

Alternative 1 - No action

Alternative 2a – Removal of sediments that exceed ecological RGOs for pesticides and inorganics to an on-site cap. Sediments exceeding ecological and human health RGOs for PAHs would be monitored for natural attenuation.

Alternative 2b - Removal and placement under an on-site cap of all sediments exceeding ecological and human health RGOs for pesticides, inorganics, and PAHs.

Alternative 3 - Removal and off-site disposal of sediments exceeding ecological and human health RGOs for pesticides, inorganics, and PAHs.

Primary issues of concern to the Service involve the presumptive remedy, the selection of Remedial Goal Options (RGOs), and the lack of compliance with Section 404 of the Clean Water Act and Section 404(b)(1) guidelines regarding wetlands mitigation and restoration.

Response: The Navy concurs with most of the above interpretation of the FS, but would like to clarify that the following points.

- The ecological risk assessment only indicates the potential for unacceptable risk to aquatic and ecological receptors. The recommended alternative for site remediation, will specifically address both the chemical and physical impacts in the area.

Detailed responses to the RGO and Section 404 wetland mitigation and restoration are presented below.

2a. **Comment:** Section 3.3 **PRESUMPTIVE REMEDY** discusses the decision criteria for the application of the presumptive remedy of source containment (i.e., an on-site cap as proposed in Alternatives 2a and 2b). The application of source containment to a landfill located in an estuarine, intertidal salt marsh is at best questionable and at worst ineffective.

Response: The majority of Site 1 is located outside of the salt water marsh. The proposed remedy will specifically address removal of waste and contaminated sediments from within the salt water marsh and place them under an engineered cap design to effectively control migration of contaminants that would result in adverse impacts to the environment.

2b. **Comment:** The likelihood is that the groundwater hydraulic head is tidally influenced (i.e., there is a twice daily flush in and out), thus providing an exposure pathway to site contaminants for groundwater to surface water, sediments, and ecological receptors. While the Site/SWMU 1 contaminant sampling plan was developed assuming application of the presumptive remedy, there was apparently no monitoring of groundwater levels relative to tidal stage to document the presence or absence of a tidally influenced hydraulic head. However, the documented salinity of the groundwater indicates that surface water and groundwater are interconnected.

Response: The tidal study is provided in the Site 1 RI report and was discussed at several of the partnering team meetings. As indicated in the comment, the surface water and groundwater near the edge of the Site are interconnected.

Water level measurements in the monitoring wells during a tidal cycle are provided in the Site 1 RI Appendix B. As suggested, this data demonstrates the groundwater elevation cycling in the monitoring wells with individual water head measurements cycling by 1 to 2 feet. At high tide, most of these wells are located at waters edge. At low tide, these wells are 200 to 1000 feet from surface water. Note that PAI-01-MW-4S, which is located approximately 130 feet from the nearest surface water shows no direct effects from the tidal cycle.

2c. **Comment:** In addition, groundwater was found to contain concentrations of naphthalene and metals (copper, lead, mercury, and zinc) potentially harmful to ecological receptors; the Remedial Investigation (RI) Report reports that pesticides and aroclors were not detected in groundwater but detection limits are not reported and extremely low concentrations of these contaminants are known to cause adverse effects to ecological receptors.

Response: Laboratory detection limits are provided in Appendix C of the RI report. The detection limit discussion and resolution has been addressed at several recent partnering team meetings. In particular, the use of method detection limits (MDLs) has eliminated most of the concerns. The investigation used the best available reliable technology for detecting these chemicals in groundwater. This concern with detection limits for groundwater is also part of the reason that the proposed remedy for these chemicals focused on the sediment and soil in which these chemicals concentrate and are measurable.

2d. **Comment:** While source containment may be practical and the presumptive remedy (an onsite cap) would reduce the potential for vertical migration of groundwater contaminants to sediments and surface water due to reduced surface infiltration, the presumptive remedy does not ensure elimination of the source of sediment and surface water contamination. This is conceded is Section 3.4.4 which states that "The landfill containment remedial action/corrective measure would need to be engineered so that groundwater containment could be implemented in the future, if it is determined to be necessary." Section 4.2.3 discussing containment states that "the contaminated media must be isolated from the primary transport mechanisms . . . to reduce the migration of contaminants . . . [via] installation of surface and subsurface barriers that either block or divert any transport media from the contaminants." How does the presumptive remedy (Alternatives 2a and 2b) address the potential twice daily flush in and out of the landfill's contaminated wastes via a tidally influenced hydraulic head? What data are utilized to conclude

that “the cap system would prevent concentrations of COCs in waste material from migrating to groundwater, sediment and surface water”?

Response: A comparison of the groundwater and surface water data from the site with very conservative screening criteria found only very minor exceedances. The surface water chemicals that were detected were more likely to be associated with particulate migration (erosion) of exposed wastes. The placement of waste materials within the landfill as indicated under Alternatives 2a and 2b would eliminate the surface water particulate migration pathway.

As indicated the groundwater was noted to contain several metals (soluble) and organics at concentrations that exceed the screening values. Based on the site wastes, these chemicals likely result from direct leaching of waste materials at the site. This leaching process is the primary reason why a low permeability cap instead of a permeable cover was considered for this site.

However, the exceedances noted were relatively low compared to the screening criteria, (e.g. maximum hazard quotients of 2.4 to 9.2). On the average, the concentration of chemicals detected in the groundwater are similar to or less than the screening values as well as background surface water values. The exception is mercury. The average calculated mercury concentration is elevated because of an elevated detection limit (0.2 µg/l). But mercury was detected in only 1 of the 8 samples collected.

Groundwater (µg/l)

Parameter	Maximum Concentration	Average Concentration	EPA Region 4 Screening Value	Background Surface Water
Naphthalene	57	9.7	23.5	Not Applic.
Copper	7.8	2.8	2.9	13
Lead	36.4	11.4	8.5	11
Mercury	0.23	0.028 to 0.11	0.025	Not Detect.
Zinc	112	53	86	66

As a result, under Alternatives 2a and 2b, the waste materials would be consolidated within the cap area and designed to be isolated from the surface water tidal cycles. Waste materials currently directly in contact with surface water would be typically elevated 5 to 10 feet above the high water mark.

The cap would be designed to minimize the flow of surface water into the cap area, and therefore minimize outflow. The flow into the cap area would be dependent on the flow area (cross section)

available, hydraulic gradient, and conductivity of the media. Since under existing conditions only minor exceedances exist in the surface water and groundwater, a reduction of only 70 to 80% is required in order to comply with the stringent ecological values for ecological receptors. Higher reductions will be targeted and should be achieved with only consolidation and containment actions.

3. **Comment:** Section 3.4.4 also contains the statement that "The results of the ERA did not indicate that groundwater poses a concern to ecological receptors. As a result, groundwater will not be retained as a medium of concern for ecological concerns." This statement is not supported in the RI Report, which contains the ERA (Ecological Risk Assessment). Naphthalene, copper, lead, mercury, and zinc were present in groundwater at concentrations that exceed those established as protective of saltwater aquatic life; four volatile organic compounds, 10 semivolatile organic compounds, and six metals were detected for which Region 4 has no ecological screening values.. The RI Report states that "The groundwater data are adequate to proceed to a feasibility study/corrective measures study to evaluation options for managing contaminated groundwater. . . . remedial options will focus on reducing infiltration and tidal effects." What is the basis of the statement in the FS that groundwater will not be retained as a medium of concern for ecological receptors? What remedial options focus on reducing tidal effects as related to groundwater? Are there data documenting tidal effects on site groundwater?

Response: The RI and FS statements are consistent. The FS acknowledges the current impact on localized groundwater and as a pathway to ecological receptors in the surface water and sediment. The statements in the FS are the basis for not selecting active remediation of the site groundwater. Effective technologies are not available to address the groundwater contaminants. Groundwater will be indirectly remediated by addressing the source of the contamination in the wastes.

The remedial options focus on controlling/eliminating the interaction between contaminated groundwater and surface water. The options specifically address this interaction by consolidation and isolation of the wastes from direct contact with the surface water; the reduction in the migration of contaminated groundwater via control of precipitation infiltration, and control of surface water migration into the capped area.

Data documenting the tidal effects on site groundwater are provided in Appendix B of the RI.

4. **Comment:** Section 3.4.3. states that surface water is retained as a medium of concern based on the results of the human health risk assessment. According to the ERA, surface water

concentrations of pentachlorophenol, copper, lead, mercury, silver, and zinc had maximum hazard quotients (HQs) ranging from 1.12 for zinc to 21.7 for copper. Exposure to surface water contaminants was included in the food chain modeling, although we cannot say what surface water consumption contributed to the calculated HQs since our copy of the RI is missing section F-1 through F-4 of Appendix F, Ecological Risk Assessment Support. Still, the ERA concluded that "Surface water contaminants do not appear to pose potential risks to ecological receptors." In section 5.0 of the FS it is conceded that Alternatives 2a and 2b will not meet the chemical specific ARARs of State Water Quality Standards for the Protection of Saltwater Aquatic Life, yet it is also stated that "surface water will be addressed through the management of soil, fill and waste, groundwater, and sediment." What is the basis for the determination that surface water contaminants do not appear to pose potential risks to ecological receptors? How will the presumptive remedy address the issue of surface water contamination relative to a tidally influenced hydraulic head?

Response: The Navy will re-issue Appendix F-1 through F-4 pages to USFWS. The basis for the lack of significant risk to ecological receptors is detailed in the Site 1 RI report and is based on low concentrations, frequency of detection, and comparison to background values. However, the Navy acknowledges that based on the groundwater data, the waste materials at the site are likely leaching these contaminants to the surface water either via the groundwater or particulate migration.

The reference to compliance with state ARARs is based on time. Alternative 2a and 2b will achieve chemical specific ARARs, although not initially. Once the wastes have been isolated and no longer act as a source of contamination, chemical concentrations in the groundwater and surface water will decrease. The uncertainty is in the length of time required for the groundwater and surface water to attenuate. As indicated above, surface water contamination will be eliminated by controlling surface water migration and precipitation inflow.

5. **Comment:** Section 3.7 **REMEDIAL GOAL OPTIONS** (RGOs) provides a summary of the site-specific RGOs selected to aid in assessing impacted sediment at Site/SWMU 1. As stated, sediment RGOs were selected from Region 4 ecological screening values (total PAHs and metals, except arsenic which was determined to be "Not Relevant" based apparently on an RGO which included "background" concentrations) and background concentrations (pesticides). The PAH and metals RGOs are based on effects on aquatic organisms and do not take into account effects on higher level consumers such as piscivorous birds that are under the jurisdiction of the Service. The selected RGOs for pesticides are one to two orders of magnitude **above** EPA's sediment screening values which are as much as two orders of magnitude **above** aquatic

organism effects values. Like the PAH and metals RGOs, the pesticide RGOs do not take into account effect on higher level receptors.

Response: The RGOs were developed in accordance with standard procedures and in accordance with EPA and Navy guidance.

Arsenic was not selected as an RGO because of low concentrations detected, infrequent exceedences of screening values, and similarity to background concentrations. A more detailed discussion is provided in Section 7.8.4 of the RI report.

Even though the selected RGOs are based primarily on effects screening values, the selected values are also protective of higher level consumers. As presented in the Site 1 RI report, the potential risk to these consumers (based on food chain HQs equal to 1.0) is limited to a few pesticides and metals. These pesticides and metals are the same chemicals that are specifically being addressed by the alternatives considered. Cleanup to these levels will also be protective of higher level consumers.

For example, back-calculated minimum RGOs for protection of the Heron and Osprey are summarized in the following table. This table shows RGOs based on NOAEL HQs equal to 1.0 and RGOs based on LOAEL HQs equal to 1.0, respectively. Note that these values assume that the chemicals are present at this concentration uniformly throughout the home range of these receptors. As a result, higher concentrations can be present, provided that lower concentrations are also present within the species home range.

Potential Range of RGOs for Protection of the Heron and Osprey

Chemical	Heron (equiv. RGO)	Osprey (equiv. RGO)
DDD (µg/kg)	39.6/396	108/1,080
DDE (µg/kg)	1.4/14	3.9/39
DDT (µg/kg)	66/666	18/180
Arsenic (mg/kg)	13.7/41	11.7/35
Lead (mg/kg)	6.3/63	5.3/53
Mercury (mg/kg)	0.036/0.36	0.03/0.3
Zinc (mg/kg)	80/729	69/620

These calculations above demonstrate that under a worst case scenario, the selected RGO in the FS are within an approximate acceptable range for protection of upper level consumers. In addition to the chemical distribution considerations, these calculations are also conservative because they assume that the food source (e.g. red drum) lives its entire life in contact with these

sediments (fish bowl scenario) and that the bird lives exclusively on these fish. In reality, the fish will feed and grow over an extended range and therefore the actual bioconcentration of these chemicals in the fish will be much lower. In combination, these considerations result in the above equivalent RGO's being conservative by one or more orders of magnitude.

In practice, by eliminating the maximum areas of contamination as proposed, the remaining areas have much lower concentrations than the RGOs. For example, of the 8 sediment samples collected outside of the proposed excavation area, only one sample had detectable concentrations of pesticides and then at a maximum concentration of 8.2 ug/kg for DDE.

6a. **Comment:** Based on the Ecological Risk Assessment, DDT, DDD, DDE, arsenic, lead, mercury, and zinc in sediment all pose risk of injury to piscivorous birds (and the Toxicity Reference Values used in the food chain modeling for arsenic, copper and lead are one to two orders of magnitude above documented adverse effects/no adverse effects concentrations); arsenic, copper, lead, and mercury pose risk to mammalian receptors; and flourenthene, pyrene, arsenic, and mercury pose a risk to fish. As stipulated in Region 4's ecological risk assessment guidance, the role of a Superfund ERA includes " to . . . (2) derive contaminant levels which would not pose unacceptable risks, and (3) provide the information necessary to make a risk management decision concerning the practical need and extent of remedial action." Use of sediment ecological screening values protective only of aquatic organisms (ER-Ls, ER-Ms, PELs) as RGOs ignores the results of the ERA and potential injury to higher level organisms; these RGOs cannot be said to represent "low risk to ecological receptors" when the results of the ERA are not included.

Response: As discussed above, the RGOs are protective of all ecological receptors.

6b. **Comment:** Use of RGOs based on aquatic effects screening values and background concentrations resulting from anthropogenic sources may significantly underestimate both the need for remedial action and the areal extent of needed remedial action.

Response: Aquatic effects screening values are protective of aquatic organisms and the potential risk to ecological consumers were addressed through the ERA and are summarized above.

In addition, failure to consider background and anthropogenic sources in the development of RGO can result in goals that are not obtainable. As for background sources, these materials

represent natural native metals. In addition, in many cases, these metals represent micronutrients essential to the health of organisms.

As noted, anthropogenic sources and in particular pesticides do require special consideration. These chemicals were routinely and commercially applied in accordance with the applicable regulations at the base and possibly disposed at some sites such as Site 1. RGOs must be developed that can distinguish between these two scenarios. The RGOs must also provide a balance between destruction/disruption of wetlands versus potential local impacts. Note also that remaining organics present in the sediments will biodegrade over time, although slowly.

However as discussed in the FS, once the initial excavation is completed, confirmation samples will be collected and evaluated for risk to human health and the environment. This evaluation will confirm that sufficient sediments have been removed. In addition, the alternatives include long term monitoring to confirm the effectiveness of the alternatives. In the event that the selected alternative is not effective, contingency remedies are available.

6c. **Comment:** As it is, the areal extent of Area I as shown in Figures 3-2, 5-1, 5-3, and 5-4, barely includes a sampling location where these aquatic effects RGOs are exceeded (SD-020-01 is on the outside boundary of the delineated contamination/ remedial action area), while SD-019-01, which has concentrations of copper and lead that are essentially equal to the RGOs, is far outside the contamination/remedial action boundary delineation. Similarly, on the eastern side of the site, SD-011-01 and SD-004-01 have concentrations of total PAHs near the aquatic screening value, with individual PAHs significantly exceeding ecological effects values; DDD and DDE concentrations at SD-011-01 exceed pesticide effects values. Yet, these two locations are considerably outside the delineated boundary of contamination/remediation.

Response: As stated above, cleanup of the site sediments to the stated RGO will be protective of higher level consumers. Background and anthropogenic sources of chemicals must be considered in establishing RGO. Otherwise, cleanups become technically impractical. As previously noted, the RGOs represent maximum chemical concentrations remaining at the site. Actual concentrations will be much lower after remediation is complete and additionally, for the pesticides, mercury, and PAHs, chemical concentrations will decrease over time due to biological processes. The metals concentrations will also likely decrease, or mineralize and become less available to biological receptors.

Because the detected concentrations approximately equal the RGO, sediment sample SD-020-01 is on the boundary of the planned excavation. In addition, a small tidal stream flows through this area and represents a practical boundary for both historic contaminant migration and excavation.

Chemical concentrations in SD-019-01, -004-01 and -011-01 are at concentrations below the RGO, and therefore are outside of the targeted cleanup area. For the RGOs, Total PAHs were selected as RGOs instead of individual PAHs. Total PAHs are based on more technical research than the individual PAH screening values. Recent research (Swartz, 1999) indicates that Total PAH effects levels could be 2 to 3 times higher than that used in the FS. Also, PAHs are noted to biodegrade. Once the source of continuing contamination is removed, these chemical concentrations will continue to decrease over time.

7. **Comment:** What is the basis for not incorporating the results of the ERA into the selection of sediment RGOs consistent with EPA guidance which states that an ERA should "provide enough information to establish site clean up goals for protection of ecological resources"?

Response: The results of the ERA were indirectly incorporated in the sediment RGOs. Based on recent experience at MRCD Parris Island Site 3 and the similarity between Site 1 and Site 3 and the example provided above, the EPA Region IV Screening Levels are also protective of upper consumer receptors.

8. **Comment:** Why is there no RGO for arsenic?

Response: Arsenic was not selected as an RGO because of low concentrations detected, infrequent exceedences of screening values, and proximity to background concentrations.

9. **Comment:** What is the basis of using "background" pesticide concentrations, resulting from years of basewide pesticide application, as RGOs when those concentrations are significantly above concentrations known to cause adverse effects to trust species? How is the use of "background" concentrations as screening values and ultimately RGOs consistent with EPA guidance which states that "Screening values should be based on contaminant levels associated with ecological effects, instead of area or regional background levels"? While "basewide application" of pesticides may not be specifically related to activities that occurred at Site/SWMU 1, these existing "background" concentrations are a result of activities that occurred at Parris Island. Should not the Remedial Action Objective/RGO at Site/SWMU 1 (as well as other sites on the base) be to achieve pesticide concentrations that are protective of trust resources, rather than to dismiss harmful concentrations as something that are present due to "basewide application"?

Response: Pesticides have in the past and continue to be used to control insect populations in the area. The values have been discussed at several partnering team meetings. Screening values presented during the RI do not consider background or regional levels. However, development of RGO for cleanup purposes does consider these other factors.

10. **Comment:** Section 5.0 **EVALUATION OF REMEDIAL ACTION/CORRECTIVE MEASURES ALTERNATIVES** proposes that excavated wetlands associated with Alternatives 2A, 2B, and 3 "be restored by allowing these areas to fill in with natural sediment deposits . . . [and] to naturally re-vegetate." Neither the impacts of the alternative actions themselves on existing wetlands (i.e., types and acreages affected) or the implications of no active restoration are discussed in the evaluation of alternatives. EPA guidance as contained in EPA/540/R-94/019 *Considering Wetlands At CERCLA Sites* states that "Attention to wetlands continues through . . . the feasibility study where the impact of the response actions on the wetlands shall be considered." Allowing natural sedimentation and revegetation does not meet the substantive requirements of Section 404(b)(1) guidelines which require compensatory mitigation for unavoidable adverse impacts on wetlands nor is this consistent with the above-referenced EPA guidance which states that "Unavoidable impacts to wetlands must be mitigated to comply with pertinent regulations and executive orders."

Response: The FS does address the impact on wetlands. For example, Page 6-4. "Under Alternatives 2a, 2b, and 3, vegetation on the landfill area and the salt marsh would be removed. Additionally, the implementation of slope stablization would encroach on wetlands. Measures would be conducted to either minimize the reduction in wetlands or to create wetland areas elsewhere. "

The use of natural sedimentation and revegetation was presented in the draft FS, because it was recognized that engineered attempts to re-establish wetland are general slow and only partially effective, especially in a tidal area such as Site 1. As discussed in responses to other partnering team member comments, the design phase of the remediation will specially incorporate reasonable and viable wetland restoration activities and will be discussed at upcoming meetings.

11. **Comment:** Further, it is the responsibility of the Natural Resource Trustees, which include the Department of Defense (DOD) at Parris Island, (1) to assess injury to natural resources resulting from site activities, which in the case of Site/SWMU 1 includes filling of wetlands from the landfilling operation as well as wetlands excavation as an unavoidable component of the remedy and (2) to develop either primary or compensatory restoration actions that would return the

injured resources to their baseline condition (i.e., prior to site activities) or would provide to the public resources comparable to those injured. Implementing wetlands restoration as part of the Site/SWMU 1 remedy would minimize or could eliminate residual injuries for which damages could be sought under the Natural Resource Damage Assessment (NRDA) process as provided for by CERCLA. Section 5.0 and the alternatives evaluated therein need to be revised to incorporate an assessment of the impacts of each alternative on wetlands, to provide for compensatory mitigation for unavoidable adverse impacts consistent with Section 404(b)(1) guidelines and EPA guidance for considering wetlands at CERCLA sites, and to provide for restoration of injured resources consistent with DOD's Natural Resource Trustee responsibilities under CERCLA and the associated NRDA regulations.

Response: The alternatives developed (except No Action) provide for the restoration of 2 to 7 acres of wetland. The action alternatives do not require the permanent taking of wetlands. Any compensatory mitigation or restoration actions that are subject to existing regulations will be preformed in accordance with our responsibility as a NRT; however, lands filled prior to the implementation of the Clean Water Act are not subject to the requirements of the same.

12. **Comment:** Finally, Section 3.2 **ARARS/MEDIA CLEANUP STANDARDS** needs some revisions. The discussion of Section 404 of the Clean Water Act as an ARAR needs modifying to clarify that site wetlands are considered "navigable waters" under Section 404 and to discuss Section 404(b)(1) guidelines. While EPA AWQCs are "non-enforceable guidelines," South Carolina has adopted these as State Water Quality Standards which are chemical specific for a number of organic and inorganic constituents and which are enforceable for the protection of aquatic life. The Magnuson-Stevens Fishery Conservation and Management Act specifies that each Federal agency shall consult with the Secretary of Commerce (through the National Marine Fisheries Service) with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by such agency that may adversely affect any essential fish habitat identified under this Act and should be added to the ARARs for Site/SWMU1. Likewise, CERCLA NRDA regulations should be included at least as a TBC in light of DOD's standing as a Natural Resource Trustee at the site.

Response: Section 404 of the clean water act is discussed in Section 3.2.2 of the FS. A more detailed evaluation of ARARs, such as the Section 404 requirements will be developed in the Remedial Design.

South Carolina adoption of surface water quality standards is discussed on Page 3-10 of the FS. This ARAR is specially addressed in each of the Alternatives in Section 5.0.

The Magnuson-Stevens Fishery Conservation and Management Act is an administrative requirement to notify of the Secretary of Commerce of actions that may adversely impact fish habit. Since the site will be remediated to eliminate environmental impacts, adverse impacts are not anticipated. However, the Secretary of Commerce will be notified of the proposed remedy.

EXECUTIVE SUMMARY

Tetra Tech NUS, Inc. (TtNUS) has prepared this Feasibility Study (FS)/Corrective Measures Study (CMS) report for the Incinerator Landfill [Site 1/Solid Waste Management Unit (SWMU) 1 and the Former Incinerator Unit (SWMU 41)], located at the Marine Corps Recruit Depot (MCRD) Parris Island, South Carolina. This report was prepared for the United States Navy (Navy) Southern Division (SOUTHDIV) Naval Facilities Engineering Command (NAVFAC) under Contract Task Order (CTO) 0020, for the Comprehensive Long-Term Environmental Action Navy (CLEAN) III Contract Number N62467-94-D-0888. The objective of this FS/CMS report is to develop and evaluate potential remedial alternatives/corrective measures for addressing risks to human health and the environment found within these areas.

SITE DESCRIPTION

MCRD Parris Island is located along the southern coast of South Carolina, approximately 1 mile south of the city of Port Royal and 3 miles south of the city of Beaufort within Beaufort County. MCRD Parris Island covers approximately 8,047 acres that consist of dry land, salt marshes, saltwater creeks, and ponds. MCRD Parris Island is the reception and recruit training facility for the Marine Corps for enlisted men from states east of the Mississippi River and for enlisted women nationwide.

Site 1 is located on the northeastern tip of Horse Island at MCRD Parris Island. The landfill extends approximately 670 feet into the marsh toward Archers Creek and is approximately 400 feet in width. The landfill occupies approximately 7 acres and was until recently covered with mature pine trees. In 2001, timber in the center of the site was harvested.

Historical records indicate that SWMU 41 was located in one of two possible locations. The former incinerator consisted of a coal-fired brick chamber approximately 43 feet long, 34 feet tall, and 20 feet wide. Based on the remedial investigation (RI)/[Resource and Conservation Recovery Act (RCRA) Facility Investigation (RFI)], the Navy determined that SWMU 41 was likely located within the area defined as Site 1 and that remediation of Site 1 would also remediate SWMU 41.

From 1921 to 1965, Site 1 served as the disposal site for combustion residues from the incinerator. The majority of wastes disposed in the landfill during this time were nonhazardous, combustible domestic wastes (ash residues) and other noncombustible wastes (e.g., cans, bottles, and construction debris). Additionally, hazardous wastes generated from the MCRD Parris Island from 1921 to 1959 were treated in the incinerator and disposed in the landfill. Paint thinners (mineral spirits), diesel fuels, kerosene, and

strippers (methylene chloride) were also reportedly poured onto the landfill and burned. No auxiliary fuels were used for open burning.

Wastes were initially piled on the land or placed in trenches into the marsh, extending the edge of the landfill farther into the marsh. Fill dirt was also used to build up the land at the edge of the marsh. The landfill progressively extended farther into the marsh as wastes were dumped on the edge of the fill. It is estimated that 56,000 cubic yards of soil, fill, and waste material were disposed at Site 1 from 1921 to 1965.

SWMU 41 remained in operation until 1959. Site 1 continued to be used for disposal of combustible trash and noncombustible waste until 1965. Since 1965, no significant disposal or intrusive activity has taken place within the boundaries of Site 1 or SWMU 41.

MEDIA OF CONCERN

Waste materials contain the source of contaminants within the Site 1 landfill and are the primary media of concern. The contaminants within the waste are a concern because:

- Contaminants are leaching to shallow groundwater.
- Contaminants are migrating to surface water and sediment via surface water runoff and erosion.
- Although not directly evaluated, contaminants likely present a direct contact threat to human health and ecological receptors.

During the RI/RFI, surface soils and sediment were found to contain several polynuclear aromatic hydrocarbons (PAHs), polynuclear biphenyls (PCBs), pesticides, and inorganics at concentrations greater than that present in background soils/sediment and in exceedance of the most stringent human health risk-based concentrations (RBCs) (residential) or ecological screening values. Surface soil and sediment are retained as media of concern in this FS/CMS.

Surface water is retained as a medium of concern in this FS/CMS because bis(2-ethylhexyl) phthalate and pentachlorophenol were observed above applicable or relevant and appropriate requirements (ARARs), to be considered (TBC) criteria, and site-specific remedial goal options (RGOs). However, because of the transient nature of surface water, surface water will be addressed through the management of wastes, surface soil, sediment, and groundwater.

Even though groundwater does not represent a direct risk to human health and ecological receptors, groundwater is retained as a medium of concern in this FS/CMS. The groundwater represents a pathway

from waste contaminants to ecological and human receptors in the adjacent surface water and sediments.

REMEDIAL ACTION OBJECTIVES/CORRECTIVE ACTION OBJECTIVES

Site-specific remedial action objectives (RAOs)/corrective action objectives (CAOs) consist of medium-specific goals for protecting human health and the environment. RAOs/CAOs are developed to permit consideration of a range of alternatives. The following RAOs/CAOs have been developed for Site 1.

- Eliminate contact with landfill contents and impacted surface soils by human and ecological receptors.

- Eliminate the migration of chemicals of concern (COCs) from the source material (impacted soil, waste, and fill) to downgradient media (i.e., sediment, surface water, and groundwater).

- Eliminate human exposure (i.e., direct exposure to maintenance worker, future construction worker, future recreational users, and hypothetical future resident) to COCs in sediment at concentrations in excess of RGOs. RGOs take into consideration an incremental lifetime cancer risk (ILCR) of 1.0E-06 for individual COCs. Additionally, RGOs take into consideration a hazard quotient (HQ) of 1.0 where noncarcinogenic effects would be expected. Elimination of COCs in sediment will also address human health concerns identified from chemicals detected in surface water.

- Eliminate exposure of ecological receptors to COCs in sediment at concentrations greater than RGOs. The sediment RGOs take into account direct contact of COCs by macroinvertebrates and are expected to be protective of upper food-chain receptors. RGOs address risks where only minor effects may be anticipated by ecological receptors and consider site background concentrations.

- Comply with chemical-specific, location-specific, and action-specific federal and state ARARs.

REMEDIAL ACTION/CORRECTIVE MEASURES ALTERNATIVE DEVELOPMENT

Remedial action/corrective measures alternatives were developed that address the COCs and exposure pathways in order to achieve the RAOs/CAOs. The following alternatives have been developed for Site 1:

- Alternative 1 - No Action. This alternative is developed per the NCP to provide a baseline for comparison to other alternatives. Under this alternative no activities would be conducted.

- Alternative 2a – Excavation and Consolidation of Pesticide and Inorganic Contaminated Sediment in Excess of Ecological RGOs and Containment of Waste. Alternative 2a consists of the following components:

  - Excavation of sediment with concentrations of inorganic chemicals (copper, mercury, and lead) and pesticides above the RGOs for protection of ecological receptors and consolidation of the sediment within the limits of the proposed cap system,

  - Monitored natural recovery for PAHs above the RGOs for the protection of ecological and human receptors,

  - Excavation of waste and sediment/waste materials outside of the limits of the proposed cap system and consolidation of the waste within the limits of the proposed cap system,

  - Installation of a low-permeability cap system over the consolidated and regraded waste and sediment,

  - Use of slope stabilization and erosion controls,

  - Restoration of salt marsh area where excavation was performed, and

  - Implementation of land-use controls for the limits of the proposed cap and the areas of sediment contaminated with arsenic and PAHs, long-term monitoring of the groundwater and the PAH contaminated sediments, 5-year reviews of the site, and operation and maintenance of the landfill cap system.

- Alternative 2b – Excavation and Consolidation of All Contaminated Sediment and Containment of Waste. Alternative 2b consists of all the same elements as Alternative 2a, except that the PAH and arsenic contaminated sediments would also be excavated and placed within the limits of the proposed cap system.

- Alternative 3 – Excavation and Off-Site Disposal of Waste and Sediment. Alternative 3 consists of the following components:

  - Excavation of sediment with concentrations of inorganic chemicals, pesticides, and PAHs above the RGOs for the protection of ecological and human receptors,

- Excavation of sediment and waste materials associated with the landfill area,

- Transportation and disposal of sediment and waste materials to approved off-site disposal facilities, and

- Restoration of salt marsh and landfill areas.

EVALUATION OF ALTERNATIVES

Each alternative was evaluated using criteria specified in the U.S. Environmental Protection Agency (U.S. EPA) Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (U.S. EPA, 1988) and RCRA Corrective Action Plan (Final) (U.S. EPA, 1994). These criteria include protection of human health and the environment; compliance with ARARS/media clean-up standards; source control; waste management standards; long-term reliability and effectiveness; reduction in toxicity, mobility, and/or volume; short-term effectiveness; implementability; and cost. Sections 5.0 and 6.0 of this report presents the results of this evaluation process. The analysis is summarized in Table ES-1.

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TABLE ES-1

COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 1 – INCINERATOR LANDFILL AND SWMU 41 - FORMER INCINERATOR UNIT
MCRD PARRIS ISLAND, SOUTH CAROLINA

Criterion	Alternative 1	Alternative 2a	Alternative 2b	Alternative 3
Overall Protection of Human Health and the Environment	Not Protective	Protective	More protective than Alternative 2a	Most protective of any alternative.
Compliance with ARARs/Media Cleanup Standards	Does not comply.	Compliance with AWQCs and MCLs in the future. Complies with federal and state solid waste and hazardous waste landfill closure requirements.	Compliance with AWQCs and MCLs in the future. Complies with federal and state solid waste and hazardous waste landfill closure requirements.	Compliance when remedial action is complete.
Source Control	No source control	Source control through presumptive remedy of containment. Limited sediment excavation and consolidation under the cap system.	Source control through presumptive remedy of containment. Total sediment excavation and consolidation under the cap system.	Source control through excavation and off-site disposal.
Waste Management Standards	Not applicable	Complies with federal and state solid waste and hazardous waste landfill closure requirements.	Complies with federal and state solid waste and hazardous waste landfill closure requirements.	Complies with federal and state solid waste and hazardous waste handling, transportation and disposal requirements.
Long-term Reliability and Effectiveness	Not effective or permanent	Effective and permanent with proper O&M and land use controls. Long-term monitoring and 5-year reviews are required.	More effective and permanent than 2a. Proper O&M required and land use controls. Long-term monitoring and 5-year reviews are required.	More effective and permanent than 2a and 2b. No O&M, land use controls, long-term monitoring, or 5-year reviews are required.
Reduction in toxicity, mobility, or volume through treatment	None	Reduction in contaminant mobility through excavation, consolidation, and capping. No enhanced treatment other than natural biological degradation.	Reduction in contaminant mobility through excavation, consolidation, and capping. No treatment.	Source removed and disposed off-site. No treatment.

TABLE ES-1

COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 1 – INCINERATOR LANDFILL AND SWMU 41 - FORMER INCINERATOR UNIT
MCRD PARRIS ISLAND, SOUTH CAROLINA

Criterion	Alternative 1	Alternative 2a	Alternative 2b	Alternative 3
Short-term Effectiveness	Not applicable	Short-term impacts to ecological habitat. Remedial actions completed in 1 year.	Short-term impacts to ecological habitat. Remedial actions completed in 1 year.	Short-term impacts to ecological habitat. Impacts to local community from transportation of waste material offsite. Remedial actions completed in 1 year.
Implementability	Not applicable	Readily Implementable	Readily Implementable	Readily Implementable
Cost	$0	Capital $6,166,000 O&M $23,000 to $70,000 Present Worth $6,513,000	Capital $7,069,000 O&M $21,000 to $70,000 Present Worth $7,391,000	Capital* $14,737,000 O&M $0 Present Worth* $14,737,000
				Capital** $13,422,000 O&M $0 Present Worth** $13,422,000
State and U.S. EPA Acceptance	To be determined	To be determined	To be determined	To be determined
Community Acceptance	To be determined	To be determined	To be determined	To be determined

* Assumes 10 percent hazardous waste.
** Assumes 1 percent hazardous waste.

AWQC = Ambient Water Quality Criteria
MCL = Maximum Contaminant Level
O&M = Operation and Maintenance
U.S. EPA = United States Environmental Protection Agency

1.0 INTRODUCTION

1.1 PURPOSE OF REPORT

Tetra Tech NUS, Inc. (TtNUS) has prepared this Feasibility Study (FS)/Corrective Measures Study (CMS) Report for the Incinerator Landfill [Site 1/Solid Waste Management Unit (SWMU) 1 and the Former Incinerator Unit (SWMU 41)], located at the Marine Corps Recruit Depot (MCRD) Parris Island, South Carolina (as shown in Figure 1-1). This report was prepared for the United States Navy (Navy) Southern Division (SOUTHDIV) Naval Facilities Engineering Command (NAVFAC) under Contract Task Order (CTO) 0020, for the Comprehensive Long-Term Environmental Action Navy (CLEAN) III Contract Number N62467-94-D-0888.

The objective of the Remedial Investigation/Resource Conservation and Recovery Act (RCRA) Facility Investigation (RI/RFI) and FS/CMS process is to gather and evaluate information sufficient to select an appropriate remedy for a given site based on an informed risk management decision-making process. An RI/RFI (TtNUS, 2001) was performed at Site/SWMU 1 between May 1998 and April 1999 that included sampling of soils, surface water, and sediment and an overall investigation of site groundwater and establishment of background conditions. Additionally the RI/RFI included investigation of surface soils at SWMU 41. The purpose of these activities was to characterize the nature and extent of contamination at Site/SWMU 1 and SWMU 41 where the potential for off-site migration exists. Both human health and ecological risk assessments were included in the report to support site decisions.

This FS/CMS Report uses the results of the RI/RFI report to develop and evaluate potential remedial alternatives/corrective measures for addressing risks to human health and the environment found within these areas.

1.2 REGULATORY SETTING

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act of 1986 (SARA) established a program for the cleanup of hazardous waste disposal and spill sites nationwide. This program contains provisions for the cleanup of contamination from the release of hazardous substances and is the framework for Installation Restoration (IR) programs at Navy and Marine Corps installations. RCRA, as amended, also establishes a cleanup program that provides for current and future hazardous waste management practices, as well as cleanup of past disposal sites at permitted or interim status Navy/Marine Corps installations. SOUTHDIVNAVFAC has the responsibility for implementing the Navy's IR Program at MCRD Parris Island.

Because of the past hazardous waste activities conducted at the MCRD Parris Island, South Carolina, the MCRD Parris Island meets criteria for conducting IR activities under the CERCLA regulatory framework. To date, the MCRD Parris Island has completed steps equivalent to the PA/SI and RI phases of the CERCLA remedial action process at Site/SWMU 1. The MCRD Parris Island also meets the criteria for conducting IR activities under the authority of RCRA because, in the late 1980s, the MCRD Parris Island submitted a RCRA Part A application. In accordance with RCRA, this action required the MCRD Parris Island to conduct corrective action for the release of hazardous waste or hazardous constituents from SWMUs. As part of this requirement, an interim RCRA Facility Assessment (RFA) was conducted in 1990 in which both the incinerator landfill and the former incinerator were addressed as SWMUs. Since this time, the MCRD Parris Island has withdrawn its Part A application.

Because of the circumstances surrounding the MCRD Parris Island's IR Program history, discussions have been held among representatives from the U.S. Marine Corps, the Navy, South Carolina Department of Health and Environmental Control (SCDHEC), and the U.S. Environmental Protection Agency (USEPA) Region 4 to determine the appropriate regulatory framework for conducting IR activities at the MCRD Parris Island. From these discussions, it has been decided that this report will encompass both CERCLA and RCRA requirements and the title, FS/CMS, reflects his decision. For ease of reading and clarity, the incinerator landfill (Site/SWMU 1) will be referred to as Site 1 for the remainder of this document. The former incinerator will be referred to as SWMU 41. In addition, because investigations have shown that SWMU 41 falls within the limits of Site 1, it can be assumed that remedial alternatives that address Site 1 will also address SWMU 41. Therefore, SWMU 41 is not explicitly discussed during alternative development and evaluation in this report.

1.3 REPORT ORGANIZATION

This report is divided into six sections. Section 1.0 presents the purpose of the report and the regulatory setting at MCRD Parris Island. Section 2.0 provides background information regarding Site 1 and SWMU 41. Section 3.0 presents the development of remedial action objectives/corrective measures objectives. Section 4.0 describes the identification, screening, and development of remedial action/corrective measures alternatives. Section 5.0 presents a detailed evaluation of the remedial action/corrective measure alternatives. Section 6.0 provides a comparative analysis of the alternatives. Appendices A through C provide support documentation for this report.

SOURCE: USGS 7.5 MINUTE PARRIS ISLAND QUADRANGLE, 1956. PHOTOREVISED 1979.

DRAWN BY D. PERRY	DATE 16-MAR-99	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7394 / OWNER NO. —
CHECKED BY CAR	DATE 5/16/01	DEPOT LOCATION MAP MCRD, PARRIS ISLAND, SOUTH CAROLINA	APPROVED BY — / DATE —
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1-1 / REV 0

P:\GIS\MCRD_PARRISISLAND\PARRIS.APR 5-14-01 MGS DEPOT LOCATION - SITE 1/41 LAYOUT

2.0 DESCRIPTION OF CURRENT CONDITIONS

2.1 SITE DESCRIPTION

MCRD Parris Island is located along the southern coast of South Carolina, approximately 1 mile south of the city of Port Royal and 3 miles south of the city of Beaufort within Beaufort County. MCRD Parris Island covers approximately 8,047 acres that consist of dry land, salt marshes, saltwater creeks, and ponds, as shown in Figure 1-1. MCRD Parris Island is the reception and recruit training facility for the Marine Corps for enlisted men from states east of the Mississippi River and for enlisted women nationwide.

Site 1 is located on the northeastern tip of Horse Island at MCRD Parris Island, as shown in Figure 1-1. The landfill extends approximately 670 feet into the marsh toward Archers Creek and is approximately 400 feet in width. The landfill occupies approximately 7 acres and was until recently covered with mature pine trees, as illustrated in Figure 2-1. In 2001, timber in the center of the site was harvested. Site 1 is located in a Flood Hazard Zone A9, indicating that parts of the site are within the 100-year flood plain.

Historical records indicate that SWMU 41 was located in one of two possible locations, as indicated in Figure 2-1. The former incinerator consisted of a coal-fired brick chamber approximately 43 feet long, 34 feet tall, and 20 feet wide. Emissions were vented through a hole in the top of the chamber. A ramp was situated along one of the unit's sides to provide access to the top of the incinerator. Trucks carried wastes up the ramp and discharged them into the hole. Based on the RI/RFI, the Navy determined that SWMU 41 was likely located within the area defined as Site 1 and that remediation of Site 1 would also remediate SWMU 41.

From 1921 to 1965, Site 1 served as the disposal site for combustion residues from the incinerator. The majority of wastes disposed in the landfill during this time were nonhazardous, combustible domestic wastes (ash residues) and other noncombustible wastes (e.g., cans, bottles, and construction debris). Additionally, hazardous wastes generated from the MCRD Parris Island from 1921 to 1959 were treated in the incinerator and disposed in the landfill. Paint thinners (mineral spirits), diesel fuels, kerosene, and strippers (methylene chloride) were also reportedly poured onto the landfill and burned (NEESA, 1986). No auxiliary fuels were used for open burning.

Wastes were initially piled on the land or placed in trenches into the marsh, extending the edge of the landfill farther into the marsh. Fill dirt was also used to build up the land at the edge of the marsh. The landfill progressively extended farther into the marsh as wastes were dumped on the edge of the fill. It is

estimated that 56,000 cubic yards of soil, fill, and waste material were disposed at Site 1 from 1921 to 1965.

SWMU 41 remained in operation until 1959. Site 1 continued to be used for disposal of combustible trash and noncombustible waste until 1965. Since 1965, no significant disposal or intrusive activity has taken place within the boundaries of Site 1 or SWMU 41.

2.2 SITE-SPECIFIC GEOLOGY AND HYDROGEOLOGY

To define the areal extent and depth of waste/fill material present at Site 1, auger soil borings were installed during the RI/RFI at locations where monitoring wells were installed and subsurface soil samples were collected. Soil boring logs for locations that were converted into monitoring wells are provided in Appendix A of the RI/RFI Report (TtNUS, 2001). These wells and borings were installed around the perimeter of the site. Based on the data obtained from the soil borings and other RI/RFI data, cross sections approximating existing conditions (e.g., ground surface and groundwater elevations, top and bottom of waste, surface features) have been generated. Figure 2-2 shows the locations of the five cross-sections that were generated. Longitudinal Cross-Section A–A' extends through the central portion of the Site 1 Landfill from the southern end to the northern tip and is presented in Figure 2-3. Cross-Sections B – B' and C – C' transect the landfill from east to west at two separate locations and are presented in Figures 2-4 and 2-5. Cross-Sections D-D' and E-E' extend along the eastern and western sides, respectively, of the landfill and are shown on Figures 2-6 and 2-7. The estimated bottom of the waste assumes that the tidal mud flat remains flat throughout the site. This assumption is supported by the mud flat's presence on either side of the site and that it stretches for several miles in either direction. The estimate also assumes that waste materials have not migrated much beyond the surface of the underlying sediments. These assumptions are supported by the soil boring data obtained from the perimeter of the landfill and historical aerial photographs that do not indicate the presence of any significant depressions in this area.

A detailed discussion of the site-specific geology and hydrogeology of Site 1 and SWMU 41 is presented in Sections 3.3 and 3.4 of the RI/RFI Report (TtNUS, 2001). The following paragraphs summarize geologic and hydrogeologic information for Site 1 and SWMU 41.

Surface soils collected from the interior of the landfill during the 1998 field event for the RI/RFI consisted of fine to medium sands with varying amounts of silt and clay. Surface debris consisting of glass and metal was observed during the field event. This material was observed in several surface soil locations at depths of 1 foot or less.

The site-specific subsurface geology at the unit has been affected by human activities. Material was buried in pits in the landfill, creating topographic high and low areas within the facility limits. In the soil boring locations along the edge of the landfill boundary, landfilled debris consisted of creosote-soaked poles, glass fragments, and construction debris, which included concrete and brick fragments. Generally, the shallow subsurface geology of the study area consists of a heterogeneous mixture of tidal- and storm-deposited silt, clay, and sand; clays are prevalent to a depth of approximately 28 feet below ground surface (bgs). Beneath the tidal sands, silts, and clays, the sediment consists of fine to coarse sands with varying clay content to depths of 34 to 36 feet bgs.

In general, a surficial groundwater table (less than 2.5 feet bgs) exists at the site where the new monitoring wells were installed. Based on the depth of the confining unit (Hawthorn Formation), which was consistently identified at approximately 36 feet bgs, the thickness of the surficial aquifer is 33.5 feet. Locally, shallow groundwater is expected to flow from the middle of the landfill facility toward the topographic low areas (surrounding tidal streams) that serve as groundwater discharge points. The geometric average hydraulic conductivity for the six shallow surficial aquifer wells and the five deep surficial aquifer wells was calculated to be approximately 2.52 feet per day [8.89×10^{-4} centimeters per second (cm/sec)] and 4.51 feet per day (1.59×10^{-3} cm/sec), respectively. The values for the shallow and deep wells are within the typical range of hydraulic conductivity for the encountered material.

The upper surficial is generally divided from the lower Floridan Aquifer by the Hawthorn Formation, which acts as a confining unit. The Hawthorn Formation is a phosphatic sand and clay unit with a reported thickness of approximately 2 to 40 feet in the study area. The results of a falling head permeability test performed on an undisturbed sample (gray-green silty to clayey, fine sand) at a depth of 39 to 41 feet bgs indicate the encountered material has a vertical hydraulic conductivity of 8.4×10^{-8} cm/sec. Based on the results of the falling head permeability test, the material likely acts as a confining unit. At soil boring PAI-01-SB-05 [well cluster PAI-01-MW-13(S)/14(D)], the confining unit is underlain to a depth of at least 50 feet bgs by fine to coarse sand that gets tighter and dryer with depth. Assuming this sand unit exists across the site, the confining unit is approximately 6 feet thick.

The Floridan Aquifer, which underlies the site, extends continuously from South Carolina into Florida. Groundwater of this aquifer occurs mainly under artesian conditions at MCRD Parris Island. The Floridan aquifer is the most important source of groundwater in the Low Country area, and wells generally less than 250 feet deep tap this aquifer system. The aquifer is the only source of potable groundwater west, north, and east of MCRD Parris Island.

2.3 NATURE AND EXTENT OF CONTAMINATION

In addition to the RI/RFI, several investigations have been conducted at Site 1 and consist of the following:

- In 1986, the Naval Energy and Environmental Support Activity (NEESA) conducted an Initial Assessment Study (IAS) (NEESA, 1986) under the Naval Assessment and Control of Installation Pollutants Program. The IAS is equivalent to the preliminary assessment phase of the CERCLA process.

- Based on the recommendations of the IAS, McClelland Consultants conducted a verification step at Site 1 (McClelland, 1990). The verification step is equivalent to the site inspection phase of the CERCLA process.

- Per the requirements of the MCRD Parris Island's application for a RCRA permit, an Interim RFA was performed from January 1990 to March 1990 (Kearney, 1990). Both Site 1 and SWMU 41 were included within this report.

The results of these investigations are summarized in Section 1.4.3 of the RI/RFI Report for Site 1 and SWMU 41 (TtNUS, 2001). Additionally, the nature and extent of contamination, as determined during the RI/RFI, is presented in Section 4.0 of the RI/RFI report (TtNUS, 2001). A summary of the nature and extent of contamination as determined during the RI/RFI is provided below.

Surface soils were found to contain several polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and several metals including lead, arsenic, aluminum, iron, mercury, vanadium, and zinc at concentrations greater than present in background soils and in exceedance of the most stringent human health risk-based concentrations (RBCs) (residential) or the most stringent ecological screening values. The highest levels of metals were generally associated with areas with little or no cover soil. Because of the common application of pesticides at the base, pesticides may or may not have resulted from waste disposal activities.

Arsenic, iron, lead, manganese, and chloroform were detected in the site groundwater at concentrations that exceed the most stringent human health criteria (drinking water standards). The presence of a salt water marsh surrounding the site and the measured salinity in the groundwater limits the use of site groundwater as a potable water supply. Naphthalene, copper, lead, mercury, and zinc were present in groundwater at concentrations that could exceed the most stringent ecological screening values for surface water if groundwater to surface water attenuation factors were not present.

Bis(2-ethylhexyl)phthalate, chrysene, pentachlorophenol, arsenic, manganese, and zinc were detected in surface water at concentrations in excess of background and the most stringent human health RBCs or the most stringent ecological screening values.

Sediments were found to contain several PAHs, pesticides, arsenic, silver, copper, lead, mercury, and zinc at concentrations greater than present in background sediments and in exceedance of the most stringent human health RBCs (residential) or the most stringent ecological screening values. Because of the common application of pesticides at the base, the pesticides may or may not be from site-related waste disposal activities.

2.4 HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

2.4.1 Human Health Risk Assessment

A baseline human health risk assessment (HHRA) was conducted to characterize and quantify potential health risks at Site 1 and SWMU 41, in the absence of remedial action. The results of the HHRA are presented in Section 6.0 of the RI/RFI Report (TtNUS, 2001). A summary of the results of the HHRA as determined during the RI/RFI is provided below.

The human health risk assessment considered site media exposure to construction workers, maintenance workers, recreational users, and potential future residents. The estimated incremental cancer risk to construction workers exceeded $1x10^{-6}$ but was less than $1x10^{-4}$. This risk is within the acceptable U.S. EPA target risk range. The noncarcinogenic risk estimate for the construction worker was slightly greater than 1.0 (2.6), indicating that toxic effects are possible. However, the only chemical with a Hazard Quotient greater than 1.0 was iron.

The estimated incremental cancer risk to maintenance workers exceeded $1x10^{-6}$ but was less than $1x10^{-4}$. This risk is within the acceptable U.S. EPA target risk range. The noncarcinogenic risk estimate for the maintenance worker was less than 1.0, indicating that toxic effects are not anticipated.

For surface water, the estimated incremental cancer risk to the adolescent recreational user exceeded $1x10^{-4}$ for surface water (at $1.1x10^{-4}$). This risk is greater than the U.S. EPA target risk range. Bis(2-ethylhexyl) phthalate and pentachlorophenol were the major contributors to this cancer risk estimate. For soils and sediments, the estimated incremental cancer risk to adolescent exceeded $1x10^{-6}$ but was less than $1x10^{-4}$. This risk is within the acceptable U.S. EPA target risk range. The

noncarcinogenic risk estimate for the adolescent recreational user indicates that toxic effects are not anticipated.

The estimated incremental cancer risk to the adult recreational user exceeded $1x10^{-6}$ but was less than $1x10^{-4}$. This risk is within the acceptable U.S. EPA target risk range. The noncarcinogenic risk estimate for the adult recreational user indicates that toxic effects are not anticipated.

The estimated incremental cancer risk to potential future residents exceeded $1x10^{-4}$ for surface water (at $4.2x10^{-4}$). Bis(2-ethylhexyl) phthalate and pentachlorophenol in surface water were the major contributors to this cancer risk estimate. This risk is greater than the U.S. EPA target risk range. Also, the noncarcinogenic risk estimate for potential future residents was greater than 1.0, indicating that toxic effects are possible.

2.4.2 Ecological Risk Assessment

An ecological risk assessment (ERA) was performed to characterize the potential risks from site-related contaminants to ecological receptors. The results of the ERA are presented in Section 7.0 of the RI/RFI Report (TtNUS, 2001). A summary of the results of the ERA as determined during the RI/RFI is provided below.

The initial ecological risk screening determined that the maximum concentrations of pentachlorophenol and several metals, pesticides, phthalates, and PAHs detected at the site exceeded U.S. EPA Region IV screening values, indicating a potential risk to ecological receptors. In addition, several other chemicals were identified as Chemicals of Potential Concern (COPCs) because of the lack of screening criteria.

The food-chain modeling evaluated 11 representative receptors and found that the majority of the initial COPCs do not represent a threat to site receptors even under a worst-case scenario (organisms constantly exposed to maximum concentrations). Chemicals that pose potential risks under this scenario consist of PCBs, pesticides, phthalates, and several metals.

The food-chain modeling found that under more realistic conditions, which consider mean chemical concentrations, the list of chemicals in which Hazard Quotients (HQ) for no observed adverse effects levels (NOAELs) exceed 1.0 was reduced to the following:

- p,p'-dichlorodiphenyl dichloroethane (DDD)(maximum HQ is 30)
- p,p'-dichlorodiphenyl dichloroethylene (DDE) (maximum HQ is 177)
- p,p'-dichlorodiphenyl trichloroethane (DDT) (maximum HQ is 66)

- aluminum (maximum HQ is 1,130)
- antimony (maximum HQ is 27)
- arsenic (maximum HQ is 10.6)
- barium (maximum HQ is 6.7)
- cadmium (maximum HQ is 3.4)
- iron (maximum HQ is 116)
- lead (maximum HQ is 195)
- mercury (maximum HQ is 41)
- thallium (maximum HQ is 10.1)
- vanadium (maximum HQ is 27.5)
- zinc (maximum HQ is 28)

In evaluating this data, the following factors should be considered.

- Except for aluminum, arsenic, thallium, and vanadium, the maximum HQs were all associated with terrestrial receptors and surface soils.

- Because of basewide application, pesticides may or may not be site related. The majority of the pesticides detected at Site/SWMU 1 were similar to typical concentrations found at the base.

2.5 APRIL 2001 SEDIMENT SAMPLING

On April 26, 2001, nine additional sediment samples were collected at Site 1 to better define the extent of contaminated sediments. The number of samples and sample analytes were determined during the February 2001 MCRD Partnering Team meeting and detailed in the draft Site Work Plan addendum dated March 29, 2001. This draft plan was implemented as a final and is provided in Appendix C.

A summary of the analytical results is presented in Table 2-1. Sample locations are presented Section 3.0 figures. Sample documentation is provided in Appendix C. The results and sample locations are described below.

Sediment samples PAI-01-SD-018-01, -019-01, and -020-01 were collected along the western edge of Site 1 to better define the extent of pesticide and metal contamination in this area. A small tidal stream (approximately 2 feet wide and 6 inches deep) flows parallel to the site along the western edge of the site. The stream is approximately 60 feet from the edge of the visible waste and is suspected to be a potential barrier to further western migration of sediment contamination. Sediment sample PAI-SD-018-01 was

collected on the landfill side (east) of this stream and found to contain pesticides, copper, lead, and mercury at concentrations in excess of the ecological screening values. Sediment sample PAI-SD-019-01 was collected approximately 100 feet west of this stream. Pesticides were not detected in this sample and the metals were detected but at concentrations less than ecological screening values. Sediment sample PAI-SD-020-01 was collected within approximately 5 feet of this stream. Pesticides were detected in this sample, but at concentrations less than ecological screening values. Copper and lead were detected in this sample and at concentrations of 1.15 and 1.27 times the ecological screening values. Based on only relatively minor exceedances of the screening values, this tidal stream represents an approximate boundary of Site related sediment contamination.

Sediment samples PAI-01-SD-21-01 and -22-01 were collected along the northwestern edge of Site 1 to better define the distribution of arsenic contamination in this area (assuming a residential use scenario). Arsenic was detected in these sediment samples at concentrations of 18.8 and 9.5 milligrams per kilogram (mg/kg), respectively. Although these concentrations exceed a human health residential use risk scenario screening value, the detected concentrations are similar to the background concentration established for MCRD Parris Island (12.4 mg/kg) and are consistent with the range of concentrations detected at the site in the 1998 and 1999 investigations (1.2 to 15.6 mg/kg).

Four sediment samples (PAI-01-SD-023-01 to -26-01) were collected along the eastern side of the Site, between a tidal stream (20 feet across and 2 to 3 feet deep) and the landfill. The samples were analyzed for copper, lead, mercury and PAHs. In 1998 and 1999, elevated levels of these metals and PAHs were detected in the sediment adjacent to the landfill. In addition, elevated levels of PAHs were noted in a sample located approximately 300 feet from the site and near this tidal stream. Treated timber was noted in this general area and is a suspected source of the PAHs. The treated lumber has since washed in toward the Site. The results of this sediment investigation found metals in each of the four samples, but at concentrations less than the ecological screening values. PAHs were detected in only one of the four sediment samples in this area, but the detected concentrations were less than ecological screening values.

TABLE 2-1

RESULTS OF APRIL 2001 SEDIMENT INVESIGATION
SITE 1 - INCINERATOR LANDFILL
MCRD PARRIS ISLAND, SOUTH CAROLINA

Chemicals			PAI-01-SD-018-01		PAI-01-SD-019-01		PAI-01-SD-020-01		PAI-01-SD-021-01	PAI-01-SD-022-01
	Eco PRG	DF MDL	4.1		3.9		3.2		1	1
2-Methylnaphthalene	--	2.51	23.3		9.8	U	8.0	U	NA	NA
Acenaphthene	--	5.35	21.9	U	20.9	U	17.1	U	NA	NA
Acenaphthylene	--	4.13	16.9	U	16.1	U	13.2	U	NA	NA
Anthracene	--	5.05	20.7	U	39.5		16.2	U	NA	NA
Benzo(a)anthracene	--	3.8	15.6	U	172.9		12.2	U	NA	NA
Benzo(a)pyrene	--	6.41	26.3	U	108.6		20.5	U	NA	NA
Benzo(b)fluoranthene	--	4.38	18.0	U	194.8		14.0	U	NA	NA
Benzo(k)fluoranthene	--	4.44	18.2	U	57.6		14.2	U	NA	NA
Chrysene	--	3.59	14.7	U	71.1		11.5	U	NA	NA
Dibenzo(a,h)anthracene	--	5.82	23.9	U	22.7	U	18.6	U	NA	NA
Fluoranthene	--	4.3	24.1		201.2		16.6		NA	NA
Fluorene	--	3.26	13.4	U	12.7	U	10.4	U	NA	NA
Indeno(1,2,3-cd)pyrene	--	7.43	30.5		72.3		23.8	U	NA	NA
Naphthalene	--	3.75	15.4	U	14.6	U	12.0	U	NA	NA
Phenanthrene	--	4.04	16.6	U	110.5		12.9	U	NA	NA
Pyrene	--	2.97	21.8		132.0		15.3		NA	NA
Total PAHs (eco)	1684		162		884		108			
		DF	4.1		3.9		3.2			
4,4'-DDE	31.6	0.302	7	J	1.2	U	3.6	J	NA	NA
4,4'-DDD	33.6	0.603	14	J	2.4	U	1.9	U	NA	NA
4,4'-DDT	34.5	0.546	70		2.1	U	1.7	U	NA	NA
DDTR	99.8		91		5.7		7.3			
Arsenic	--		NA		NA		NA		18.8	9.5
Copper	18.7		78.8		18		21.6		NA	NA
Lead	30.2		238		28.8		38.4		NA	NA
Mercury	0.13		0.15		0.07		0.09		NA	NA

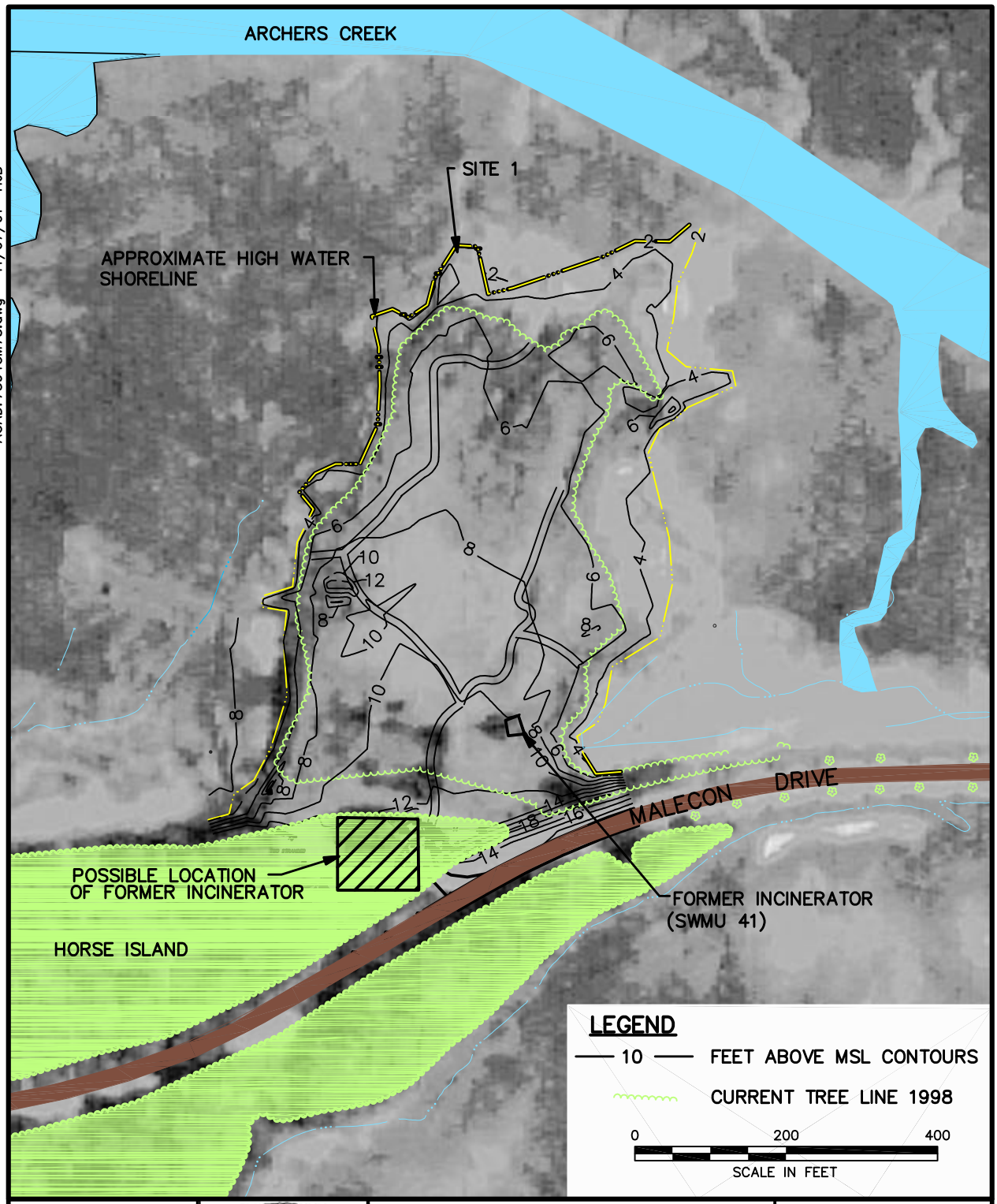
TABLE 2-1

RESULTS OF APRIL 2001 SEDIMENT INVESIGATION
SITE 1 - INCINERATOR LANDFILL
MCRD PARRIS ISLAND, SOUTH CAROLINA

CHEMICALS			PAI-01-SD-023-01		PAI-01-SD-024-01		PAI-01-SD-025-01		PAI-01-SD-026-01	
	Eco PRG	DF MDL	1.6		1.5		2.2		14	
2-Methylnaphthalene	--	2.51	4.0	U	3.8	U	5.5	U	35.1	U
Acenaphthene	--	5.35	8.6	U	8.0	U	11.8	U	74.9	U
Acenaphthylene	--	4.13	6.6	U	6.2	U	9.1	U	57.8	U
Anthracene	--	5.05	8.1	U	7.6	U	11.1	U	70.7	U
Benzo(a)anthracene	--	3.8	6.1	U	5.7	U	8.4	U	53.2	U
Benzo(a)pyrene	--	6.41	10.3	U	9.6	U	14.1	U	89.7	U
Benzo(b)fluoranthene	--	4.38	7.0	U	6.6	U	9.6	U	136.6	
Benzo(k)fluoranthene	--	4.44	7.1	U	6.7	U	9.8	U	42.8	
Chrysene	--	3.59	5.7	U	5.4	U	7.9	U	87.0	
Dibenzo(a,h)anthracene	--	5.82	9.3	U	8.7	U	12.8	U	81.5	U
Fluoranthene	--	4.3	6.9	U	6.5	U	9.5	U	66.6	
Fluorene	--	3.26	5.2	U	4.9	U	7.2	U	45.6	U
Indeno(1,2,3-cd)pyrene	--	7.43	11.9	U	11.1	U	16.3	U	104.0	U
Naphthalene	--	3.75	6.0	U	5.6	U	8.3	U	52.5	U
Phenanthrene	--	4.04	6.5	U	6.1	U	8.9	U	56.6	U
Pyrene	--	2.97	4.8	U	4.5	U	6.5	U	50.3	
Total PAHs	1684		44		41		60		1008	
4,4'-DDE	31.6		NA		NA		NA		NA	
4,4'-DDD	33.6		NA		NA		NA		NA	
4,4'-DDT	34.5		NA		NA		NA		NA	
DDTR	99.8									
Arsenic	--		NA		NA		NA		NA	
Copper	18.7		4.5		3		7.8		13.7	
Lead	30.2		8.6		6.2		12.1		17.5	
Mercury	0.13		0.01		0.01		0.03		0.04	

Eco PRG is based on EPA Region IV PRGs
NA is not analyzed.
MDL is the method detection limit
The DF is the dilution factor that is adjusted by the laboratory for sample moisture and matrix dilution.
Total PAHs were calculated using the Detection Limit (DL), the report will use 1/2 the detection limit.

U indicates that the analyte was not detected.
J indicates that the value was estimated.
-- No ecological preliminary remediation goals.



ACAD: 7394CM73.dwg 11/07/01 HJB

DRAWN BY HJP DATE 5/14/01		SITE LAYOUT SITE 1 – INCINERATOR LANDFILL AND SWMU 41 – FORMER INCINERATOR MCRD PARRIS ISLAND, SOUTH CAROLINA	CONTRACT NO. 7394
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-1 / REV. 0

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98

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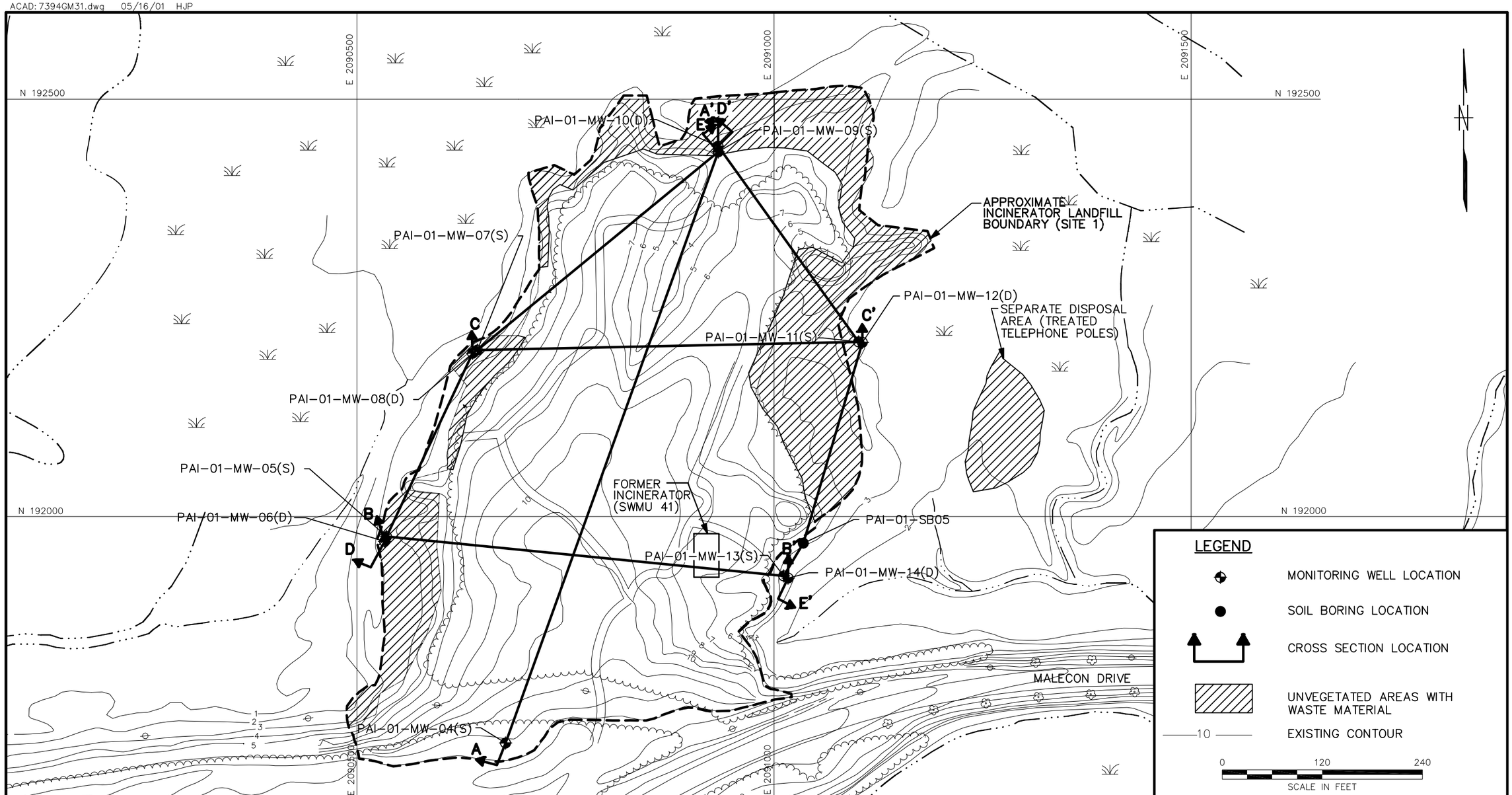

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DRAWN BY HJP DATE 4/15/01
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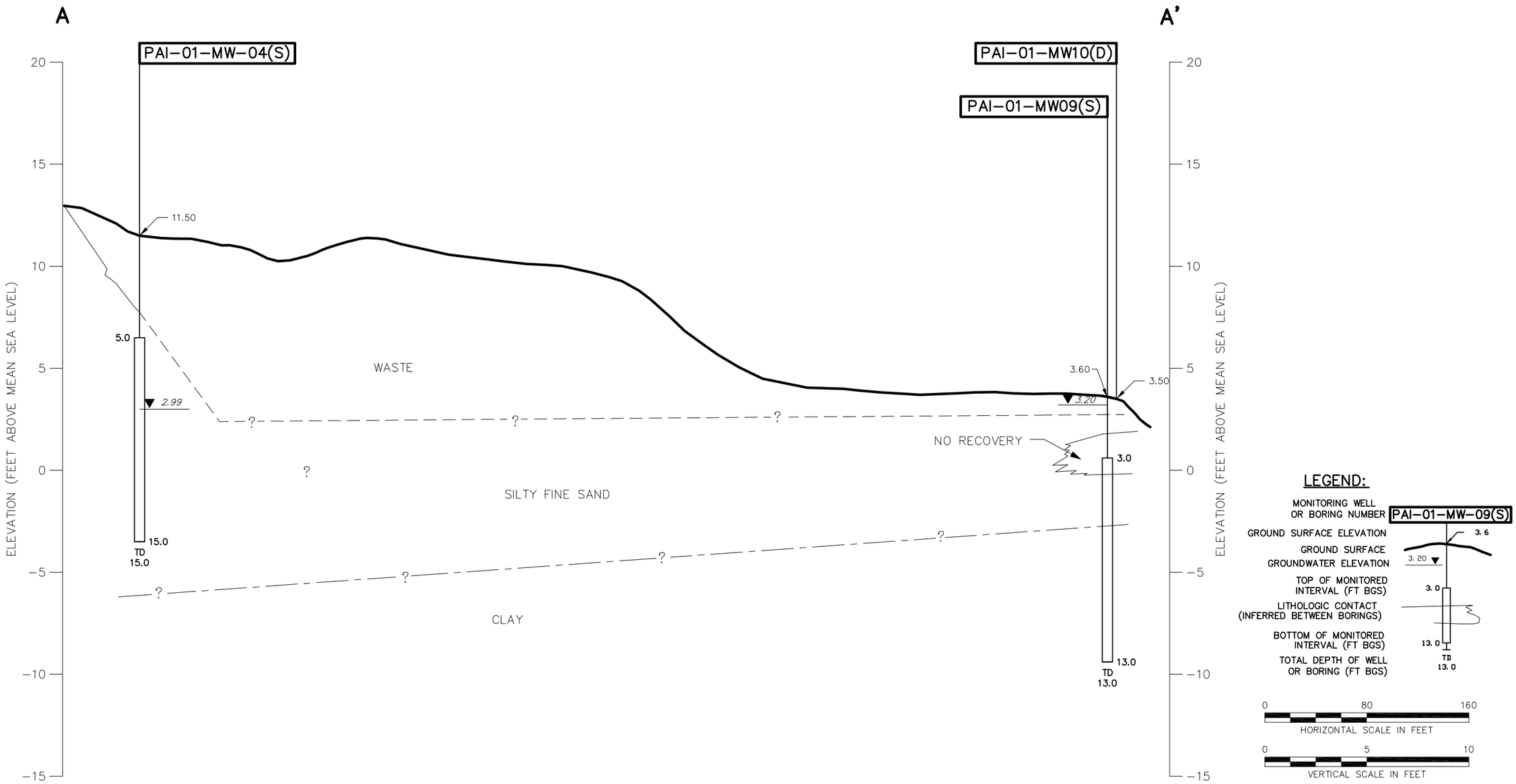
COST/SCHED-AREA
SCALE AS NOTED

CROSS SECTION LOCATION AND WASTE DELINEATION MAP
SITE 1 – INCINERATOR LANDFILL AND SWMU 41 – FORMER INCINERATOR
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7394
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-2
REV. 0

FORM CADD NO. SDIV_BH.DWG – REV 0 – 1/20/98

ACAD: 7394GX21.dwg 01/11/02 HJB



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 12/27/00

CHECKED BY DATE

COST/SCHED-AREA

SCALE AS NOTED

CROSS SECTION A-A'
SITE 1 – INCINERATOR LANDFILL AND
SWMU 41 – FORMER INCINERATOR
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7394

APPROVED BY DATE

APPROVED BY DATE

DRAWING NO. FIGURE 2-3

REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

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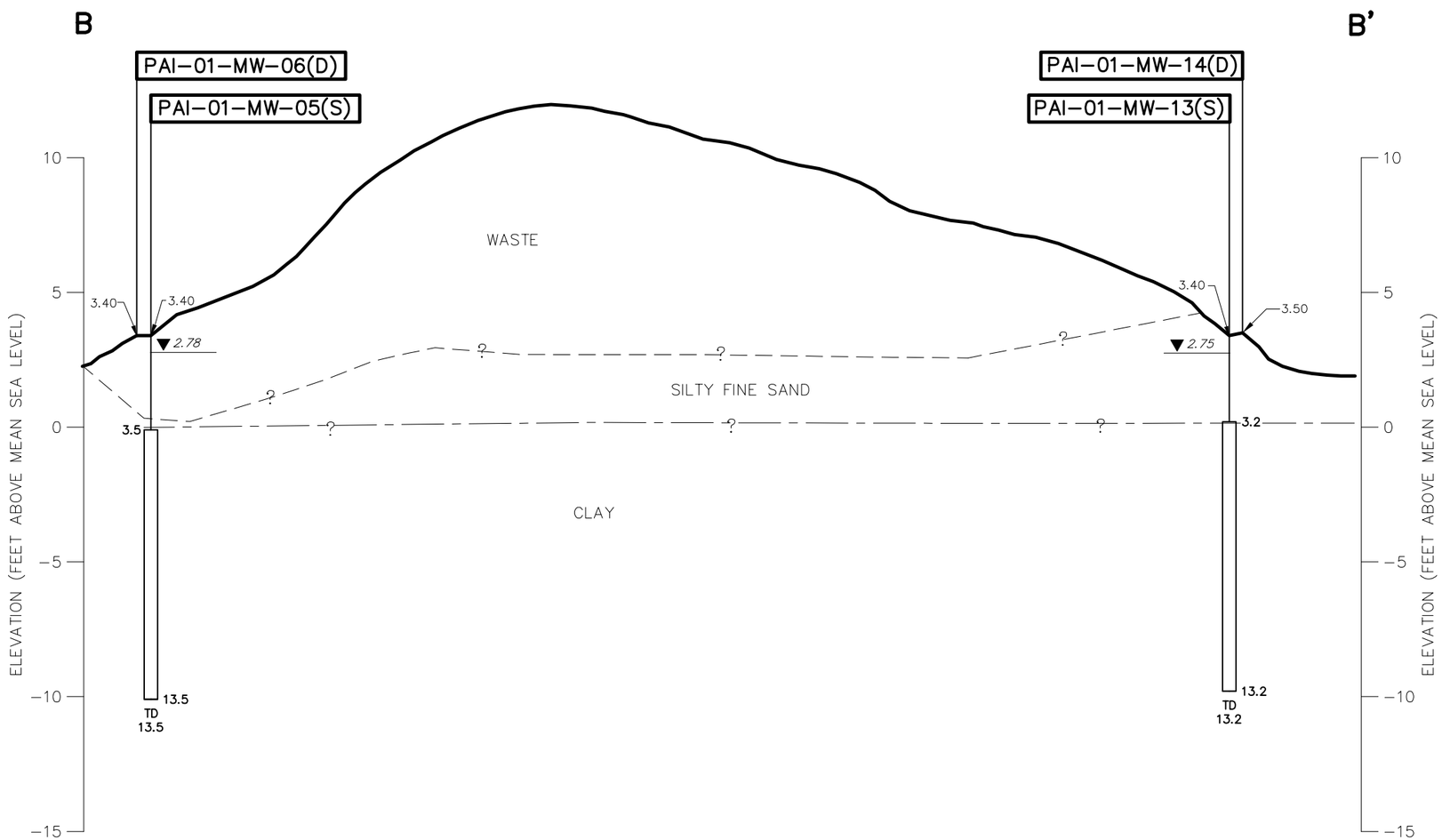

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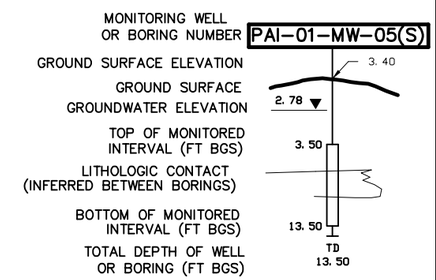

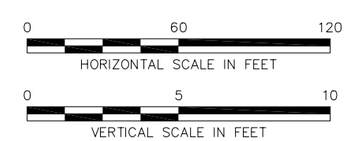

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

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COST/SCHED-AREA
SCALE AS NOTED

CROSS SECTION B-B'
SITE 1 - INCINERATOR LANDFILL AND
SWMU 41 - FORMER INCINERATOR
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7394
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-4
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

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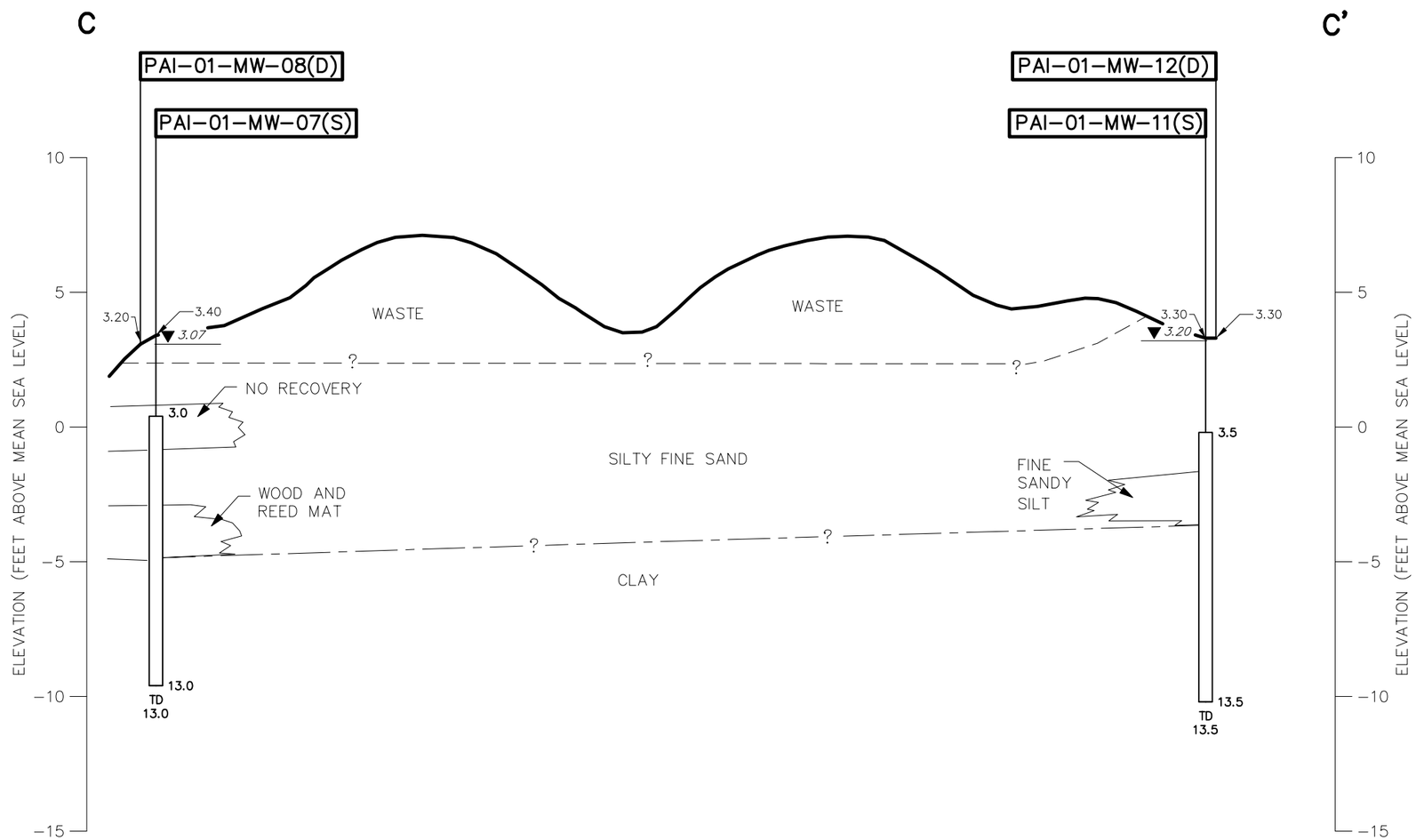

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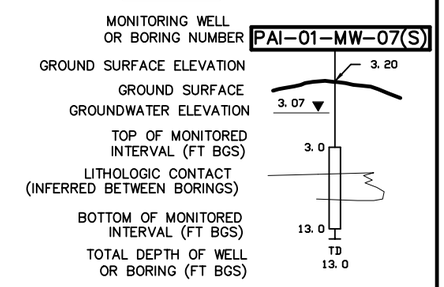

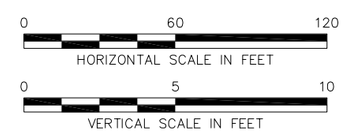

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CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

CROSS SECTION C-C'
SITE 1 - INCINERATOR LANDFILL AND
SMWU 41 - FORMER INCINERATOR
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7394
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DRAWING NO. FIGURE 2-5
REV. 0

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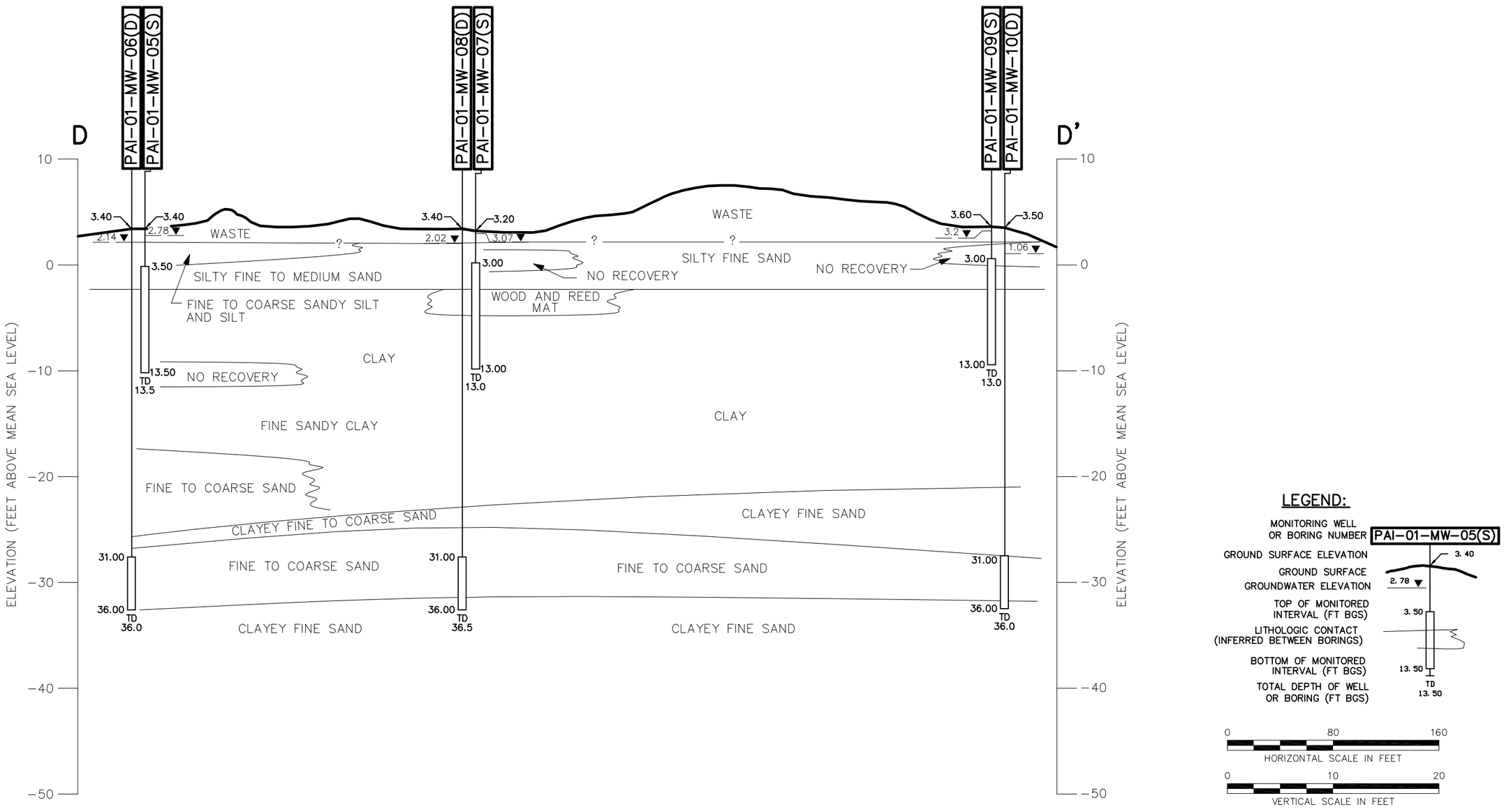

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DRAWN BY HJP DATE 12/22/00
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COST/SCHED-AREA
SCALE AS NOTED

CROSS SECTION D-D'
SITE - 1 INCINERATOR LANDFILL AND
SWMU 41 - FORMER INCINERATOR
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7394
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DRAWING NO. FIGURE 2-6
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

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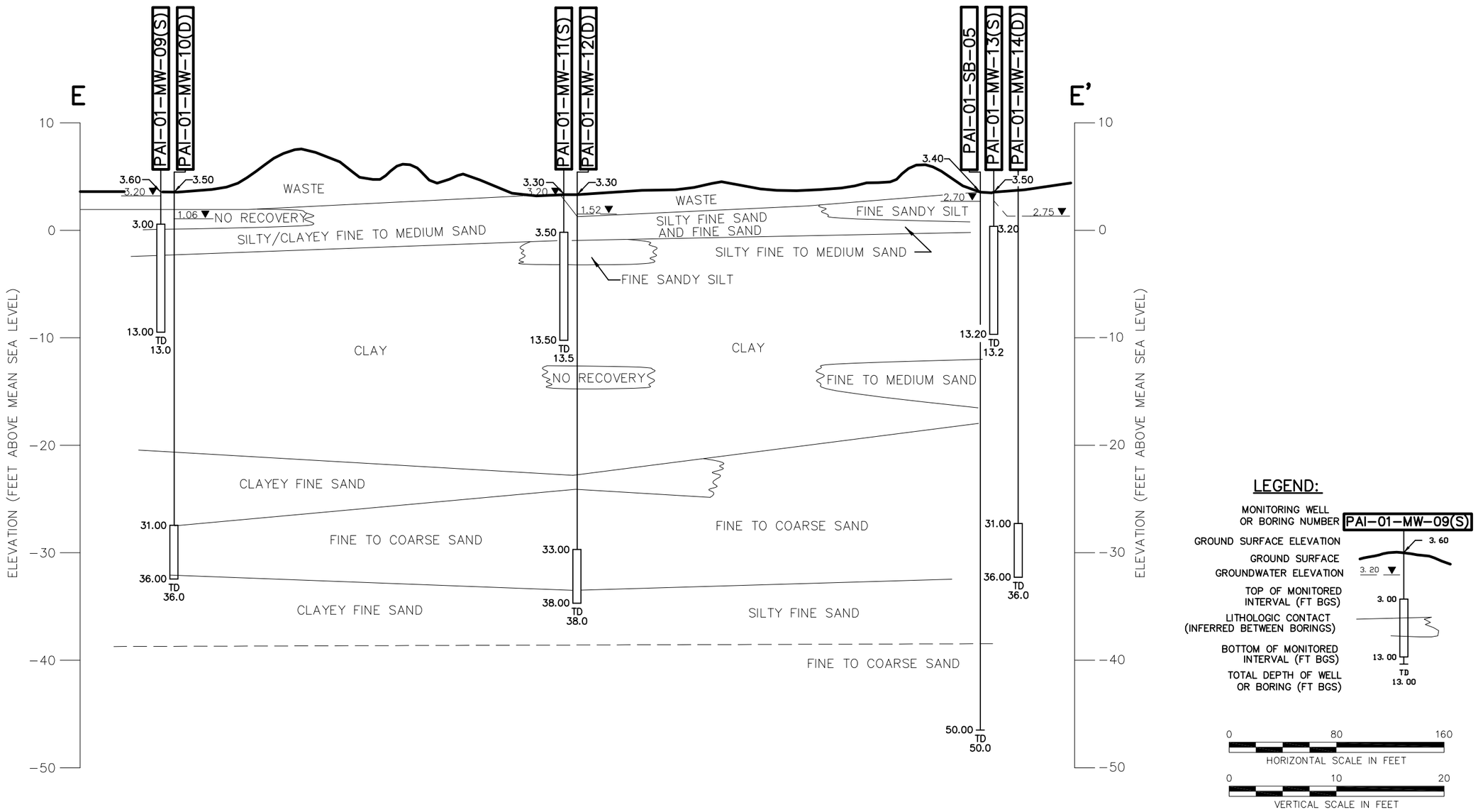

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DRAWN BY HJP DATE 12/28/98
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COST/SCHED-AREA
SCALE AS NOTED

CROSS SECTION E-E'
SITE 1 – INCINERATOR LANDFILL AND
SWMU 41 – FORMER INCINERATOR
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7394
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DRAWING NO. FIGURE 2-7
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

3.0 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES/CORRECTIVE MEASURES OBJECTIVES

3.1 INTRODUCTION

Remedial Action Objectives/Corrective Action Objectives (RAOs/CAOs) are developed as medium- and chemical-specific objectives that will result in the protection of human health and the environment. Typically, RAOs/CAOs are developed based on promulgated standards [e.g., Ambient Water Quality Criteria (AWQC)], background concentrations determined from a site-specific investigation, and human health and ecological risk-based concentrations developed in accordance with the U.S. EPA risk assessment guidance.

Section 3.0 presents the development of RAOs/CAOs for Site 1 at MCRD Parris Island. Section 3.2 presents Applicable or Relevant and Appropriate Requirements (ARARs), which include requirements, criteria, or limitations promulgated under the Federal and state law that address a chemical, action, or location at a site. Section 3.3 presents a discussion on presumptive remedies for landfills and the applicability of a presumptive remedy approach for Site 1. Sections 3.4 and 3.5 discuss the media and Chemicals of Concern (COCs) that will be addressed in this FS/CMS. Based on ARARs and the identified media of concern and COCs, Section 3.6 presents the site-specific RAOs/CAOs. A range of chemical-specific values or Remedial Goal Options (RGOs) that would attain these objectives is presented in Section 3.7. Lastly, Section 3.8 presents areas of waste and impacted sediment at Site 1 based on the selected RGOs.

3.2 ARARS/MEDIA CLEANUP STANDARDS

ARARs/media cleanup standards, which include the requirements, criteria, or limitations promulgated under the Federal and state law that address a chemical, location, or action at a site, are presented in this section.

The definition of ARARs is as follows:

- Any standard, requirement, criterion, or limitation under Federal environmental law.
- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-citing law that is more stringent than the associated Federal standard, requirement, criterion, or limitation.

One of the primary concerns during the development of RAOs/CAOs is the degree of human health and environmental protection afforded by a given remedy. Consideration should be given to remedies that attain or exceed ARARs.

Definitions of the two types of ARARs, as well as other to be considered (TBC) criteria, are given below:

- Applicable Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site.

- Relevant and Appropriate Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that, while not "applicable," address problems or situations sufficiently similar (relevant) to those encountered at a site that their use is well suited (appropriate) to the particular site.

- TBC Criteria are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing remedial actions or necessary for determining what is protective of human health and/or the environment. Examples of TBC criteria include U.S. EPA Drinking Water Advisories and RBCs.

These requirements are presented to provide decision makers with a complete evaluation of potential ARARs in developing, identifying, and selecting a corrective measure alternative.

ARARs fall into three categories, based on the manner in which they are applied:

- Chemical Specific: Health-/risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Examples of chemical-specific ARARs include Maximum Contaminant Levels (MCLs) and Clean Water Act (CWA) water quality criteria. Chemical-specific ARARs are considered in evaluating the extent of site cleanup.

- Location Specific: Restrictions based on the concentration of hazardous substances or the conduct of activities in specific locations. These may restrict or preclude certain remedial action/corrective measures or may apply only to certain portions of site. Examples of location-specific ARARs include floodplain and coastal zone management requirements. Location-specific ARARs pertain to special site features.

- Action Specific: Technology- or activity-based controls or restrictions on activities related to management of hazardous waste. Action-specific ARARs pertain to implementing a given remedy.

Tables 3-1 and 3-2 present a summary of Federal and state ARARs and TBCs for potential remedial action/corrective measures undertaken for Site 1 at MCRD Parris Island. The following sections present a brief description of each chemical-, location-, or action-specific ARAR and TBC contained in Tables 3-1 and 3-2.

3.2.1 Chemical-Specific ARARs and TBCs

This section presents a summary of Federal and state chemical-specific ARARs and TBCs. These criteria provide medium-specific guidance on "acceptable" or "permissible" concentrations of chemicals.

The Safe Drinking Water Act (SDWA) [40 Code of Federal Regulations (CFR) 140-143] promulgated National Primary Drinking Water Standard Maximum Contaminant Levels (MCLs) (40 CFR 141). MCLs are enforceable standards for chemicals in public drinking water supply systems. They consider not only health factors but also the economic and technical feasibility of removing a chemical from a water supply system. Secondary MCLs (SMCLs) (40 CFR 143) are not enforceable but are intended as guidelines for chemicals that may adversely affect the aesthetic quality of drinking water, such as taste, odor, color, and appearance, and may deter public acceptance of drinking water provided by public water systems.

The SDWA also established MCL Goals (MCLGs) for several organic and inorganic compounds in drinking water. MCLGs are set at levels of no known or anticipated adverse health effects, with an adequate margin of safety. The National Contingency Plan (NCP) [40 CFR 300.430(e)(2)(i)] states that MCLGs that are set at levels above zero shall be attained by remedial actions for groundwater or surface waters that are current or potential sources of drinking water [where the MCLGs are relevant and appropriate under the circumstances of the release based on the factors in Section 300.400(g)(2) of the NCP]. If an MCLG is found not to be relevant and appropriate, the corresponding MCL will be achieved where relevant and appropriate to the circumstances of the release. For MCLGs that are set at zero, the MCL promulgated for that chemical under the SDWA will be attained by the remedial action. In cases involving multiple contaminants or pathways where attainment of chemical-specific ARARs will result in a cumulative cancer risk in excess of 1E-04, criteria in paragraph (e)(2)(i)(A) of Section 300.430 (i.e., risk-based criteria) may be considered when determining the cleanup level to be attained. The NCP explains that cleanup levels set at zero (generally the case for carcinogens) are not appropriate because complete elimination of risk is not possible and because "true zero" cannot be detected.

The groundwater at Site 1 is saline to brackish and is not a viable source of drinking water and, therefore, the SDWA is not applicable.

The CWA sets U.S. EPA AWQCs that are non-enforceable guidelines developed for pollutants in surface waters, pursuant to Section 304(a)(1) of the CWA. Although AWQCs are not legally enforceable, they should be considered as relevant and appropriate requirements. AWQCs are available for the protection of human health from exposure to chemicals in surface water as well as from ingestion of aquatic biota and for the protection of freshwater and saltwater aquatic life. AWQCs may be considered for existing discharges to the marsh and actions that involve groundwater treatment and/or discharge to nearby surface waters.

RCRA Subtitle C regulates the treatment, storage, and disposal of hazardous waste from its generation until its ultimate disposal. In general, RCRA Subtitle C requirements for the treatment, storage, or disposal of hazardous waste will be applicable if

- The waste is a listed or characteristic waste under RCRA.
- The waste was treated, stored, or disposed (as defined in 40 CFR 260.10) after the effective date of the RCRA requirements under consideration.
- The activity at the CERCLA site constitutes current treatment, storage, or disposal as defined by RCRA.

The following chemical-specific requirements included in the RCRA Subtitle C regulations are potentially applicable to MCRD Parris Island.

- Identification and listing of hazardous waste (40 CFR 261)
- Groundwater protection and groundwater monitoring (40 CFR 264.90-264.101)
- Land disposal restrictions (40 CFR 268.1-268.50)

U.S. EPA Health Advisories (U.S. EPA, 1996a) are nonenforceable guidelines (TBCs) developed by the U.S. EPA Office of Drinking Water for chemicals that may be intermittently encountered in public water supply systems. Health advisories are available for short-term, longer-term, and lifetime exposure for a 10-kilogram child and/or a 70-kilogram adult. Health advisories may be pertinent for remedial action/corrective measures involving groundwater, especially for chemicals that are not regulated under the SDWA.

U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) (U.S. EPA, 2000) are concentrations in soil, groundwater, and air that, if exceeded, may be of potential concern to human receptors. These

concentrations are calculated for a Target Hazard Quotient of 1.0 for noncarcinogenic effects and a Target Risk of 1.0E-6 for carcinogenic effects. Region 9 PRGs are TBC.

Generic Soil Screening Levels (SSLs) (U.S. EPA, 1996b) are soil levels that, if exceeded through three possible exposure pathways, may be of potential concern to human receptors. SSLs consider the following exposure pathways: direct ingestion of soil, inhalation of volatile compounds and fugitive dust, and migration to groundwater. SSLs are TBC.

Dutch Soil Clean-up Act Ecological Screening Values (ESVs) (Beyer, 1990) and Dutch Ministry of Housing Intervention Values and Target Values - Soil Quality Standards (MHSPE, 1994) are published ESVs for soil. Soil screening levels from the Netherlands were taken from the interim Dutch Soil Clean-up Act (Beyer, 1990). Three categories were identified by the Dutch: Category A refers to background concentrations in soil or detection limits; Category B refers to moderate soil contamination that requires additional study; and Category C refers to threshold values that require immediate cleanup. The newer Dutch values (MHSPE, 1994) include target values and intervention values. Target values represent the "soil quality required for the full restoration of the soil's functionality for human, animal and plant life," or "soil quality ultimately aimed for." The intervention values replace the 1990 C values and represent "the concentration levels of the contaminants in the soil . . . above which the functionality of the soil for human, plant, and animal life is seriously impaired or threatened." The 1994 intervention values also take into account ecotoxicological considerations. These values are TBC.

Oak Ridge National Laboratory Toxicity Benchmarks for Soil (Efroymson, 1997a and 1997b) are surface soil guidelines indicative of toxicity to soil invertebrates and terrestrial plants. The values were derived using data from field and laboratory studies, bibliographic databases, and published literature. These values are TBC.

Canadian Council of Ministers of the Environment Soil Quality Guidelines (CCME, 1997) is a listing of ESVs for surface soil. The derivation process for the guidelines considers adverse effects from direct soil contact and from the ingestion of soil and food. Four approaches were used to evaluate contact with soil: weight of evidence, lowest-observed-effect concentration method, median effects method, and comparison with nutrient and energy cycling. These values are TBC.

The memorandum entitled Ecological Risk Assessment at Military Bases (U.S. EPA Region 4, 1998) contains a listing of ESVs for surface soils, sediments, and surface water. The ESVs consist largely of the TBC sources cited in this section (Section 3.2.1). Many of the surface water screening values are Federal AWQCs and, thus, are relevant and appropriate.

Effect Range-Low (ER-L) and Effects Range-Median (ER-M) Level (Long et al., 1995). ER-L and ER-M values are based on data from many studies where sediment concentrations were coupled with apparent biological effects (Long et al., 1995). With all data combined, the ER-L is the 10th percentile of sediment concentrations associated with effects to benthic organisms. The 50th percentile of the effects data is the ER-M. Concentrations below the ER-L represent a minimal effects range within which biological effects would rarely be observed. Concentrations between the ER-L and ER-M represent a possible effects range within which effects would occasionally occur. Concentrations above the ER-M represent a probable-effects range within which effects would frequently occur. These values are TBC.

Probable Effects Levels (PELs) and Threshold Effects Levels (TELs) (FDEP, 1994) are similar to ER-L and ER-M values; however, the TELs and PELs also incorporate chemical concentrations observed or predicted to be associated with no adverse biological effects (no-effects data). The TEL is the geometric mean of the 15th percentile in the effects data set and the 50th percentile in the no-effects data set. Sediment contaminant concentrations below the TEL (i.e., the minimal effects range) are not considered to represent significant hazards to aquatic organisms (FDEP, 1994). The PEL is the geometric mean of the 50th percentile in the effects data set and 85th percentile in the no-effects data set. The PEL represents the lower limit of the range of chemical concentrations that are usually or always associated with adverse biological effects. Contaminant concentrations between the TEL and the PEL constitute the possible effects range (i.e., adverse biological effects are possible). These values are TBC.

South Carolina State Primary Drinking Water Regulations (R.61-58) are promulgated pursuant to S.C. Code Sections 44-55-10 et seq. and are collectively known as the State Primary Drinking Water Regulations. Standards within these regulations are for maintaining the purity of the drinking water of the state. Regulation 61-58.5 establishes MCLs in groundwater for inorganic, organic, and volatile synthetic organic chemicals. Additionally, Regulation 61-58.5 establishes SMCLs and lead and copper action levels. These criteria are applicable to public water systems, defined as any public or privately owned waterworks system that provides drinking water, whether bottled or piped, for human consumption, including the source of supply, whether the source of supply is of surface or subsurface origin; all structures and appurtenances used for the collection, treatment, storage, or distribution of drinking water delivered to consumers; and any part or portion of the system and including any water treatment facility that in any way alters the physical, chemical, radiological, or bacteriological characteristics of drinking water, provided that public water system shall not include a drinking water system serving a single private residence or dwelling.

Since all groundwater in the State of South Carolina is considered a potential drinking water source regardless of salinity, these regulations are applicable. Thallium in 1 out of 11 groundwater monitoring wells exceeded the MCL [3.1 micrograms per liter (µg/L) versus 2 µg/L}. Also, lead exceeded the action level in several wells (maximum 36.4 µg/L versus 15 µg/L).

Hazardous Waste Management Regulations (R.61-79) promulgated pursuant to authority in the South Carolina Hazardous Waste Management Act (§44-56-30) regulate the management of hazardous waste. Similar to RCRA, the following chemical-specific requirements included in the Hazardous Waste Management Regulations are potentially applicable to MCRD Parris Island:

- Identification and listing of hazardous waste (R.61-79.261)
- Groundwater protection and groundwater monitoring (R.61-79.264)
- Land disposal restrictions (R.61-79.268)

3.2.2 Location-Specific ARARs and TBCs

This section presents a summary of Federal and state location-specific ARARs and TBCs. These potential ARARs and TBCs are as follows.

U.S. EPA's Groundwater Protection Strategy (U.S. EPA, 1984) policy is to protect groundwater for its highest present or potential beneficial use. The strategy designates three categories of groundwater:

- Class I - Special Groundwater: Waters that are highly vulnerable to contamination and are either irreplaceable or ecologically vital sources of drinking water.

- Class II - Current and Potential Sources of Drinking Water and Waters Having Other Beneficial Uses: Waters that are currently used or that are potentially available.

- Class III - Groundwater Not a Potential Source of Drinking Water and of Limited Beneficial Use. Class III groundwater units are further subdivided into two subclasses.

  - Subclass IIIA includes groundwater units that are highly to intermediately interconnected to adjacent groundwater units of a higher class and/or surface waters. They may, as a result, be contributing to the degradation of the adjacent waters. They may be managed at a similar level as Class II groundwater, depending upon the potential for producing adverse effects on the quality of adjacent waters.

  - Subclass IIIB is restricted to groundwater characterized by a low degree of interconnection to adjacent surface waters or other groundwater units of a higher class within the Classification Review Area. These groundwaters are naturally isolated from sources of drinking waters in such a way that there is little potential for producing adverse effects on quality. They have low resource values outside of mining or waste disposal.

Groundwater at Site 1 is likely considered Class IIIA.

CWA Section 404 River and Harbors Act, Section 10 (40 CFR 230, 33 CFR 320-330) prohibits the unauthorized obstruction or alteration of any navigable waters of the United States. Examples of activities requiring an Army Corps of Engineers permit (33 CFR 322) include construction of a structure in or over any waters of the United States, excavation or deposit of material in such waters, and various types of work performed in such waters, including fill and stream channelization. The waters in the vicinity of Site 1, most notably Archers Creek, are classified as navigable waters and, therefore, the Act is applicable.

Federal Floodplain Management Executive Order [Executive Order (E.O.) 11988] requires Federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with occupancy and modification of flood plains. Site 1 is located within the 100-year floodplain and is therefore a potentially applicable ARAR.

Federal Protection of Wetlands Executive Order (E.O. 11990) is an applicable ARAR that requires Federal agencies, in carrying out their responsibilities, to take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. Site 1 is located within a wetlands area.

The Endangered Species Act of 1973 [16 United States Code (U.S.C.) 1531 et seq.] provides for consideration of the impacts on endangered and threatened species and their critical habitats. Remedial action/corrective measures, if required, would need to be conducted in a manner such that the continued existence of any endangered or threatened species is not jeopardized or its critical habitat is not adversely affected. Consultation with the United States Fish and Wildlife Service (USFWS) is also required. The Endangered Species Act applies because bald eagles are known to inhabit the area around Site 1 and wood storks and alligators are sometimes observed in the vicinity.

The Fish and Wildlife Coordination Act (16 U.S.C. 661, et seq.) (40 CFR 122.49) provides for consideration of the impacts on wetlands and protected habitats. The act requires that Federal agencies, before issuing a permit or undertaking Federal action for the modification of any body of water, consult with the appropriate state agency exercising jurisdiction over wildlife resources to conserve those resources. Consultation with the USFWS is also required.

The Coastal Zone Management Act of 1972 (16 U.S.C. 1451, et seq.) provides for the preservation and protection of coastal zone areas, management of coastal zones to be the state's responsibility, and the management of coastal zone development to be in such a way as to minimize the effects on coastal zone

resources. Section 304(1) excludes Federal lands from the coastal area if those lands are subject solely to the discretion of or are held in trust by the Federal government. However, under Section 307 (c), paragraphs (1) and (2), Federal activities and development projects in or directly affecting the coastal zone must be consistent to the maximum extent practicable with a federally approved state management program.

Historic Sites, Buildings, and Antiquities Act of 1935 (16 U.S.C. 461 et seq.) states that it is Federal policy to preserve historic and prehistoric properties of national significance. Site 1 is not classified as such a property nor is it known to possess aspects of historic or prehistoric significance; however, this Act would be applicable if information were found to classify it as such a property. As such, this Act is potentially applicable.

Archaeological and Historic Preservation Act of 1974 (16 U.S.C. 469 et seq.) contains provisions for the protection of historic and archaeological data affected by any Federal construction project or federally licensed project, activity, or program. Although no such data are known to exist within the boundaries of Site 1, this Act would be applicable if such data were to be found.

Archaeological Resources Protection Act of 1979 [16 U.S.C. 479(aa) et seq.] requires Federal land managers to issue permits for the excavation or removal of archaeological artifacts from lands under their jurisdiction. The Act requires that relevant Native American tribes be notified of permit issuance if significant religious or cultural sites will be affected. Artifacts have not previously been discovered within the boundaries of Site 1; however, if such artifacts were to be found during remedial activities, this Act would be applicable.

Native American Grave Protection and Repatriation Act of 1990 (25 U.S.C. 3001 et seq.) is an applicable requirement and requires, upon discovery of human remains during a Federal undertaking, cessation of activity for a minimum of 30 days and consultation with Native American groups.

Bald Eagle Protection Act of 1940, as amended (16 U.S.C. 688 et seq.), is an applicable requirement and contains provisions for prohibiting the disturbance of bald eagles. Because a bald eagle is known to nest in the vicinity of Site 1, remedial activities would need to be conducted to minimize the disturbance to this species.

Conservation Programs on Military Reservations (Sikes Act) of 1960, as amended (16 U.S.C. 670(a) et seq.), is an applicable requirement and requires that military installations manage natural resources for multipurpose uses and public access appropriate for those uses consistent with the military department's mission.

Marine Mammal Protection Act of 1972, as amended (16 U.S.C. 1361 et seq.), mandates a moratorium on the killing, capturing, harming, importing, and disturbing of marine mammals and marine mammal products. Marine mammals are not known to inhabit Archers Creek adjacent to Site 1 and, therefore, this Act is not applicable.

Water Classifications and Standards (R.61-68) promulgated pursuant to authority in the South Carolina Pollution Control Act (Section 48-1-10 et seq.) establish a system and rules for managing and protecting the quality of South Carolina's surface water and groundwater. The regulations establish the state's official classified water uses for all state waters, establish general rules and specific numeric water-quality standards for protecting classified and existing water uses, and establish procedures for classifying waters of the state. Classified Water (R.61-69) contains classifications of water bodies in South Carolina.

Site 1 is bordered by Archers Creek, which is classified under R.61-69 as SA. According to R.61-69, waters classified as SA are tidal saltwaters suitable for primary and secondary contact recreation, crabbing, and fishing, except harvesting of clams, mussels, or oysters for market purposes or human consumption. They are also suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora.

Because Site 1 groundwater is not freshwater (i.e., salinity readings greater than 0.048 percent as identified by SCDHEC, 1998), it is not considered an underground source of drinking water. Further support of this is provided under R.61-68, which defines an underground source of drinking water as a water with fewer than 10,000 mg/L total dissolved solids (TDS). During the RI/RFI, Site 1 groundwater had an average TDS of 17,908 mg/L, which indicates that Site 1 groundwater is not an underground source of drinking water.

South Carolina Coastal Zone Management Act (§44-39-10) was promulgated to encourage development of coastal resources within the framework of a coastal planning program. The program is designed to protect the sensitive and fragile areas from inappropriate development and provide adequate environmental safeguards with respect to the construction of facilities in the critical areas of the coastal zone. This statute is applicable in that remedial action/corrective measures would need to be implemented to protect nearby coastal areas.

Groundwater Mixing Zone Application Guidance (SCDHEC, 1997b) provides guidance on preparing groundwater mixing zone applications and to furnish technical recommendations on meeting the conditions for a groundwater mixing zone established under R.61-68. A mixing zone is a hydrogeologically controlled three-dimensional flow path in the subsurface, which constitutes the pathway for waste constituents to migrate from a source. Non-attainment of MCLs within the mixing zone is permitted upon acceptance of the mixing zone application to SCDHEC.

3.2.3 Action-Specific ARARs and TBCs

This section presents a summary of Federal and state action-specific ARARs and TBCs. These potential ARARs and TBCs are as follows.

RCRA Subtitle C regulates the treatment, storage, and disposal of hazardous waste from its generation until its ultimate disposal. In general, RCRA Subtitle C requirements for the treatment, storage, or disposal of hazardous waste will be applicable if

- The waste is a listed or characteristic waste under RCRA.
- The waste was treated, stored, or disposed (as defined in 40 CFR 260.10) after the effective date of the RCRA requirements under consideration.
- The activity at the CERCLA site constitutes current treatment, storage, or disposal as defined by RCRA.

RCRA Subtitle C requirements may be applicable when the waste is sufficiently similar to a hazardous waste and/or the on-site remedial action constitutes treatment, storage, or disposal and the particular RCRA requirement is well suited to the circumstances of the contaminant release and site. RCRA Subtitle C requirements may also be applicable when the remedial action constitutes generation of a hazardous waste. On-site activities, mandated by a federally ordered Superfund cleanup, must comply with the substantive requirements of RCRA Subtitle C but not with the administrative requirements (i.e., permits) of RCRA. All RCRA Subtitle C requirements must be met if the cleanup is not under Federal order and/or when the hazardous waste moves off site.

The following requirements included in the RCRA Subtitle C regulations may pertain to Site 1 at MCRD Parris Island.

- Hazardous waste generator requirements (40 CFR 262) – Regulations with which a generator that treats, stores, or disposes of hazardous waste on site must comply. Applicable if hazardous waste is generated during remedial action.
- Transportation requirements (40 CFR 263) – Regulations for the manifest and recordkeeping systems and for the immediate action and cleanup of hazardous waste discharges (spills) during transportation. Applicable if hazardous waste is shipped off site.

- Standards for owners and operators of hazardous waste treatment, storage, and disposal (TSD) facilities (40 CFR 264). Regulations that govern the treatment, storage, and disposal of hazardous waste. Applicable if hazardous waste is sent to a TSD. In addition, the offsite landfill must be in compliance with its permit (CERCLA Offsite Rule).

- Interim status standards for owners and operators of hazardous waste TSD facilities (40 CFR 265) – Includes regulations for final cover requirements for final closure of interim status landfills. Under these regulations, the owner or operator must cover the landfill with a final cover designed and constructed to provide long-term minimization of migration of liquids through the closed landfill, function with minimum maintenance, promote drainage and minimize erosion or abrasion of the cover, accommodate settling and subsidence so that the cover's integrity is maintained, and have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present. Because the type of waste disposed in the Site 1 landfill was primarily nonhazardous in nature, these requirements are not applicable; however, certain aspects are relevant and appropriate.

- Land Disposal Restrictions (LDRs) (40 CFR 268) - Applicable only if hazardous waste is shipped off site, because re-grading of waste at Site 1 will be handled under a Corrective Action Management Unit (CAMU) which would not trigger LDRs. CAMUs function solely to manage wastes that are generated at a RCRA facility for the purpose of implementing remedial actions required at the facility.

Based on data obtained during the RI/RFI and other investigations, surface soil, sediment, surface water, and groundwater at Site 1 are not expected to be a characteristic or listed RCRA-hazardous waste. However, waste materials were not tested and, if excavated for off-site disposal, would have to be properly classified.

The Hazardous and Solid Waste Amendments (HWSA) are the 1984 amendments to RCRA that require phasing out land disposal of hazardous waste. Additionally, the HSWA establishes a corrective actions program requiring four basic elements (assessment, investigation, CMS, implementation) and establishes a regulatory program for underground storage tanks (USTs).

RCRA Subtitle D establishes design and operating criteria for solid waste (nonhazardous) landfills. In general, RCRA Subtitle D establishes minimum design and operating criteria for all solid waste landfills that

- Receive municipal solid waste as defined in 40 CFR 258
- Codispose sewage sludge with municipal solid waste
- Receive nonhazardous municipal solid waste combustion ash
- Are not regulated under Subtitle C of RCRA

The closure and post-closure care requirements under RCRA Subtitle D are intended to minimize the infiltration of water into the landfill and maintain the integrity of the cover during the post-closure period by minimizing cover erosion. They include closure and post-closure plans (post-closure plans must include a description of monitoring and maintenance activities, as well as a description of any uses of the property during the post-closure period) and minimum requirements for a final landfill cover. The landfill cover is designed to minimize infiltration and erosion and

- Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present or a permeability no greater than 1×10^{-5} cm/sec, whichever is less.

- Minimize infiltration through the closed Municipal Solid Waste Landfill (MSWLF) by the use of an infiltration layer that contains a minimum 18 inches of earthen material.

- Minimize erosion of the final cover by the use of an erosion layer that contains a minimum 6 inches of earthen material that is capable of sustaining native plant growth.

These criteria do not apply to municipal solid waste landfill units that do not receive waste after October 9, 1991 and are therefore not applicable as disposal activities at Site 1 ceased in 1965; however, certain aspects are relevant and appropriate.

The Clean Water Act (CWA), as amended, governs point-source discharges through the National Pollutant Discharge Elimination System (NPDES), discharge or dredge or fill material, and oil and hazardous waste spills to United States waters. NPDES requirements (40 CFR 122) will be applicable if the direct discharge of pollutants into surface waters is part of the remedial action.

Toxic Substances Control Act (TSCA) (40 CFR 761.60-761.79 Subpart D Storage and Disposal) specifies treatment, storage, and disposal requirements for PCBs based on the PCB concentration of the original material. Specifically, remediation for non-liquids (soil, rags, debris) exceeding 50 parts per million (ppm) is addressed in 40 CFR 761.6. TSCA is not considered an ARAR because PCBs were not detected in site media at a concentration greater than 50 ppm.

National Ambient Air Quality Standards (NAAQS) (40 CFR 50) promulgated under the Clean Air Act (CAA) (42 U.S.C. 7401) require the attainment and maintenance of primary and secondary NAAQS to protect public health and public welfare, respectively. These standards are not source specific but rather are national limitations on ambient air quality. States are responsible for assuring compliance with the

NAAQS. The implementation, maintenance, and enforcement of NAAQS are potentially applicable ARARs.

Also promulgated under the CAA are New Source Performance Standards (NSPS) (40 CFR 60) and National Emissions Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR 61). NSPS are established for new sources of air emissions to ensure that the new stationary sources minimize emissions. These standards are for categories of stationary sources that cause or contribute to air pollution that may endanger public health or welfare. NSPS regulations are not considered an ARAR at MCRD Parris Island. NESHAPs, which are emission standards for source types (i.e., industrial categories) that emit hazardous air pollutants, are considered potentially applicable for MCRD Parris Island.

Department of Transportation (DOT) Rules for Hazardous Materials Transport (49 CFR Parts 107 and 171-179) regulate the transport of hazardous materials, including packaging, shipping equipment, and placarding. These rules are considered potentially applicable to wastes shipped off site for laboratory analysis, treatment, or disposal.

The Occupational Safety and Health Administration (OSHA) Standards (29 CFR 1910) regulate occupational safety and health requirements applicable to workers engaged in on-site field activities.

National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.) requires Federal agencies to evaluate the environmental impacts associated with major actions that they fund, support, permit, or implement. Specifically, NEPA requires Federal agencies to consider five issues during the planning of major action: the environmental impact of the proposed action; any adverse impacts that cannot be avoided with the proposed implementation; alternatives to the proposed action; the relationship between short-term and long-term effects; and any irreversible and irretrievable commitments of resources that would be involved in a proposed action. Remedial action/corrective measures could constitute significant activities, thereby making NEPA requirements ARARs; however, activities conducted in accordance with the NCP are considered to meet the substantive NEPA requirements.

Soil Conservation Act (U.S.C. 5901 et seq.) provides for the application of soil conservation practices on Federal lands. During remedial activities, implementation of such practices would be required.

Presumptive Remedy for CERCLA Municipal Landfill Sites (U.S. EPA, 1993) establishes containment as the presumptive remedy for CERCLA municipal landfills because the volume and heterogeneity of the waste in municipal landfills generally make treatment impracticable. Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills (U.S. EPA, 1996c) provides guidance on applying the

containment presumptive remedy to military landfills. Site 1 was investigated assuming that the landfill presumptive remedy would be implemented.

Policy on Land Use Controls (LUCs) Associated with Environmental Restoration Activities (DOD, 2001) requires that feasibility studies that consider a remedy requiring a land use restriction shall include the costs of implementing and maintaining the LUC, as well as an evaluation of an "unrestricted use" alternative. This policy is applicable to the Site 1 FS/CMS because LUCs are a typical part of the presumptive remedy for landfills.

Well Standards (R. 61-71) set forth requirements for protecting underground sources of drinking water from contamination and include provisions for the classification and regulation of wells and establishment of standards for location, construction, materials, reporting, operation, maintenance, and abandonment. These regulations are applicable for any remedial action/corrective measure that involves the installation or abandonment of monitoring wells at Site 1.

Hazardous Waste Management Regulations (R.61-79) promulgated pursuant to authority in the S.C. Hazardous Waste Management Act (§44-56-30) regulate the management of hazardous waste. Similar to RCRA requirements, Hazardous Waste Management Regulations may be applicable when the waste is sufficiently similar to a hazardous waste and/or the on-site remedial action constitutes treatment, storage, or disposal and the particular requirement is well suited to the circumstances of the contaminant release and site. Hazardous Waste Management Regulations may also be applicable when the remedial action constitutes generation of a hazardous waste.

The following requirements included in the Hazardous Waste Management Regulations are potentially applicable at Site 1.

- Hazardous waste generator requirements (R.61-79.262).
- Transportation requirements (R.61-79.263).
- Standards for owners and operators of hazardous waste treatment, storage, and disposal (TSD) facilities (R.61-79.264).
- Interim status standards for owners and operators of hazardous waste TSD facilities (R.61-79.265).
- Land Disposal Restrictions (LDRs) (R.61-79.268) - Applicable if hazardous waste is shipped offsite, or disposal is triggered for onsite activities. If hazardous waste is shipped offsite, treatment of some of

the material may be required. Remedial actions will be conducted so as to not trigger disposal of hazardous wastes.

Based on data obtained during the RI/RFI and other investigations, surface soil, sediment, surface water, and groundwater at Site 1 are not expected to be a characteristic or listed RCRA-hazardous waste. However, waste materials were not tested during the RI. If excavated for offsite disposal excavated, waste would have to be properly classified.

The interim status standards for owners and operators of hazardous waste TSD facilities (R.61-79.265) also include regulations for final cover requirements for final closure of interim status landfills. Under these regulations, the owner or operator must cover the landfill with a final cover designed and constructed to provide long-term minimization of migration of liquids through the closed landfill, function with minimum maintenance, promote drainage and minimize erosion or abrasion of the cover, accommodate settling and subsidence so that the cover's integrity is maintained, and have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present. Because the type of waste disposed in the Site 1 landfill was primarily nonhazardous in nature, these requirements are not applicable; however, certain aspects are relevant and appropriate.

Air Pollution Control Regulations and Standards (R.61-62) are promulgated pursuant to the Pollution Control Act S.C. Code Sections 48-1-10 et seq. Standards within these regulations are for maintaining the purity of the air resources of the state. Regulation 62-5 establishes Air Pollution Control Standards and include Ambient Air Quality Standards and Standards for VOCs and Toxic Air Pollutants. These regulations would be applicable for remedial action/correctives measures that would result in emissions to the atmosphere.

Solid Waste Management: Collection, Temporary Storage, and Transportation of Municipal Solid Waste (R.61-107.5) establishes minimum standards for the collection, temporary storage, and transportation of solid waste prior to processing, disposal, etc. of that waste. This regulation applies to any person who collects, temporarily stores, and/or transports municipal solid waste. This regulation is applicable to the management of any solid waste generated during remedial action/corrective measures at Site 1.

Solid Waste Management: Construction, Demolition, and Land-Clearing Debris Landfills (R.61-107.11) establishes minimum standards for the site selection, design, operation, and closure of construction, demolition, and land-clearing debris landfills. Some construction, demolition, and land-clearing debris may have been disposed at Site 1; however, other types of waste are co-mingled with this debris and, therefore, other South Carolina landfill regulations would supercede. This regulation is not applicable, although certain aspects are relevant and appropriate.

Solid Waste Management: Municipal Solid Waste Landfills (MSWLF) (R.61-107.258) establishes minimum criteria under the South Carolina Solid Waste Policy and Management Act of 1991, as amended, and all applicable Federal regulations, for all MSWLF units, as well as for MSWLFs that are used to dispose of sewage sludge. These regulations apply to owners and operators of new MSWLF units, existing MSWLF units, and lateral expansions. The effective date of this regulation is October 9, 1993.

These regulations include a description of a final cover system for the landfill that is designed to minimize infiltration and erosion. The final cover system is to be designed and constructed to

- Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present or a permeability no greater than 1×10^{-5} cm/sec, whichever is less.

- Minimize infiltration through the closed MSWLF by the use of an infiltration layer that contains a minimum 18 inches of earthen material.

- Minimize erosion of the final cover by the use of an erosion layer that contains a minimum 1 foot of earthen material that is capable of sustaining native plant growth.

Because disposal activities ceased in 1965, this regulation is not applicable; however, certain aspects are relevant and appropriate.

Sanitary Landfill Design, Construction, and Operation (R.61-70) sets forth regulations for the disposal of refuse (solid waste) on land without creating pollution, nuisances, environmental threats, or hazards to public health and safety. The regulation states that, beginning on July 1, 1972, no system for land disposal of refuse (solid waste) shall be operated in South Carolina without a written permit issued by the State Board of Health. Per this regulation, “a final cover shall be applied to any surface that represents the final grade of the sanitary landfill. A minimum of two feet of a well-graded soil cover, compacted and graded, will usually fulfill the requirements of final cover.” Because disposal activities ceased in 1965, this regulation is not applicable; however, certain aspects are relevant and appropriate.

Standards for Stormwater Management and Sediment Reduction (R.72-300 and R.72-405) requires that all land disturbing activities under the jurisdiction of SCDHEC must be performed in a manner in which erosion is controlled and sediment is retained on the site to the maximum extent feasible and stormwater is managed in a manner such that no significant on-site or off-site damage and/or problem is caused or increased. Approval of a stormwater management and sediment control plan is necessary prior to engaging in any land-disturbing activity related to residential, commercial, industrial, or institutional land

use. This regulation is applicable if remedial action/corrective measures involve land-disturbance activities.

General Objectives and Components of Contamination Assessments and Remedial Actions (SCDHEC, 1994) is a TBC that provides guidance for conducting contamination assessments and remedial action activities.

Soil/Groundwater Remediation Guidance Document (SCDHEC, 1992) is a TBC that provides guidance for conducting groundwater and soil remediation.

Stormwater Management and Sediment Control Handbook for Land Disturbance Activities (SCDHEC, 1997a) is a compilation of existing South Carolina stormwater management regulations and supporting information for land disturbance permitting.

3.3 PRESUMPTIVE REMEDY

The Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills (U.S. EPA, 1996c) discusses the decision criteria for the application of this presumptive remedy. Based on U.S. EPA's scientific and engineering evaluation of past remedies selected for military landfills, preferred technologies or presumptive remedies have been developed for similar sites. Presumptive remedies are expected to be used when circumstances are suitable. In 1993, U.S. EPA established source containment as the preferred remedial action for CERCLA municipal landfill sites. In 1996, this remedial action was also chosen for military landfills (U.S. EPA, 1996c). The guidance document presents a decision tree for selection of the presumptive remedy. The following is an evaluation of the decision tree results for Site 1:

- **Collect Available Information: waste type, operating history, monitoring data, state permit/closure, size/volume, etc.** The majority of wastes reportedly disposed in the landfill during 1921 to 1965 were nonhazardous, combustible domestic wastes (ash residue) and other noncombustible wastes (e.g., cans, bottles, and construction debris). Lesser amounts of hazardous waste were reportedly treated in the incinerator and disposed in the landfill. The presence of military waste [i.e. Unexploded Ordinance (UXO)] is not expected at Site 1. Based on the types of waste reportedly disposed in the landfill, the presumptive remedy of containment is appropriate.

- **Consider the Effects of Land Reuse Plans on Remedy Selection.** The final reuse of Site 1 has not been determined. In general, smaller landfills that are generally defined as less than 2 acres make the option of excavation more practical than containment. The Site 1 landfill/waste is estimated

to be in an area of approximately 7 acres, making the application of the presumptive remedy applicable for this criterion.

- **Do Landfill Contents Meet Municipal Landfill-Type Waste Definition?** The wastes are mainly nonhazardous debris, which can be considered as municipal wastes; therefore, treatment is not warranted.

- **Are Military-Specific Wastes Present?** Military wastes (i.e., UXO) were not reportedly disposed at Site 1 and have not been encountered during previous investigations.

- **Is Excavation Practical?** Landfills with waste volumes that exceed 100,000 cubic yards of material are usually suitable for the presumptive remedy of containment. Conversely, excavation is usually practical for landfills with volumes of waste less than that limit. Site 1 is estimated to have approximately 56,000 cubic yards of waste material and 5,000 cubic yards of contaminated sediment. This volume would make the decision subject to determination for either the application of the presumptive remedy of containment or the implementation of removal and disposal. The detailed evaluation alternatives presented in Section 5.0 will aid in the determination of the practical application of excavation.

- **Is Containment Practical?** The determination as to the practical application of containment is similar to the discussion above for the practical application of excavation. Containment is practical and is implementable at Site 1.

Based on the results of the evaluation, the presumptive remedy of containment is potentially appropriate for Site 1 and it will be considered in this FS/CMS.

3.4 MEDIA OF CONCERN

In accordance with the U.S. EPA's Presumptive Remedy for CERCLA Municipal Landfill Sites (U.S. EPA, 1993) and Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills (Interim Guidance) (U.S. EPA, 1996c), the Site 1 RI/RFI characterized media where the potential for off-site migration of contamination was suspected, but did not characterize the landfill contents. Media that were investigated during the RI/RFI consisted of surface soil and downgradient groundwater, surface water, and sediment. The human health risk evaluations for Site 1 were conducted in accordance with U.S. EPA presumptive landfill remedy directives, which provide that, where an established human health standard for a contaminant along a migration pathway is exceeded, there is a basis for selecting a presumptive remedy of containment. Only a streamlined risk assessment was performed for Site 1, and it focused on

contaminant migration pathways (i.e., surface soil and downgradient groundwater, surface water, and sediment).

As discussed previously, the U.S. EPA directives for municipal landfills and military landfills with similar characteristics establish containment as the presumptive remedy. The primary medium of concern under a presumptive remedy is the soil, fill, and waste within the landfill that contains the source of contaminants that present an unacceptable risk to human health and the environment. Where a presumptive landfill remedy of containment is being applied, the remedy components to be considered may be limited to a landfill cap, source area groundwater control, leachate collection and treatment, landfill gas collection and treatment, and institutional controls, unless site conditions dictate otherwise. The presumptive remedy does not address exposure pathways outside the landfill, nor does it include any long-term response actions for groundwater. A response action for exposure pathways outside the source may be selected together with the presumptive remedy, thereby developing a comprehensive site response, or the exposure pathways may be addressed as an operable unit separate from the presumptive remedy. For Site 1, a response action for exposure pathways outside the source will be selected along with the presumptive remedy of containment to provide a comprehensive site response.

The following sections provide the rationale for retaining specific media for this FS/CMS.

3.4.1 Soil, Fill, and Waste

The soil, fill, and waste material that contain the source of contaminants within the Site 1 landfill are the primary media of concern. The contaminants within the soil, fill, and waste of the Site 1 landfill are a concern because of the following:

- Contaminants are leaching to shallow groundwater.
- Contaminants in surface soils are migrating to surface water and sediment via surface water runoff, erosion of unstable slopes, and leaching.
- Contaminants present a direct contact threat.

In accordance with the U.S. EPA guidance for the presumptive remedy guidance, the estimated 56,000 cubic yards of soil, fill, and waste material in the landfill were not fully characterized during the RI/RFI and therefore COCs were not selected for this medium. Surface soil sampling was completed throughout the site, but primarily along the perimeter of the landfill. It is presumed that the containment remedy will address the contaminants present in the soil, fill, and waste.

3.4.2 Sediment

Based on the nature and extent of contamination and the results of the HHRA and ERA presented in the Site 1 RI/RFI, sediment in the areas downgradient of the Site 1 landfill are retained as media of concern for this FS/CMS. The extent of sediment contamination was further refined during a supplemental sampling and analysis program that was conducted in April 2001. A remedial action/corrective measure (e.g., excavation of sediment with COC concentrations in excess of RGOs and consolidation of the material under an engineered landfill cap) is necessary to address this medium.

The results of the HHRA showed that under some exposure scenarios carcinogenic PAHs and arsenic in sediment contributed a significant portion of the carcinogenic risks to human receptors. PAHs were detected at elevated levels in six sediment samples (i.e., SD-001-01, SD-002-01, SD-003-01, SD-009-01, SD-011-01, and SD-017-01). Arsenic was detected in two sediment samples, SD-010-01 and SD-015-01, at concentrations that exceed background and the most stringent human health risk scenario (residential). No concentrations of chemicals detected in sediment contributed significantly to noncarcinogenic risks.

The results of the ERA indicate that sediment COCs include total PAHs, DDT, DDD, DDE, alpha chlordane, gamma chlordane, copper, lead, and mercury. Concentrations of total PAHs and some individual PAHs [e.g., benzo(a)pyrene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and pyrene] in sediment were elevated relative to sediment guidelines in samples SD-017-01 and SD-001-01. The results of the food-chain modeling indicate that PAH compounds pose negligible risks to upper level receptors. However, these compounds could pose potential ecological risks to benthic organisms in the vicinity of these two samples. Chlordane concentrations could pose potential risks to some aquatic receptors in the vicinity of sediment sample SD-09-01. Sediment concentrations of DDT and its metabolites DDD and DDE could also pose potential risks to some aquatic receptors in the vicinity of sediment sample SD-09-01. Lead could pose potential risks to benthic invertebrates in the vicinity of sediment samples SD-009-01 and SD-003-01.

3.4.3 Surface Water

Based on the results of the HHRA, surface water is retained as a medium of concern in this FS/CMS. The results of the HHRA showed that bis(2-ethylhexyl)phthalate and pentachlorophenol were the only surface water COCs. These two contaminants contributed the most to the risks from exposure to surface water. The maximum detected concentrations of these two chemicals were both found in surface water sample PAI-01-SW-003. Bis(2-ethylhexyl)phthalate was also detected in surface soil and groundwater at the site. Because of the transient nature of surface water, it will be addressed through the management of fill and waste, surface soil, and groundwater. It is anticipated that the containment remedial action/corrective measure for soil, fill and waste, coupled with a remedial action/corrective measure for sediment, would

reduce the potential for migration of these COCs to surface water. For example, if contaminated sediment were excavated and consolidated with the soil, fill, and waste and the entire consolidated mass were capped with an engineered landfill cap, the source of the surface water contamination would be contained. The remedial action/corrective measure would also minimize vertical contaminant migration to groundwater, which in turn would result in a decrease in contaminant migration to surface water. Consequently, surface water will be addressed through the management of soil, fill and waste, groundwater, and sediment.

The results of the ERA indicate that surface water contaminants do not pose potential risks to ecological receptors.

3.4.4 Groundwater

Groundwater is not currently used as a potable water supply at the site nor is it expected to be used in the future as a potable water supply. This scenario is based on the high salinity (salinity readings greater than 0.048 percent) and TDS (average TDS of 17,908 mg/L) of the groundwater. In addition, there are no off-site residents located downgradient in the immediate vicinity of the site who might use groundwater as a potable water supply. Because exposure routes to groundwater were considered incomplete, groundwater was not included in the HHRA conducted in the Site 1 RI/RFI.

However, to address the groundwater containment component of the presumptive remedy, groundwater COPCs for human health from the Site 1 RI/RFI were compared to Federal and state MCLs (see Table 3-3). Concentrations of COPCs in groundwater did not exceed primary Federal or state MCLs, with the exception of the action level for lead in five of 11 monitoring wells and the MCL for thallium in one of 11 monitoring wells. In accordance with the presumptive remedy guidance, a containment remedial action/corrective measure will be selected for the Site 1 landfill that minimizes infiltration through the soil, fill, and waste material, and therefore will significantly reduce vertical contaminant migration to the shallow groundwater. A groundwater monitoring program will also be implemented as part of the remedial action/corrective action to evaluate the effectiveness of the containment remedy and to determine the need for groundwater containment. The landfill containment remedial action/corrective measure would need to be engineered so that groundwater containment could be implemented in the future, if it is determined to be necessary. The remedial action/corrective measure would also require that restrictions be placed on Site 1 to prevent the installation of wells for potable water supply. Consequently, groundwater will be retained as a medium of concern and initially addressed through the containment of fill and waste, surface soil, and sediment, and the implementation of restrictions.

The results of the ERA did not indicate that groundwater poses a concern to ecological receptors. As a result, groundwater will not be retained as a medium of concern for ecological concerns.

3.5 CHEMICALS OF CONCERN

The following section presents the human health and ecological COCs that were identified during the Site 1 RI/RFI. Based on the information presented in Section 3.4, COCs are only identified for the sediment and the soil media. The sediment and soil COCs were identified in the HHRA and ERA completed for the Site 1 RI/RFI.

3.5.1 Sediment

Human Health

Sediment COCs for protection of human health were selected from the chemicals identified in the Site 1 RI/RFI HHRA that exceeded an Incremental Lifetime Cancer Risk (ILCR) of 1.0E-06 or an HQ of 1 for exposure to sediment by a receptor. (As discussed in Section 3.4, because of the transient nature and presence of only minor contamination, surface water and groundwater COCs will be addressed via soil and sediment actions.) Several chemicals exceeded the ILCR of 1.0E-06; however, no chemicals exceed a HQ of 1. The receptors that had ILCRs greater than 1.0E-06 due to concentrations of chemicals in sediment included: maintenance worker, adolescent recreational user, adult recreational user, child resident, adult resident, and lifelong resident. The chemicals retained as COCs are as follows.

Organics

Carcinogenic PAHs (Benzo(a)pyrene Equivalents)

It should be noted that a sample-specific benzo(a)pyrene (BAP) equivalent concentration is calculated with sample-specific concentrations of the following carcinogenic PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene and toxicity equivalent factors (TEFs) (U.S. EPA, 1995).

Inorganics

- Arsenic

Ecological

Sediment COCs for ecological receptors (macroinvertebrates and upper food-chain receptors) were selected during the Site 1 RI/RFI ERA. The following chemicals were selected as ecological COCs for sediment.

Organics

- Total PAHs
- 4,4'-DDD
- 4,4'-DDT
- alpha-Chlordane
- 4,4'-DDE
  gamma-Chlordane

Inorganics

- Copper
- Lead
- Mercury

It should be noted that for the ERA the following 13 PAHs were included in Total PAHs: Low Molecular Weight PAHs (2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene) and High Molecular Weight PAHs (benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, and pyrene.

3.5.2 Soil

Even though soils will be addressed with the waste materials at the site, soil COCs have also been developed.

Human Health

Soil COCs for protection of human health were selected from the chemicals identified in the Site 1 RI/RFI HHRA that exceeded an Incremental Lifetime Cancer Risk (ILCR) of 1.0E-06 or a Hazard Quotient (HQ) of 1 for exposure to soil by a receptor. Several chemicals exceeded the ILCR of 1.0E-06; and two chemicals exceed a HQ of 1. The receptors that had ILCRs greater than 1.0E-06 due to concentrations of chemicals in soil included: maintenance worker, child resident, adult resident, and lifelong resident. The chemicals retained as COCs are as follows.

Organics

Carcinogenic PAHs (Benzo(a)pyrene Equivalents)
4,4-'DDT
4,4-'DDE

It should be noted that a sample-specific BAP equivalent concentration is calculated with sample-specific concentrations of the following carcinogenic PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene and toxicity equivalent factors (TEFs) (U.S. EPA, 1995).

Inorganics

- Arsenic
- Antimony
- Lead

Ecological

Soil COCs for ecological receptors (macroinvertebrates and upper food-chain receptors) were selected during the Site 1 RI/RFI ERA. The following chemicals were selected as ecological COCs for soil.

Organics

- Total PAHs
- 4,4’-DDD
- Gamma-BHC
- 4,4'-DDT
- alpha-BHC
- Aroclor 1260
- 4,4'-DDE
- Beta-BHC

Inorganics

- Antimony
- Copper
- Mercury
- Arsenic
- Chromium
- Vanadium
- Cadmium
- Lead
- Zinc

It should be noted that for the ERA the following 13 PAHs were included in Total PAHs: Low Molecular Weight PAHs (2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene) and High Molecular Weight PAHs (benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, and pyrene.

3.6 REMEDIAL ACTION OBJECTIVES/CORRECTIVE ACTION OBJECTIVES

Site-specific remedial action objectives (RAOs)/corrective action objectives (CAOs) consist of medium-specific goals for protecting human health and the environment. RAOs/CAOs are developed to permit consideration of a range of alternatives. The following RAOs/CAOs have been developed for Site 1.

- Eliminate contact with landfill contents and impacted surface soils by human and ecological receptors.

- Eliminate the migration of COCs from the source material (impacted soil, waste, and fill) to downgradient media (i.e., sediment, surface water, and groundwater).

- Eliminate human exposure (i.e., direct exposure to maintenance worker, future construction worker, future recreational users, and hypothetical future resident) to COCs in sediment at concentrations in excess of Remedial Goal Options (RGOs). RGOs take into consideration an ILCR of 1.0E-06 for individual COCs. Additionally, RGOs take into consideration a HQ of 1.0 where noncarcinogenic effects would be expected. Elimination of COCs in sediment will also address human health concerns identified from chemicals detected in surface water.

- Eliminate exposure of ecological receptors to COCs in sediment at concentrations greater than RGOs. The sediment RGOs take into account direct contact of COCs by macroinvertebrates and are expected to be protective of upper food-chain receptors. RGOs address risks where “low effects” may be anticipated by ecological receptors and consider site background concentrations.

- Comply with chemical-specific, location-specific, and action-specific federal and state ARARs.

3.7 REMEDIAL GOAL OPTIONS

As discussed in Section 3.4, RGOs were selected to aid in assessing impacted soils and sediments. These two media are the most impacted at the site, and addressing these will address other potentially impacted media, including surface water and groundwater. A summary of these site-specific RGOs is provided below.

Sediment and Soil

The following site-specific RGOs were selected for sediment and soil.

- Human health RGOs based on exposure to sediment and soil. Sediment and soil RGOs for the protection of human receptors were selected from Region 9 Soil PRGs for residential use, Office of Solid Waste and Emergency Response (OSWER) Soil Screening Levels for Residential Use, and background concentrations. Criteria were identified for the full list of human health and ecological COCs. The Region 9 soil PRGs are appropriate for Site 1 because the sediment and soil are not continuously inundated. The Region 9 soil PRGs correspond to an ILCR of 1.0E-06 or a HQ of 1 for a hypothetical residential receptor from each individual chemical. Compliance with the Region 9 soil PRGs would also achieve compliance with other reasonable human health risk scenarios (i.e., maintenance worker, future construction worker, and future recreational users). The selected human health RGOs are presented in Tables 3-4 and 3-5. For carcinogenic PAHs, RGOs were selected for individual PAHs and for BAP equivalents. The method for calculating BAP equivalents is provided in Table 3-4. Compliance with the BAP equivalent RGO would correspond to a cumulative cancer risk of 7.0E-06 for a hypothetical residential receptor.

- Ecological RGOs. Sediment and soil RGOs for the protection of ecological receptors were selected from Region 4 ecological screening values (ESVs) and background concentrations. The Region 4 ESVs are conservative, for example some are based on Effects Range-Low (ER-L) values obtained from Long et al. (1995). The ER-L is the 10th percentile of sediment concentrations associated with effects to benthic organisms. The selected ecological RGOs are presented in Tables 3-4 and 3-5. For PAHs, ESVs are presented for individual PAHs and Total PAHs, however, only an RGO for Total PAHs was selected. This approach is consistent with EPA Region 4 guidance. The PAHs included in the Total PAH sum are detailed in Tables 3-4 and 3-5.

3.8 QUANTITY OF IMPACTED MEDIA

The total area and volume of the existing landfill were estimated. In addition, the extent of impacted sediment was estimated by comparison of the RGO sets identified in Section 3.6 to sediment analytical results. The supporting calculations for these quantities are presented in Appendix A.

3.8.1 Existing Landfill

Figure 3-1 illustrates the estimated limit of the landfill. This limit was estimated from historical information and information acquired during site visits. This limit, along with existing and historic topography information, as used to calculate the area and volume of the Site 1 – Incinerator Landfill. The supporting calculations and assumptions for the calculations are provided in Appendix A. The calculated area and volume are provided below.

Area of Existing Landfill (acres)	Volume of Existing Landfill (cubic yards)
6.8	55,600

3.8.2 Impacted Sediment

COC concentrations detected in sediment were compared against RGOs that represent a human health ILCR equal to 1.0E-06 and low risk to ecological receptors. COC concentrations at seven out of 13 sediment locations exceed RGOs. For this scenario, RGOs that represent a human health ILCR equal to 1.0E-06 are exceeded at 5 locations (see Figure 3-2) and RGOs that represent a low risk to ecological receptors are exceeded at 5 locations (see Figure 3-2).

The area and volume of impacted sediment delineated on Figure 3-2 were estimated and the information is summarized below. The impacted sediment was delineated by area (i.e., I, II, and III), receptor (i.e., human health and ecological), and general COCs (i.e., PAHs, pesticides, and inorganics) for area and

volume calculations. This approach was taken to make evaluation of technologies and alternatives easier in the later sections of this FS/CMS. The supporting calculations and assumptions for the calculations are provided in Appendix A.

Area	Receptor	COCs	Area (acres)	Volume (yd^3)
I	Human Health	BAP Eq.	0.48	779
		Arsenic	0	0
	Ecological	Total PAHs	0.48	779
		Pesticides	0.43	687
		Inorganics	0.91	1466
	Total	All	0.91	1466
II	Human Health	BAP Eq.	0	0
		Arsenic	1.89	3046
	Ecological	Total PAHs	0	0
		Pesticides	0	0
		Inorganics	0	0
	Total	All	1.89	3046
III	Human Health	BAP Eq.	0.98	1584
		Arsenic	0	0
	Ecological	Total PAHs	0.98	1584
		Pesticides	0	0
		Inorganics	0.42	676
	Total	All	1.4	1584

TABLE 3-1

FEDERAL ARARs/MEDIA CLEAN-UP STANDARDS AND TBCs
MCRD PARRIS ISLAND, SOUTH CAROLINA

ARAR	Citation/Reference	ARAR Type	Rationale for Use at MCRD Parris Island
Chemical-Specific ARARs			
Safe Drinking Water Act MCLs, MCLGs, and SMCLs	40 CFR 140-143	Not applicable	Would be used as protective levels for groundwater that are current or potential drinking water sources; however, groundwater is saline to brackish and is not a viable drinking water source.
Ambient Water Quality Criteria	Section 304 of the Clean Water Act	Relevant and appropriate	Criteria for assessing the need for surface water remedial action/corrective measures.
RCRA Subtitle C – Hazardous Waste Identifications and Listing Regulations	40 CFR 261	Potentially applicable	Would be used to identify a material as a hazardous waste and thus determine the applicability and relevance of RCRA C Hazardous Waste Rules.
U.S. EPA Health Advisories	U.S. EPA, 1996a	To be considered criteria (TBC)	Benchmark values for assessing the need for groundwater remedial action/corrective measures.
Preliminary Remediation Goals (PRGs)	U.S. EPA Region 9, 2000	TBC	Benchmark values for assessing the need for soil, groundwater, and air remedial action/corrective measures.
Generic Soil Screening Levels	U.S. EPA, 1996b	TBC	Benchmark values for assessing the need for soil remedial action/corrective measures.
Dutch Soil Clean-up Act Ecological Screening Values	Beyer, 1990	TBC	Benchmark values for assessing the need for soil remedial action/corrective measures.
Dutch Ministry of Housing Intervention Values and Target Values – Soil Quality Standards	MHSPE, 1994	TBC	Benchmark values for assessing the need for soil remedial action/corrective measures.
Oak Ridge National Laboratory Toxicity Benchmarks for Soil	Efroymson, 1997a and 1997b	TBC	Benchmark values for assessing the need for soil remedial action/corrective measures.
Canadian Council of Ministers of the Environment Soil Quality Guidelines	CCME, 1997	TBC	Benchmark values for assessing the need for soil remedial action/corrective measures.
Ecological Risk Assessment at Military Bases	U.S. EPA Region 4, 1998	TBC	Memorandum consists of benchmark values for assessing the need for surface soils, sediment and surface water remedial action/corrective measures.
ER-L and ER-M Levels	Long et al., 1995	TBC	Benchmark values for assessing the need for sediment remedial action/corrective measures.
PELs and TELs	FDEP, 1994	TBC	Benchmark values for assessing the need for sediment remedial action/corrective measures.

TABLE 3-1

FEDERAL ARARs/MEDIA CLEAN-UP STANDARDS AND TBCs
MCRD PARRIS ISLAND, SOUTH CAROLINA

ARAR	Citation/Reference	ARAR Type	Rationale for Use at MCRD Parris Island
Location-Specific ARARs			
U.S. EPA's Groundwater Protection Strategy	U.S. EPA, 1984	TBC	Surficial groundwater at Site 1 is likely designated Class IIIA.
CWA Section 404 River and Harbors Act, Section 10	40 CFR 230, 33 CFR 320-330	Applicable	Prohibits the unauthorized obstruction or alteration of any navigable waters of the United States. The waters within the vicinity of Site 1, most notably Archers Creek, are classified as navigable waters and, therefore, the Act is applicable.
Floodplain Management	Executive Order 11988	Applicable	Site 1 is located within the 100-year floodplain.
Protection of Wetlands	Executive Order 11990	Applicable	Site 1 is located within a wetlands area.
Endangered Species Act	16 U.S.C. 1531 et seq.	Applicable	A bald eagle is known to nest in the vicinity of Site 1. Wood storks and alligators are sometimes observed in the vicinity.
Fish and Wildlife Coordination Act	16 U.S.C. 661 et seq., 40 CFR Part 122.49	Applicable	Ensures that remedial action/corrective measures protect nearby wetlands and protected habitats.
Coastal Zone Management Act	16 U.S.C. 1451 et seq.	Applicable	Ensures that remedial action/corrective measures protect coastal resources.
Historic Sites, Buildings, and Antiquities Act of 1935	16 U.S.C. 461 et seq.	Potentially Applicable	This Act would be applicable if information is found to classify Site 1 as a historic or prehistoric property of national significance.
Archaeological and Historic Preservation Act of 1974	16 U.S.C. 469 et seq.	Potentially Applicable	This Act would be applicable if historic and archaeological artifacts were to be affected by remedial activities. No such artifacts are known to exist within the boundaries of Site 1 and none are expected because the landfill consists primarily of incinerator ash and fill used to expand the edge of the landfill into the marsh.
Archaeological Resources Protection Act of 1979	16 U.S.C. 479(aa) et seq.	Potentially Applicable	This Act would be applicable if archaeological artifacts were discovered during remedial activities. No such artifacts are known to exist within the boundaries of Site 1 and none are expected because the landfill consists primarily of fill dirt used to expand the edge of the landfill into the marsh.
Native American Grave Protection and Repatriation Act of 1990	25 U.S.C. 3001 et seq.	Potentially Applicable	This Act would be applicable if human remains were discovered during remedial activities.
Bald Eagle Protection Act of 1940, as Amended	16 U.S.C. 688 et seq.	Potentially Applicable	This Act includes provisions for prohibiting the disturbance of bald eagles. Because a bald eagle is known to nest within 1000 feet of Site 1, remedial activities would need to be conducted to minimize the disturbance to this species.

TABLE 3-1

FEDERAL ARARs/MEDIA CLEAN-UP STANDARDS AND TBCs
MCRD PARRIS ISLAND, SOUTH CAROLINA

ARAR	Citation/Reference	ARAR Type	Rationale for Use at MCRD Parris Island
Conservation Programs on Military Reservations (Sikes Act) of 1960, as Amended	16 U.S.C. 670(a) et seq.	Applicable	This act requires that military installations manage natural resources for multipurpose uses and public access appropriate for those uses consistent with the military department's mission.
Marine Mammal Protection Act of 1972 as Amended	16 U.S.C. 1361 et seq.	Not Applicable	Marine mammals are not known to inhabit Archers Creek.

Action-Specific ARARs

Solid Waste Disposal Act (SWDA)/ RCRA Subtitle C	42 U.S.C 6905, 6912a, 6924-6925	_	_
• Standards for Hazardous Waste Generators	40 CFR 262	Potentially applicable	Applicable for removed site wastes determined to be hazardous.
• Standards for Hazardous Waste	40 CFR 263	Potentially applicable	Applicable for site wastes determined hazardous that are transported off site.
• Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities	40 CFR 264	Potentially applicable	These regulations would be applicable to waste removed from the site including both on-site and off-site management.
• Interim status standards for owners and operators of hazardous waste TSD facilities	40 CFR 265	Relevant and appropriate	Establishes design and operating criteria for hazardous landfills. Because the type of waste disposed in the Site 1 landfill was primarily nonhazardous in nature, these requirements are not applicable; however, certain aspects are relevant and appropriate.
• RCRA Land Disposal Restrictions (LDR) Requirements	40 CFR 268	Potentially applicable	If off-site treatment or disposal of contaminated media and/or disposal of treatment residuals that may be considered hazardous waste is necessary, it would be subject to land disposal restrictions.
Hazardous and Solid Waste Amendments of 1984	42 U.S.C. 6926	Potentially Applicable	Establishes a corrective actions program requiring four basic elements (assessment, investigation, CMS, implementation).
RCRA Subtitle D	40 U.S.C 6901	Relevant and appropriate	Establishes design and operating criteria for solid waste (nonhazardous) landfills; however, disposal activities ceased prior to the effective date of the regulation.
The Clean Water Act (CWA) National Pollution Discharge Elimination System	40 CFR 122	Potentially applicable	These requirements are applicable for all alternatives that include a surface water discharge.
Toxic Substances Control Act	40 CFR 761	Not an ARAR	Remedial action/corrective measures may be driven by reducing PCB concentrations in affected media to meet published levels.

TABLE 3-1

FEDERAL ARARs/MEDIA CLEAN-UP STANDARDS AND TBCs
MCRD PARRIS ISLAND, SOUTH CAROLINA

ARAR	Citation/Reference	ARAR Type	Rationale for Use at MCRD Parris Island
Clean Air Act National Ambient Air Quality Standards (NAAQs)	42 U.S.C §7401- 7642, 40 CFR Part 50	Potentially applicable	Remedial action/corrective measures involving treatment of media could result in emissions to the atmosphere.
U.S. EPA Clean Air Act New Source Performance Standards (NSPS)	40 CFR 60	Not an ARAR	Remedial action/corrective measures involving treatment of media could result in emissions to the atmosphere.
Clean Air Act National Emission Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR 60	Potentially applicable	Existing source types are not present on site.
DOT Hazardous Materials Transportation	49 CFR	Potentially applicable	These rules are considered potentially applicable depending on whether wastes are shipped off site for laboratory analysis, treatment, or disposal.
OSHA Standards	29 CFR 1910.120	Applicable	On-site activities are required to follow OSHA requirements.
National Environmental Policies Act	42 U.S.C 4321 et seq.	Relevant and appropriate	Remedial action/corrective measures could constitute significant activities, thereby making NEPA requirements ARARs; however, activities conducted in accordance with the NCP are considered to meet the substantive NEPA requirements.
Soil Conservation Act	U.S.C. 5901 et seq.	Applicable	During remedial activities, implementation of soil conservation practices would be required.
Presumptive Remedy for CERCLA Municipal Landfill Sites	U.S. EPA, 1993	TBC	Through this directive, U.S. EPA has identified containment as the presumptive remedy for such landfill sites.
Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills	U.S. EPA, 1996c	TBC	Provides the framework for determining the applicability of the containment presumptive remedy to military landfills.
Policy on Land Use Controls Associated with Environmental Restoration Activities	DOD, 2001	TBC	Requires that feasibility studies that consider a remedy requiring a land use restriction shall include the costs of implementing and maintaining the LUC, as well as an evaluation of an “unrestricted use” alternative.

TABLE 3-2

STATE OF SOUTH CAROLINA ARARs/MEDIA CLEAN-UP STANDARDS AND TBCs
MCRD PARRIS ISLAND, SOUTH CAROLINA

ARAR	Citation/Reference	ARAR Type	Rationale for Use at MCRD Parris Island
Chemical-Specific ARARs			
State Primary Drinking Water Regulations Groundwater Sources and Treatment Surface Water Sources and Treatment MCL in Drinking Water Control of Lead and Copper	R.61-58 to R.61-58.11 R.61-58.2 R.61-58.3 R.61-58.5 R.61-58.11	Applicable	Although it is unlikely that site groundwater could be used as a drinking water source, it would be used as protective levels for groundwaters that are current or potential drinking water sources.
South Carolina Hazardous Waste Management Act Hazardous Waste Management Regulations	§44-56-30 R.61-79	Potentially applicable	Would be used to identify a material as a hazardous waste and thus determine the applicability and relevance of Hazardous Waste Management Regulations.
Location-Specific ARARs			
Water Classifications and Standards Classified Water	R.61-68 R.61-69	Applicable	Surficial groundwater is not an underground source of drinking water due to salinity and TDS levels. The surface water at Site 1 is classified as SA (tidal saltwaters).
Coastal Zone Management Act	§48-39-10	Applicable	Ensures that remedial action/corrective measures protect coastal resources.
Groundwater Mixing Zone Application Guidance	SCDHEC, 1997b	TBC	Guidance for completing an application to obtain groundwater waiver for non-attainment of MCLs.
Action-Specific ARARs			
Well Standards	R.61-71	Potentially applicable	Applicable if remedial action/corrective measures involve the installation or abandonment of monitoring wells.
Hazardous Waste Management Act	§44-56-30	-	-
• Standards for Hazardous Waste Generators	R.61-79.262	Potentially applicable	Applicable for removed site wastes determined to be hazardous.
• Standards for Hazardous Waste Transporters	R.61-79.263	Potentially applicable	Applicable for removed site wastes determined to be hazardous that are transported off site.
• Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal (TSD) Facilities	R.61-79.264	Potentially applicable	These regulations would be applicable to waste removed from the site including both on-site and off-site management.
• Interim status standards for owners and operators of hazardous waste TSD facilities	R.61-79.265	Relevant and appropriate	Establishes design and operating criteria for hazardous landfills. Because the type of waste disposed in the landfill was primarily nonhazardous in nature, these requirements are not applicable; however, certain aspects are relevant and appropriate.

TABLE 3-2

STATE OF SOUTH CAROLINA ARARs/MEDIA CLEAN-UP STANDARDS AND TBCs
MCRD PARRIS ISLAND, SOUTH CAROLINA

ARAR	Citation/Reference	ARAR Type	Rationale for Use at MCRD Parris Island
• Land Disposal Restrictions (LDR) Requirements	R.61-79.268	Potentially applicable	If off-site treatment or disposal of contaminated media and/or disposal of treatment residuals that may be considered hazardous waste is necessary, it would be subject to land disposal restrictions. Consolidation activities at Site 1 would be conducted so as to not trigger LDRs.
Air Pollution Control Regulations and Standards	R.61-62	Potentially applicable	Remedial action/corrective measures involving treatment of media could result in emissions to the atmosphere.
Solid Waste Management: Collection, Temporary Storage, and Transportation of Solid Waste	R.61-107.5	Potentially applicable	Applicable if solid waste is generated during remedial action/corrective measures.
Solid Waste Management: Construction, Demolition, and Land Clearing Debris Landfills	R.61-107.11	Relevant and appropriate	Construction, demolition, and land-clearing debris is co-mingled with other wastes.
Solid Waste Management: Municipal Solid Waste Landfills	R.61-107.258	Relevant and appropriate	Contains design and construction requirements for municipal landfills; however, disposal activities ceased prior to the effective date of the regulation.
Sanitary Landfill Design, Construction, and Operation	R.61-70	Relevant and appropriate	Contains design and construction requirements for sanitary landfills; however, disposal activities ceased prior to the effective date of the regulation.
Standards for Stormwater Management and Sediment Reduction	R.72-300 and R.72-405	Potentially applicable	Applicable if remedial action/corrective measures involve land-disturbance activities.
General Objectives and Components of Contamination Assessments and Remedial Actions	SCDHEC, 1994	TBC	Provides guidance for conducting remedial action activities.
Soil/Groundwater Remediation Guidance Document	SCDHEC, 1992	TBC	Provides guidance for conducting groundwater and soil remediation.
Stormwater and Management and Sediment Control Handbook for Land Disturbance Activities	SCDHEC, 1997a	TBC	Guidance document to be following if remedial action/corrective measures involve land-disturbance activities.

TABLE 3-3

COMPARISON OF GROUNDWATER HUMAN HEALTH COPCs[1]
TO FEDERAL AND STATE GROUNDWATER CRITERIA
SITE 1 – INCINERATOR LANDFILL
MCRD PARRIS ISLAND, SOUTH CAROLINA

Human Health COPCs	Maximum Concentration	Detection Frequency	Federal MCLs[1]	State MCLs[2]	Background Surface Water
VOCs (µg/L)					
Chloroform	0.9	3/11	80	100	ND
SVOCs (µg/L)					
Dibenzofuran	3	2/11	--	--	ND
Napthalene	57	4/11	--	--	ND
Phenanthrene	8	4/11	--	--	ND
INORGANICS (UNFILTERED) (µg/L)					
Aluminum	3970	5/10	--	--	3100
Arsenic	4.4	6/11	50	50	5.1
Barium	1030	11/11	2000	2000	38
Cadmium	ND	0/11	5	5	ND
Iron	12700	7/10	--	--	2090
Lead	34.7	10/11	15[3]	--	ND
Manganese	1320	7/11	--	--	53
Thallium	ND	0/11	2	2	ND
Vanadium	32.6	8/11	--	--	18
INORGANICS (FILTERED) (µg/L)					
Aluminum	44.4	1/11	--	--	ND
Arsenic	4.0	4/11	50	50	4.3
Barium	1230	11/11	2000	2000	256
Cadmium	2.7	4/11	5	5	ND
Iron	13300	7/11	--	--	48
Lead	36.4	10/11	15[3]	--	11
Manganese	1300	9/11	--	--	18
Thallium	3.1	1/11	2	2	ND
Vanadium	27.8	7/11	--	--	15

1 Site groundwater was not found to be a potential threat to ecological receptors.
2 U.S. EPA Drinking Water Regulations and Health Advisories, Summer 2000.
3 South Carolina State Drinking Water Regulations, Chapter 61-58.
4 Treatment Technique, Lead Action Level.
"--" Not Available.
ND Not Detected.
SVOCs Semivolatile Organic Compounds
VOCs Volatile Organic Compounds
Shading indicates that the criterion was exceeded.

TABLE 3-4

SELECTION OF SEDIMENT RGOs
FOR THE PROTECTION OF HUMAN AND ECOLOGICAL RECEPTORS
SITE 1 - INCINERATOR LANDFILL
MCRD PARRIS ISLAND, SOUTH CAROLINA

COCs	Maximum Concentration	Background/ Typical Facility Sediment Concentration (1)	Region 9 Residential Soil PRG (2)	Selected Site 1 Human Health Sediment RGO	Region 4 ESV (3)	Selected Site 1 Ecological RGO
PAHs (ug/kg)						
2-Methylnaphthalene	ND	ND	56000 (7)	NR	330	NR
Acenaphthene	ND	ND	3700000	NR	330	NR
Acenaphthylene	380	ND	2300000 (8)	NR	330	NR
Anthracene	770	ND	22000000	NR	330	NR
Benzo(a)anthracene	2200	ND	620	NR	330	NR
Benzo(a)pyrene	1700	ND	62	NR	330	NR
Benzo(b)fluoranthene	1800	ND	620	NR	NA	NR
Benzo(g,h,i)perylene	990	ND	2300000 (8)	NR	NA	NR
Benzo(k)fluoranthene	850	ND	6200	NR	NA	NR
Carbazole	580	ND	24000	NR	NA	NR
Chrysene	2300	ND	62000	NR	330	NR
Dibenzo(a,h)anthracene	1600	ND	62	NR	330	NR
Fluoranthene	6600	ND	2300000	NR	330	NR
Fluorene	160	ND	2600000	NR	330	NR
Indeno(1,2,3-cd)pyrene	1100	518	620	NR	NA	NR
Naphthalene	ND	ND	56000	NR	330	NR
Phenanthrene	2600	ND	2300000 (8)	NR	330	NR
Pyrene	5400	ND	2300000	NR	330	NR
BAP Equivalents (4)	3821	NR	434 (9)	434	NA	NR
Total PAHs (5)	29455	NR	NA	NR	1684	1684
PESTICIDES (ug/kg)						
4,4'-DDD	260	33.6	2400	NR	3.3	33.6
4,4'-DDE	120	31.6	1700	NR	3.3	31.6
4,4'-DDT	270	34.5	1700	NR	3.3	34.5
DDTR (6)	650	99.8	5800 (6)	NR	3.3 (6)	99.8
Alpha Chlordane	52	13.9	1600 (10)	NR	1.7 (10)	13.9
Gamma Chlordane	130	13.2	1600 (10)	NR	1.7 (10)	13.2
INORGANICs (mg/kg)						
Arsenic	18.8	12	0.39	12.4 (12)	7.24	NR
Copper	95.3	10	2900	NR	18.7	18.7
Lead	238	21	400 (11)	NR	30.2	30.2
Mercury	0.67	0.09	23	NR	0.13	0.13

1 Background/typical facility sediment concentrations taken from Site 1 RI/RFI (TtNUS, 2001). Pesticide values are typical facility concentrations.
2 U.S. EPA Region 9 PRG Residential Soil Table (USEPA, 2000)
3 U.S. EPA Region 4 Ecological Screening Values (USEPA, 1998)
4 BAP equivalents = benzo(a)anthracene(0.1) + benzo(a)pyrene(1.0) + benzo(b)fluoranthene(0.1) + benzo(k)fluoranthene(0.01) + chrysene(0.001) + dibenzo(a,h)anthracene(1.0) + indeno(1,2,3-cd)pyrene (0.1)
5 Total PAHs = Low Molecular Weight PAHs + High Molecular Weight PAHs
* Low Molecular Weight = 2-methylnaphthalene + acenaphthene + acenaphthylene + anthracene + fluorene + naphthalene + phenanthrene
* High Molecular Weight PAHs = benzo(a)anthracene + benzo(a)pyrene + chyrsene + dibenzo(a,h)anthracene + fluoranthene + pyrene
* If a PAH is detected, 1/2 of the detection limit should be used for nondetected PAHs to calculate Total PAHs and BAP Equivalents.
6 DDTR = DDD + DDE + DDT.
7 Value is for naphthalene.
8 Value is for pyrene.
9 Calculated as 7 x benzo(a)pyrene Region 9 PRG.
10 Based on total chlordane.
11 OSWER Soil Screening Level for Residential Land Use (USEPA, 1994).
12 RGO is PRG + Background per EPA guidance.

ND = Nondetect
NA = Not Available
NR = Not Relevant

TABLE 3-5

SELECTION OF SURFACE SOIL RGOs
FOR THE PROTECTION OF HUMAN AND ECOLOGICAL RECEPTORS
SITE 1 - INCINERATOR LANDFILL AND SWMU 41 - FORMER INCINERATOR
MCRD PARRIS ISLAND, SOUTH CAROLINA

Surface Soil COCs	Maximum Concentration	Background/ Typical Facility Concentration (1)	Region 9 Residential Soil PRG (2)	Selected Human Health Soil RGO	Region 4 ESV (3)	Selected Ecological RGO
PAHs (ug/kg)						
BAP Equivalents (4)	854	NA	434(9)	434(9)	NA	NA
Total PAHs (5)	7464	NA	NA	NA	1000	1000
PESTICIDES/PCBs (ug/kg)						
Alpha-BHC	42	NA	90	NR	2.5	2.5
Beta-BHC	33	NA	320	NR	1	1
Gamma-BHC (Lindane)	75	NA	440	NR	0.05	0.05
4,4'-DDD	180	33.6	2400	1700	2.5	33.6 (1)
4,4'-DDE	4200	31.6	1700	NR	2.5	31.6 (1)
4,4'-DDT	4400	34.5	1700	1700	2.5	34.5 (1)
DDTR (6)	8780	99.8	5800	5800	9.9	99.8
Aroclor-1260	80	NA	220	NR	20	20
INORGANICs (mg/kg)						
Aluminum	8610	7270	76000	NR	50	7270 (1)
Antimony	90.6	ND	31	31	3.5	3.5
Arsenic	24.9	1.44	0.39	1.83 (12)	10	10
Barium	178	24	5400	NR	165	165
Cadmium	5.4	ND	37	NR	1.6	1.6
Chromium	53.2	6.2	210	NR	0.4	6.2 (1)
Copper	131	1.5	2900	NR	40	40
Iron	147000	3920	23000	26920 (12)	200	3920 (1)
Lead	8380	12.5	400	412.5 (12)	50	50
Manganese	752	129	1,800	NR	100	129 (1)
Mercury	1.1	0.11	23	NR	0.1	0.110 (1)
Nickel	47.8	1.8	1600	NR	30	30
Selenium	1.1	0.29	390	NR	0.81	0.81
Silver	2.4	ND	390	NR	2	2
Vanadium	47.4	9.5	550	NR	2	9.5 (1)
Zinc	497	9.7	23000	NR	50	50

1 Background/typical facility concentrations taken from Site 1 RI/RFI (TtNUS, 2001). Pesticide values are typical facility concentrations.
2 U.S. EPA Region 9 PRG Residential Soil Table (U.S. EPA, 2000)
3 U.S. EPA Region 4 Ecological Screening Values (U.S. EPA, 1998)
4 BAP equivalents = benzo(a)anthracene(0.1) + benzo(a)pyrene(1.0) + benzo(b)fluoranthene(0.1) + benzo(k)fluoranthene(0.01) + chrysene(0.001) + dibenzo(a,h)anthracene(1.0) + indeno(1,2,3-cd)pyrene (0.1)
5 Total PAHs = Low Molecular Weight PAHs + High Molecular Weight PAHs
* Low Molecular Weight = 2-methylnaphthalene + acenaphthene + acenaphthylene + anthracene + fluorene + naphthalene + phenanthre
* High Molecular Weight PAHs = benzo(a)anthracene + benzo(a)pyrene + chyrsene + dibenzo(a,h)anthracene + fluoranthene + pyrene
* One-half of the detection limit is used for nondetected PAHs to calculate Total PAHs and BAP Equivalents.
6 DDTR = DDD + DDE + DDT.
7 Value is for naphthalene.
8 Value is for pyrene.
9 Calculated as 7 x benzo(a)pyrene Region 9 PRG.
10 Based on total chlordane.
11 OSWER Soil Screening Level for Residential Land Use (U.S. EPA, 1994).
12 RGO is PRG + Background per U.S. EPA guidance.
ND = Nondetect
NA = Not Available
NR = Not Relevant. Maximum Concentration is Below RGO

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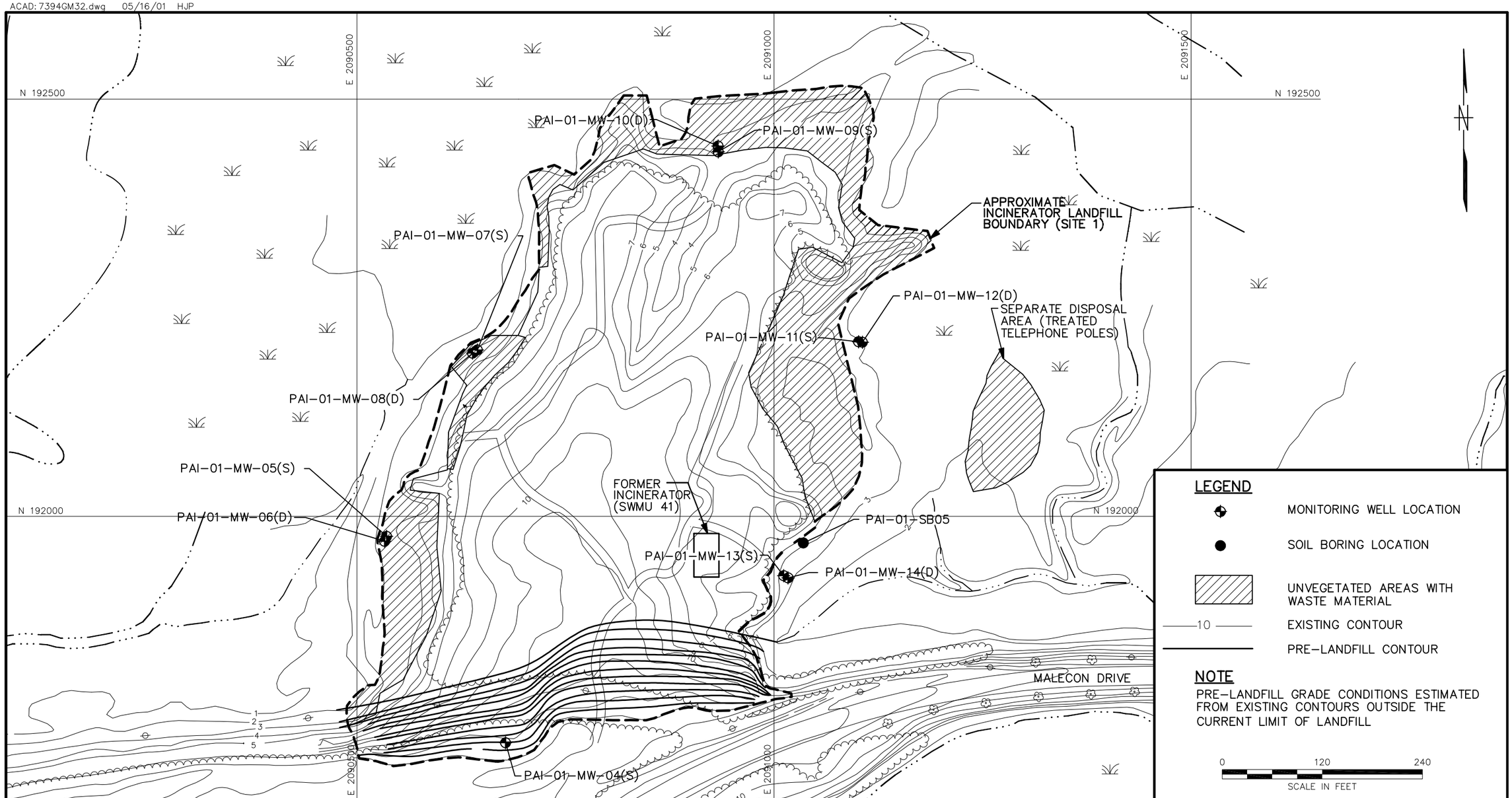

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 5/14/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

WASTE DELINEATION MAP
SITE 1 – INCINERATOR LANDFILL AND
SWMU 41 – FORMER INCINERATOR
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7394
APPROVED BY DATE
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DRAWING NO. FIGURE 3-1
REV. 0

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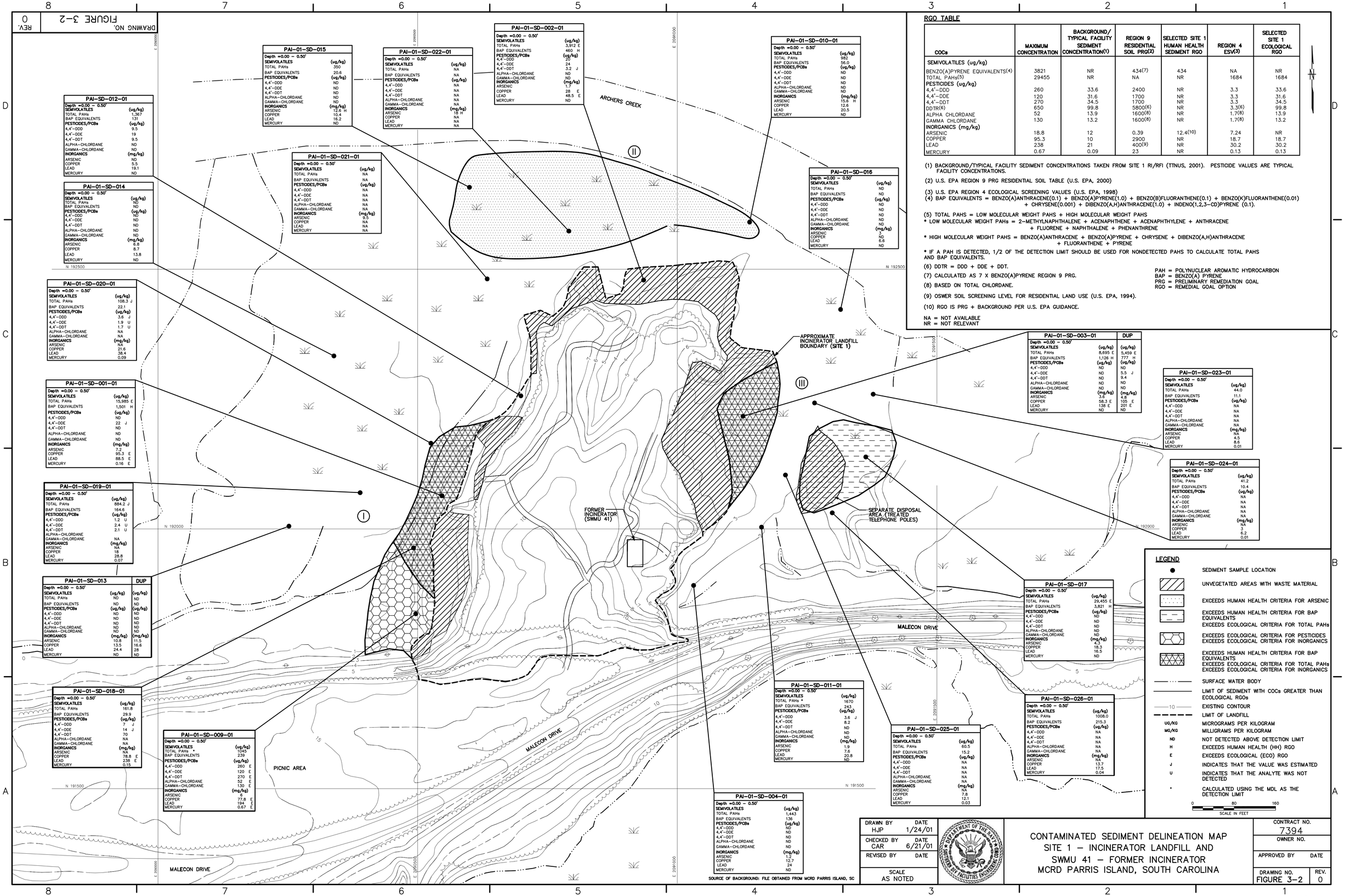

RGO TABLE

COCs	MAXIMUM CONCENTRATION	BACKGROUND/ TYPICAL FACILITY SEDIMENT CONCENTRATION(1)	REGION 9 RESIDENTIAL SOIL PRG(2)	SELECTED SITE 1 HUMAN HEALTH SEDIMENT RGO	REGION 4 ESV(3)	SELECTED SITE 1 ECOLOGICAL RGO
SEMIVOLATILES (ug/kg)						
BENZO(A)PYRENE EQUIVALENTS(4)	3821	NR	434(7)	434	NA	NR
TOTAL PAHs(5)	29455	NR	NA	NR	1684	1684
PESTICIDES (ug/kg)						
4,4'-DDD	260	33.6	2400	NR	3.3	33.6
4,4'-DDE	120	31.6	1700	NR	3.3	31.6
4,4'-DDT	270	34.5	1700	NR	3.3	34.5
DDTR(6)	650	99.8	5800(6)	NR	3.3(6)	99.8
ALPHA CHLORDANE	52	13.9	1600(8)	NR	1.7(8)	13.9
GAMMA CHLORDANE	130	13.2	1600(8)	NR	1.7(8)	13.2
INORGANICS (mg/kg)						
ARSENIC	18.8	12	0.39	12.4(10)	7.24	NR
COPPER	95.3	10	2900	NR	18.7	18.7
LEAD	238	21	400(9)	NR	30.2	30.2
MERCURY	0.67	0.09	23	NR	0.13	0.13

(1) BACKGROUND/TYPICAL FACILITY SEDIMENT CONCENTRATIONS TAKEN FROM SITE 1 RI/RFI (TTNUS, 2001). PESTICIDE VALUES ARE TYPICAL FACILITY CONCENTRATIONS.

(2) U.S. EPA REGION 9 PRG RESIDENTIAL SOIL TABLE (U.S. EPA, 2000)

(3) U.S. EPA REGION 4 ECOLOGICAL SCREENING VALUES (U.S. EPA, 1998)

(4) BAP EQUIVALENTS = BENZO(A)ANTHRACENE(0.1) + BENZO(A)PYRENE(1.0) + BENZO(B)FLUORANTHENE(0.1) + BENZO(K)FLUORANTHENE(0.01) + CHRYSENE(0.001) + DIBENZO(A,H)ANTHRACENE(1.0) + INDENO(1,2,3-CD)PYRENE (0.1).

(5) TOTAL PAHS = LOW MOLECULAR WEIGHT PAHS + HIGH MOLECULAR WEIGHT PAHS

* LOW MOLECULAR WEIGHT PAHs = 2-METHYLNAPHTHALENE + ACENAPHTHENE + ACENAPHTHYLENE + ANTHRACENE + FLUORENE + NAPHTHALENE + PHENANTHRENE

* HIGH MOLECULAR WEIGHT PAHs = BENZO(A)ANTHRACENE + BENZO(A)PYRENE + CHRYSENE + DIBENZO(A,H)ANTHRACENE + FLUORANTHENE + PYRENE

* IF A PAH IS DETECTED, 1/2 OF THE DETECTION LIMIT SHOULD BE USED FOR NONDETECTED PAHS TO CALCULATE TOTAL PAHS AND BAP EQUIVALENTS.

(6) DDTR = DDD + DDE + DDT.

(7) CALCULATED AS 7 X BENZO(A)PYRENE REGION 9 PRG.

(8) BASED ON TOTAL CHLORDANE.

(9) OSWER SOIL SCREENING LEVEL FOR RESIDENTIAL LAND USE (U.S. EPA, 1994).

(10) RGO IS PRG + BACKGROUND PER U.S. EPA GUIDANCE.

NA = NOT AVAILABLE
NR = NOT RELEVANT

PAH = POLYNUCLEAR AROMATIC HYDROCARBON
BAP = BENZO(A) PYRENE
PRG = PRELIMINARY REMEDIATION GOAL
RGO = REMEDIAL GOAL OPTION

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SCALE AS NOTED	

CONTAMINATED SEDIMENT DELINEATION MAP
SITE 1 – INCINERATOR LANDFILL AND
SWMU 41 – FORMER INCINERATOR
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7394
OWNER NO.
APPROVED BY DATE
DRAWING NO. FIGURE 3-2
REV. 0

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DRAWING NO. FIGURE 3-2 REV. 0

4.0 IDENTIFICATION, SCREENING, AND DEVELOPMENT OF REMEDIAL ACTION/CORRECTIVE MEASURE ALTERNATIVES

4.1 INTRODUCTION

This section presents the identification and screening of remedial technologies and the development of remedial action/corrective measure alternatives formulated to achieve RAOs/CAOs for Site 1. The identification and screening of technologies and the development of alternatives are based upon the information presented in Section 3.0 and involve the following activities:

- Identification of technologies and applicable process options.
- Screening of potential technologies and applicable process options.
- Development of alternatives by assembling the remaining technologies into alternatives that have the potential to achieve the defined RAOs/CAOs.

4.2 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

This section identifies potential remedial technologies and process options that may be used to achieve RAOs/CAOs. Technologies and process options can be grouped according to general response actions (GRAs). Alternatives are then formulated by combining GRAs to address the RAOs/CAOs. The categories of GRAs that could be implemented to achieve or address the RAOs/CAOs for Site 1 include:

- No action
- Institutional controls (land use controls)
- Containment
- Removal
- Treatment
- Disposal

The application of containment at the site would meet the requirements of the guidance for the presumptive remedy for landfills. The application of the presumptive remedy for this site would typically eliminate most of the GRAs from further consideration; however, each of the GRAs is briefly discussed to evaluate unrestricted use of the property per Department of Defense (DOD) guidance (DOD, 2001). Furthermore, remedial actions pertaining to impacted sediment will be defined and evaluated with the remedial alternatives for the landfill. Each of the GRAs is discussed below.

4.2.1 No Action

No action is a general response action wherein the status quo is maintained at the site. No action is normally retained to provide a baseline for comparison with other alternatives. No additional activities would be conducted at the site to address existing waste and sediment contamination. There are no implementability concerns, because the contaminated media are considered to be left “as is”. Institutional controls, containment, removal, treatment, or other mitigating actions are not provided to reduce the potential for exposure. The no action alternative does not reduce toxicity, mobility, or volume. However, in the long term, contaminants may detoxify, become immobilized, migrate, and/or impact additional media in the future. Associated risks would be unknown.

4.2.2 Institutional Controls (Land Use Controls)

Access controls (e.g., physical barriers) and/or site development through the MCRD Parris Island Master Plan, Land Use Control Assurance Plan (LUCAP), and the Site 1 Land Use Control Implementation Plan (LUCIP) are institutional control options that may be considered for implementation to reduce or control pathways of exposure to hazardous substances at the site. Controls could involve the use of such measures as groundwater use restriction or surface soil, sediment, and groundwater monitoring networks. The application of institutional controls alone does not reduce the volume, mobility, and toxicity of the contaminants.

4.2.3 Containment

Containment involves the application of physical measures to reduce the potential for contaminant migration and thereby reduce the risk from both chemical and physical exposure to the public and the environment. The contaminated media must be isolated from the primary transport mechanisms (i.e., wind, erosion, tidal/wave action, surface water, and groundwater) to reduce the migration of contaminants. Contaminated media are isolated by the installation of surface and subsurface barriers that either block or divert any transport media from the contaminants.

4.2.4 Removal

Removal action is a general response action wherein technologies are used to move contaminated media from its present location in order to be treated and/or disposed elsewhere. Treatment and/or disposal process options can be combined with removal process options to develop alternatives.

4.2.5 Treatment

The treatment response action, including both in-situ and ex-situ treatment process options, includes physical, chemical, biological, solidification or thermal technologies designed to reduce the mobility, toxicity, and/or volume of the contaminants present. Treatment can be used with removal and disposal process options to develop alternatives.

4.2.6 Disposal

Disposal technologies include placement of removed or treated materials in an on-site or an off-site permanent disposal facility. Removal options and possibly treatment options can be used with disposal process options to develop alternatives. The toxicity, mobility, or volume of the contaminants is not reduced through the singular application of disposal. This response action would reduce or control exposure pathways related to direct human and ecological contact with contaminated material.

4.3 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR WASTE AND SEDIMENT

In this section, technologies and process options are identified under each GRA and screened at a preliminary level to focus on relevant technologies and process options. Screening is conducted at a more detailed level based on certain evaluation criteria. Finally, process options are selected to represent the technologies that have passed the detailed evaluation and screening.

Tables 4-1 and 4-2 summarize the preliminary screening of technologies and process options applicable to waste and sediment. The tables present the GRAs, identifies the technologies and process options, and provides a brief description of each process option followed by the screening comments. All technologies and process options that are not eliminated because of implementation concerns will be evaluated in greater detail in Section 4.5.

4.4 EVALUATION CRITERIA

The evaluation criteria for detailed screening of technologies and process options that have been retained after the preliminary screening in Section 4.3 are effectiveness, implementability, and cost. The following are descriptions of the evaluation criteria:

- Effectiveness
  - Protection of human health and environment; reduction in toxicity, mobility, and volume; and permanence of solution
  - Ability of the technology to address the estimated areas or volumes of contaminated media

- Ability of the technology to meet the remediation goals identified in the remedial action objectives
- Technical reliability (innovative versus well-proven) with respect to contaminants and site conditions

- Implementability
  - Overall technical feasibility at the site
  - Availability of vendors, mobile units, storage and disposal services, etc
  - Administrative feasibility
  - Special long-term maintenance and operation requirements

- Cost (Qualitative)
  - Capital cost
  - Operation and maintenance (O&M) costs

All of the items listed above may not apply directly to each technology and, therefore, will be addressed only as appropriate. Screening evaluations at this stage generally focus on effectiveness and implementability, with less emphasis on cost evaluations. Technologies whose use would be precluded by waste characteristics and inapplicability under the given site conditions are screened and eliminated from further consideration. Each technology presented in this section is not necessarily intended to be implemented alone because it may be combined with other technologies into remedial action alternatives.

4.5 FINAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR WASTE AND SEDIMENT

4.5.1 Technologies and Process Options for Waste

The final screening of technologies and process options is based on the evaluation criteria described in Section 4.4. The following are the technologies and process options for waste material that passed preliminary screening and remain for final screening.

General Response Action	Remedial Technology	Process Options
No Action	None	Not Applicable
Institutional Controls (Land Use Controls)	Access/Use Restrictions	Limited Site Access Site Development Restrictions
	Monitoring	Sediment, Surface Water, and Groundwater Monitoring
Containment	Capping	Single Layer Cap/Multilayer Cap
	Bank Revetment (Slope Stabilization and Erosion Control Measures)	Riprap, Gabions, Erosion Control Matting, Vegetation, Resloping of banks

General Response Action	Remedial Technology	Process Options
Removal	Excavation of Waste Materials	Excavation of Waste Materials
Disposal	On-Site Consolidation/ Disposal	On-Site Consolidation/ Disposal
	Off-Site Disposal	Permitted Treatment/Storage/Disposal Facility

4.5.1.1 No Action

No action consists of maintaining status quo at the site. No action is retained as a baseline for comparison purposes.

Effectiveness

No action would not be effective in achieving the RAOs/CAOs for surface soil where human and ecological exposure to impacted surface soil would continue. Migration of waste material and surface soil COCs to the adjacent sediment and surface water and to the groundwater would continue.

Implementability

There are no implementability concerns with no action.

Cost

There are no costs associated with no action.

Conclusion

No action is retained as required by the NCP to provide a baseline comparison.

4.5.1.2 Institutional Controls (Land Use Controls) and Monitoring

Institutional controls (land use controls) are measures for reducing contact with contaminated media. Such measures could include restrictions to on-site access such as signs, fencing, and/or security gates. Site development restrictions may be imposed to allow only non-residential development, restrict construction practices, and prohibit the use of groundwater as a drinking water source. Monitoring, which would involve the collection of environmental samples such as groundwater, surface water, and sediment, followed by analysis for target contaminants, could be conducted to assess the trends of contaminants in those media.

Post action assessments, 5-year reviews, and other evaluation activities may be required to develop complete alternatives.

Effectiveness

Institutional controls would be partially effective. Fencing and security gates may be effective in minimizing human exposure, but would not be effective for protecting ecological receptors. Site wastes would continue to erode and impact the surrounding marsh. Site development restrictions, such as allowing only nonresidential development, would be effective in reducing exposure risks. Restrictions could be implemented to prohibit use of groundwater as a drinking water source. A potable water supply is available at the base. Since the groundwater is predominantly saline, residential use of the groundwater is unlikely. Restrictions for prohibiting unauthorized intrusive activity could include a provision for site workers to wear proper personal protection equipment (PPE) during remedial activities.

Sampling and analysis of environmental media by themselves would be ineffective in minimizing the migration of contaminants in the environment, but they can be used for assessing the migration of contaminants. In particular, they can be used to determine if actual migration of contaminants is occurring or if contaminants are attenuating through natural processes such as biodegradation, advection, adsorption, and dilution. Sampling and analysis of environmental samples would also be required to aid in assessing the effectiveness of remedial activities.

Implementability

The institutional controls listed above are readily available would be implementable. Site access and development restrictions could be implemented by incorporating the restrictions into the MCRD Parris Island Master Plan and LUCAP, as well as the LUCIP for the site. Sampling equipment and analytical test methods are readily available and implementable.

Cost

Costs of access/use restrictions would be low. Costs associated with sampling and analysis are also low to moderate.

Conclusion

Retain the use of institutional controls to enforce access/use restrictions. Controls could include restrictions on unauthorized intrusive activities, groundwater usage, and residential development. Monitoring could be implemented to ensure that remedial actions are effective. These controls could be used in conjunction with other remedial alternatives addressed in this FS/CMS.

4.5.1.3 Containment

The technologies considered under containment are capping, slope stabilization, and erosion control measures. These remedial alternatives serve different purposes in containment and are not mutually exclusive. The implementation of containment would be consistent with the application of the landfill presumptive remedy.

4.5.1.3.1 Capping

Multilayer caps consist of layers of soil, clay, and/or synthetic materials placed over contaminated areas. Materials used in the construction of such caps include clay or synthetic, low-permeability material such as linear low-density polyethylene (LLDPE) or polyvinyl chloride (PVC). Low-permeability caps composed of synthetic material or clay are also suited for reducing contaminant migration to groundwater due to rainfall infiltration and surface runoff. The purposes of a cap at Site 1 would be to minimize the potential for human and ecological contact with the soil, to reduce erosion of impacted surface soil as a result of surface water runoff, waves, and/or wind, and to minimize infiltration and vertical containment migration. Biotic barriers to impede burrowing animals would also be considered during design of an appropriate cap system.

Effectiveness

Multilayer caps as a physical barrier can be effective in reducing risk associated with human and ecological exposure to contaminated media beneath the cap. Multilayer caps can also be effective in reducing the infiltration of rainfall/surface water runoff into the wastes beneath the cover, which in turn reduces vertical contaminant migration.

Implementability

Capping is a common remedial alternative and would be fully implementable. Synthetic materials are readily available from several vendors and the materials are commonly used. It is anticipated that borrow sources can be identified relatively close to the base. The main concern with the implementation of the cap would be its maintenance under the influence of natural (e.g., storms and burrowing animals) and human interferences (e.g., development). Proper engineering and continued O&M would minimize the impacts of natural interferences. Because the site is under federal control, human interferences could also be minimized.

Cost

Costs of caps are moderate to high, depending on the materials and labor involved in placement. O&M costs for caps are typically low to moderate.

Conclusion

Multilayer capping is retained for development as an alternative. This technology meets the requirements of the presumptive remedy for landfills.

4.5.1.3.2 Slope Stabilization and Erosion Control Measures

Slope stabilization and erosion control measures consist of methods for minimizing the potential for failure of the landfill cap sideslopes and reducing the erosion rate of the surface soil due to surface water runoff, waves, and/or wind. Slope stabilization measures could include installation of riprap or gabions at the toe of slope to function as a toe-fill buttress. Erosion control measures could consist of providing a vegetated cover, erosion control matting, gabions, and/or riprap on the landfill as required to control erosion. Typically, vegetation is seeded on flatter grades, whereas riprap material and other devices are used on steeper grades. The type and extent of slope stabilization and erosion control measures implemented are a function of site conditions, which include the landfill geometry, groundwater and surface elevations, and the characteristics (e.g., shear strength) of the materials comprising the cap system, landfill, and underlying soil.

Effectiveness

Slope stabilization methods could be an effective way to minimize the potential for failure of the sideslopes of the landfill cap. However, to determine whether these measures would be adequate in the long term to protect against failure from weather and seismic events, additional geotechnical study would be required. Erosion control measures would be an effective way of reducing the transport of impacted surface soil and waste material to sediment and surface water.

Implementability

The construction of stabilization and erosion control measures is common for landfill and excavation remedial alternatives and would be fully implementable. Materials are readily available and the materials are commonly used.

Cost

The cost of implementation of slope stabilization and erosion control measures are moderate to high.

Conclusion

Retain the use of slope stabilization and erosion control measures as an effective means of minimizing failure of the landfill cap system sideslopes and reducing the migration of contaminated material into the environment.

4.5.1.4 Removal

Excavation may be implemented for the removal alternative that is under consideration for landfill material. Excavation can be performed by a variety of equipment, such as hydraulic excavators, track loaders, backhoes, grade-alls, etc. The type of equipment selected must take into consideration several factors, such as type of material, load-supporting ability of the soil, rate of excavation required, depth of excavation, etc.

Effectiveness

Excavation can be effective in removing contaminated materials from the site because it is applicable to the complete range of contaminant groups with no particular target group. Additionally, the volume and depth of contaminated material does not prohibit the use of such measures. Confirmatory sampling may be required to verify the completion of the removal action. Samples must be taken from the exposed faces of the excavation area and analyzed for COCs to ensure that the residual material is not contaminated at unacceptable levels. Bulk excavation may require the use of temporary containment measures to minimize the migration of contaminated material into the surrounding surface waters and sediments (e.g., cofferdams or silt fences) during removal activities.

Implementability

The availability of excavation equipment is not of concern. The technology is well proven and established in the construction/remediation industry. Because some waste is located below the elevation of tidal fluctuations and the normal water table evaluation, some method of dewatering would need to be employed to facilitate total excavation of the waste material. Planning would be required to perform excavation activities during periods of acceptable weather conditions. During excavation, OSHA requirements must be met to ensure that the exposure of the workers to COCs is minimized.

Cost

Excavation costs are directly proportional to the extent of excavation required but are typically low. However, because dewatering is a concern at this site, excavation costs would be moderate to high.

Conclusion

Retain excavation of landfill materials for further consideration in the development of remedial alternatives/corrective measures. Although the application of the presumptive remedy for this site would typically eliminate this option from further consideration, removal is retained to evaluate unrestricted use of the property per DOD guidance (DOD, 2001).

4.5.1.5 Disposal

4.5.1.5.1 On-Site Consolidation/Disposal

On-site consolidation of landfill material would involve moving waste from outside of the footprint of the landfill cap system and consolidating the waste within the limits of the landfill cap system. Additionally, a newly constructed on-site disposal area could be created to contain waste materials.

Effectiveness

On-site consolidation or disposal can be effective for small volumes and isolated pockets of waste materials that are widely distributed outside of a main disposal area. This technology is especially effective if the wastes are nonhazardous and excavation and disposal does not trigger Federal LDRs.

Implementability

Consolidation and placement of excavated material under a cap system is easy to moderate to implement. The geotechnical properties of the waste can be an important factor in the consolidation of waste material. Excavation and deposition activities may expose the workers to the contaminants present in the waste materials, but adequate PPE and observance of OSHA requirements can address potential health concerns. Potentially, land use controls and the base master plan would be required on any site where wastes are allowed to remain with or without treatment.

Cost

Capital and O&M costs of on-site consolidation with a cover are low to moderate. Creation of an on-site disposal area is moderate to high.

Conclusion

On-site consolidation is retained as a technology for development of a remedial alternative. On-site disposal (i.e., constructed disposal cell) is eliminated from further consideration in the development of remedial alternatives.

4.5.1.5.2 Off-Site Disposal

Off-site disposal involves transport of excavated landfill material or waste to an appropriate off-site disposal facility. A permitted treatment, storage, and disposal facility would be required for any hazardous waste, as defined by RCRA. Current off-site facility approval for CERCLA waste disposal also is required. In addition, LDRs currently require that some hazardous wastes be treated to render them nonhazardous prior to disposal. A permitted, solid waste disposal facility would be used for all nonhazardous waste, as defined by RCRA.

Effectiveness

Off-site disposal is effective because contaminated media are taken off site, and minimal residual risks would remain. Landfills are effective at isolating wastes from the environment. The waste-specific requirements vary from state to state and by individual landfills. The selection is based on waste-specific effectiveness, permitting, and cost considerations.

Implementability

Off-site disposal of landfill material is implementable. Permitting requirements are variable based on the particular state and landfill. In general, the more protective a landfill is, the easier it is to obtain waste approval.

Cost

The cost of off-site disposal is highly variable, ranging from low to high for nonhazardous and hazardous waste landfills, respectively.

Conclusion

Retain off-site disposal of excavated landfill waste for further consideration in the development of remedial alternatives. Although the application of the presumptive remedy for this site would typically eliminate this option from further consideration, off-site disposal is retained to evaluate unrestricted use of the property per DOD guidance (DOD, 2001).

4.5.2 Technologies and Process Options for Sediment

The final screening of technologies and process options is based on the evaluation criteria described in Section 4.4. The following are the sediment technologies and process options that passed preliminary screening and remain for final screening.

General Response Action	Remedial Technology	Process Options
No Action	None	Not Applicable
Institutional Controls (Land Use Controls)	Access/Use Restrictions	Limited Site Access Site Development Restrictions
	Monitoring	Sediment Monitoring
Removal	Bulk Excavation	Bulk Excavation
In-Situ Treatment	Biological	Monitored Natural Recovery
Disposal	On-Site Consolidation/ Disposal	On-Site Consolidation/ Disposal
	Off-Site Disposal	Permitted Treatment/Storage/Disposal Facility

4.5.2.1 No Action

No action consists of maintaining status quo at the site. No action is retained as a baseline for comparison purposes.

Effectiveness

No action would not be effective in achieving the RAOs/CAOs for sediment where human and ecological exposure to impacted sediment would continue. Migration of sediment COCs to surface water would continue.

Implementability

There are no implementability concerns with no action.

Cost

There are no costs associated with no action.

Conclusion

No action is retained as required by NCP to provide a baseline comparison.

4.5.2.2 Institutional Controls (Land Use Controls) and Monitoring

Institutional controls (land use controls) are measures for reducing contact with contaminated media. Such measures could include restrictions for on-site access such as signs, fencing, and/or security gates near the entrances of the landfill area and saltwater marsh. Site development restrictions may be imposed to allow only non-residential development. Monitoring, which would involve the collection of environmental samples followed by analysis for target contaminants, could be conducted to assess trends of contaminants in the media of concern.

Effectiveness

Institutional controls and monitoring would be partially effective. They would not address potential risks to ecological receptors. Controls may be effective at reducing human health exposure. Warning signs could be an effective method for reducing risks to the adult recreational user.

Sampling and analysis of environmental media by themselves are ineffective in minimizing the migration of contaminants in the environment, but they can be used for assessing the migration of contaminants. In particular, they can be used to determine if actual migration of contaminants is occurring or if contaminants are attenuating through natural processes such as biodegradation, advection, adsorption, and dilution. Sampling and analysis of environmental samples would also be required to aid in assessing the effectiveness of remedial activities.

Implementability

The institutional controls listed above are readily available and implementable. Site access and development restrictions could be implemented by incorporating the restrictions into the MCRD Parris Island Master Plan and LUCAP, as well as the LUCIP for Site 1. Sampling equipment and analytical test methods are readily available and implementable.

Cost

Costs of access/use restrictions are low. Costs associated with sampling and analysis are also low.

Conclusion

Retain the use of institutional controls to enforce access/use restrictions. Controls could include restrictions on residential development. Monitoring could be implemented to ensure that remedial actions

are effective. Although institutional controls may not be protective of ecological receptors, they could be used in conjunction with other remedial alternatives addressed in this FS/CMS.

4.5.2.3 Removal

Bulk excavation is the only type of removal alternative that is under consideration for sediment. Bulk excavation would apply to sediment when water levels in the salt marsh are low or controlled to accommodate removal. The site sediments vary from being moderately dry at low tide to saturated at high tide. The typical depth of water expected to cover sediments during high tide ranges from 2 inches to 1 foot. Migration of some contaminated sediment may occur during excavation activities. Excavation can be performed by a variety of equipment, such as hydraulic excavators, backhoes, grade-alls, etc. The type of equipment selected must take into consideration several factors, such as type of material, load-supporting ability of the soil, rate of excavation required, depth of excavation, etc. Usually hydraulic excavators, draglines, clamshells, or backhoes are used for deep excavation and/or when required excavation rates are high.

Effectiveness

Excavation can be effective in removing contaminated material from the site because it is applicable to the complete range of contaminant groups with no particular target group. Additionally, the volume of contaminated sediment does not prohibit the use of such measures. Confirmatory sampling is required to verify the completion of the removal action. Samples must be taken from the exposed faces of the excavation area and analyzed for the COCs to ensure that the residual material is not contaminated at unacceptable levels. Bulk excavation may require the use of temporary containment measures to minimize the migration of contaminated sediment into the surface waters (e.g., cofferdams or silt fences) during removal activities.

Implementability

The availability of excavation equipment is not of concern. The technology is well proven and established in the construction/remediation industry. Because the area of impacted sediment is within a low-lying salt marsh that is tidally influenced, implementation of excavation could be difficult with respect to saturated sediments and accessibility for excavation and transportation equipment. Some method of dewatering would need to be employed to minimize or eliminate tidal influence on the area and facilitate excavation of the saturated sediments. During sediment removal, OSHA requirements must be met to ensure that the exposure of the workers to COCs is minimized.

Cost

Excavation costs are directly proportional to the extent of excavation required but are typically low. Excavation costs also depend upon the accessibility of the sediments which could make excavation costs moderate to high.

Conclusion

Retain excavation of sediment for further consideration in the development of remedial alternatives/corrective measures.

4.5.2.4 In-Situ Treatment

Based on the results of the preliminary screening section, this section will evaluate one in-situ treatment technology for sediment, monitored natural recovery.

Under monitored natural recovery, concentrations of site COCs may gradually decrease due to processes such as biodegradation, advection, dispersion, adsorption, and dilution.

Effectiveness

Monitored natural recovery is not effective in the remediation of inorganics chemicals. Concentrations of inorganic chemicals can diminish over time due to natural processes such as advection and dispersion. Organic chemicals such as PAHs, pesticides, and PCBs can biodegrade naturally, although long periods of time are required. Uptake may be effective with certain combinations of contaminants and vegetation types.

Implementability

For monitored natural recovery, methods, equipment, and personnel to conduct monitoring activities are readily available and implementable.

Cost

Costs associated with sampling and analysis would be low.

Conclusion

Retain monitored natural recovery as a remedial alternative technology based on the effectiveness with PAHs.

4.5.2.5 Disposal

4.5.2.5.1 On-Site Consolidation/Disposal

On-site consolidation/disposal of contaminated sediment would involve excavation of impacted areas (discussed in removal) followed by dewatering and consolidation on the landfill area. Disposal would be combined with other actions for the landfill that would involve containment. Monitoring of groundwater would be required to detect any migration of contaminants.

Effectiveness

On-site consolidation/disposal can be effective for the impacted sediment. This technology is especially effective if the wastes are nonhazardous and dredging and disposal does not trigger Federal LDRs as would be expected with the impacted sediment at Site 1.

Implementability

On-site disposal technologies can be implemented. Consolidation within the landfill area is easily implementable. Excavation and deposition activities may expose the workers to the contaminants present in the sediment, but adequate PPE and observance of OSHA requirements can address potential health concerns. Land use controls and the Base Master Plan would be required on any site where wastes are allowed to remain with or without treatment.

Cost

Capital and O&M costs of on-site consolidation within a contiguous area (the Incinerator Landfill area) are low to moderate.

Conclusion

Retain on-site consolidation/disposal of sediment for further consideration in the development of remedial alternatives. Sediment may require dewatering prior to the placement of the material within the landfill area. The option is dependant on the combination of technologies (such as containment) for the landfill area.

4.5.2.5.2 Off-Site Disposal

Off-site disposal involves transport of excavated sediment to an off-site disposal facility. A permitted treatment, storage, and disposal facility would be required for any hazardous waste, as defined by RCRA.

In addition, LDRs currently require that some hazardous wastes be treated to render them nonhazardous prior to disposal. A permitted, solid waste disposal facility would be used for all nonhazardous waste, as defined by RCRA.

Effectiveness

Off-site disposal is effective because contaminated sediment are taken off site, and minimal residual risks would remain. Landfills are effective at isolating wastes from the environment. The waste-specific requirements vary from state to state and by individual landfills. The selection is based on waste-specific effectiveness, permitting, and cost considerations.

Implementability

Off-site disposal of sediment is implementable. Permitting requirements are variable based on the particular state and landfill. In general, the more protective a landfill is, the easier it is to obtain waste approval. Dewatering of the sediment may be required prior to transportation and disposal.

Cost

The cost of off-site landfilling is highly variable, ranging from low to high for nonhazardous and hazardous waste landfills, respectively.

Conclusion

Retain off-site disposal of excavated sediment for further consideration in the development of remedial alternatives. Off-site disposal is retained to evaluate unrestricted use of the property per DOD guidance (DOD, 2001).

4.6 SUMMARY OF SCREENING AND SELECTION OF REPRESENTATIVE PROCESS OPTIONS FOR WASTE AND SEDIMENT

Based on the screening process conducted in Sections 4.5, the following technologies have been retained and are summarized as follows.

Selected Technologies and Process Options for Waste

General Response Action	Remedial Technology	Process Options
No Action	None	Not Applicable
Institutional Controls (Land Use Controls)	Access/Use Restrictions	Limited Site Access Site Development Restrictions
	Monitoring	Monitoring
Containment	Capping	Single Layer Cap/Multilayer Cap
	Bank Revetment (Slope Stabilization and Erosion Control Measures)	Riprap, Gabions, Erosion Control Matting, Vegetation, Resloping
Removal	Excavation of Waste Materials	Excavation of Waste Materials
Disposal	On-Site Consolidation/ Disposal	On-Site Consolidation/ Disposal
	Off-Site Disposal	Permitted Treatment/Storage/Disposal Facility

Selected Technologies and Process Options for Sediment

General Response Action	Remedial Technology	Process Options
No Action	None	Not Applicable
Institutional Controls (Land Use Controls)	Access/Use Restrictions	Limited Site Access Site Development Restrictions
	Monitoring	Monitoring
Removal	Excavation of Sediment Materials	Excavation of Sediment Materials
In-Situ Treatment	Biological	Monitored Natural Recovery
Disposal	On-Site Consolidation/ Disposal	On-Site Consolidation/ Disposal
	Off-Site Disposal	Permitted Treatment/Storage/Disposal Facility

4.7 IDENTIFICATION OF REMEDIAL ACTIONS/CORRECTIVE MEASURE ALTERNATIVES FOR SITE 1

This section describes alternatives for Site 1 considering the information provided in the previous sections. Alternatives are briefly explained in this section and a detailed description and evaluation of each alternative is provided in Section 5.0.

The waste material in the landfill is being considered under the presumptive remedy guidance for landfills. However, due to the presence of contaminated sediment outside the limits of the landfill, additional non-presumptive remedy options have been retained for consideration in the development of alternatives (USEPA, 1993). Combinations of the application of the presumptive remedy for the landfill area and options

for the extent of sediment excavation are developed as Alternative 2a and Alternative 2b. The variation between these alternatives is the RGOs used for the delineation of impacted sediment and the corresponding volumes of sediment to be excavated. Alternative 2a utilizes excavation of the sediments contaminated with pesticides and inorganics (i.e., copper, lead, and mercury) in excess of ecological RGOs. Arsenic and PAH contaminated sediments would remain in place and would be addressed with landuse controls and monitored natural recovery (PAHs only). Alternative 2b would include excavation of all sediments with COC concentrations greater than RGOs.

Alternative 3 was developed to meet the requirements of the DOD guidance which allows for the unrestricted use of the site after remedial actions are complete (DOD, 2001) and features excavation and off-site disposal of all waste and contaminated sediment.

The alternatives were developed to address the COCs and exposure pathways in order to achieve the RAOs/CAOs. The alternatives were developed to show a range of alternatives to address all contaminants that could potentially affect ecological and human receptors.

The following alternatives have been developed for Site 1:

- Alternative 1 - No Action (This alternative is developed per the NCP to provide a baseline for comparison to other alternatives).

- Alternative 2a – Excavation and Consolidation of Pesticide and Inorganic Contaminated Sediment in Excess of Ecological RGOs and Containment of Waste (follows the presumptive remedy evaluation).

- Alternative 2b – Excavation and Consolidation of All Contaminated Sediment and Containment of Waste (follows the presumptive remedy evaluation).

- Alternative 3 – Excavation and Off-Site Disposal of Waste and Sediment (follows unrestricted land use evaluation).

These alternatives are briefly described as follows.

4.7.1 Alternative 1 - No Action

The no-action alternative maintains the site at status quo. This alternative is retained to provide a baseline for comparison to other alternatives and, therefore, does not address the wastes present or impacted sediment.

4.7.2 Alternative 2a – Excavation and Consolidation of Pesticide and Inorganic Contaminated Sediment in Excess of Ecological RGOs and Containment of Waste

Alternative 2a consists of the following components:

- Excavation of sediment with concentrations of inorganic chemicals and pesticides above the RGOs for protection of ecological receptors and consolidation of the sediment within the limits of the proposed cap system,

- Monitored natural recovery for PAHs above the RGOs for the protection of ecological and human receptors,

- Excavation of waste and sediment/waste materials outside of the limits of the proposed cap system and consolidation of the waste within the limits of the proposed cap system,

- Installation of a low-permeability cap system over the consolidated and regraded waste and sediment,

- Use of slope stabilization and erosion controls,

- Restoration of salt marsh area where excavation was performed, and

- Implementation of land use controls for the limits of the proposed cap and the areas of sediment contaminated with arsenic and PAHs, long-term monitoring of the groundwater and the PAH contaminated sediments, 5-year reviews of the site, and operation and maintenance of the landfill cap system.

4.7.3 Alternative 2b – Excavation and Consolidation of All Contaminated Sediment and Containment of Waste

Alternative 2b consists of the following components:

- Excavation of sediment with concentrations of inorganic chemicals, pesticides, and PAHs above the RGOs for the protection of ecological and human receptors and consolidation of the excavated sediment within the limits of the proposed cap,

- Excavation of waste and sediment/waste materials outside of the limits of the proposed cap system and consolidation of the waste within the limits of the proposed cap system,

- Installation of a low-permeability cap system over the consolidated and regraded waste and sediment,

- Use of slope stabilization and erosion controls,

- Restoration of salt marsh area where excavation was performed, and

- Implementation of land use controls for the limits of the proposed cap, long-term monitoring of the groundwater, 5-year reviews of the site, and operation and maintenance of the landfill cap system.

4.7.4 Alternative 3 – Excavation and Off-Site Disposal of Waste and Sediment

Alternative 3 consists of the following components:

- Excavation of sediment with concentrations of inorganic chemicals, pesticides, and PAHs above the RGOs for the protection of ecological and human receptors,

- Excavation of sediment and waste materials associated with the landfill area,

- Transportation and disposal of sediment and waste materials to approved off-site disposal facilities, and

- Restoration of salt marsh and landfill areas.

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TABLE 4-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR WASTE
SITE 1 – INCINERATOR LANDFILL
MCRD PARRIS ISLAND, SOUTH CAROLINA

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
GENERAL RESPONSE ACTION: NO ACTION				
No Action	No Action	No activities conducted to address contamination.	Required as baseline for comparison.	Yes
GENERAL RESPONSE ACTION: INSTITUTIONAL CONTROLS				
Institutional Controls (Land Use Controls)	Limited Site Access	Physical barrier (fence) used to restrict access to the site.	Physical restrictions could be effective in reducing human exposure to site contaminants. Does not reduce contaminant exposure to ecological receptors.	Yes
	Site Development Restrictions	Administrative action used to restrict future site use.	Administrative action is used to reduce human exposure to site contaminants. Does not reduce contaminant exposure to ecological receptors.	Yes
Monitoring	Monitoring	Sampling and analysis of environmental media to assess contaminant migration and future environmental impacts.	Effective only to assess contaminant levels on site and migration off site. Can be used to determine if conditions are changing and to determine whether remedial actions/corrective measures are effective.	Yes
GENERAL RESPONSE ACTION: CONTAINMENT				
Soil Cover	Native Soil	Layer of native soil is placed over the site to reduce human and ecological exposure to impacted surface soil. The soil layer also reduces migration of contaminants.	Would provide a barrier for potential human and ecological exposure pathways and reduce transport of COCs in soil to sediment and surface water. Does not comply with landfill requirements or limit vertical contaminant migration of soluble contaminants.	No
Capping	Clay Cap/Synthetic Membrane/ Asphalt/ Concrete	Use of low permeability materials constructed over the site to provide a barrier to water infiltration and also reduce direct contact with and ingestion of chemicals, as well as migration to surface water.	Would provide a barrier for potential human and ecological exposure pathways and reduce transport of COCs in soil to sediment and surface water. Would also reduce contaminant migration via infiltrating water. Groundwater is currently not significantly impacted by site contaminants.	Yes
Bank Revetment	Slope Stabilization and Erosion Control	Permanent or temporary sloping of banks and/or protecting the banks with stone rip rap, vegetation, matting, etc. to stabilize slopes.	The type and extent of slope stabilization measures implemented are a function of site conditions which include the shear strength of the materials comprising the landfill cap system and underlying soil, geometry, tidal effects, and water surface elevations.	Yes
Vertical Barrier	Slurry Wall	Soil/bentonite or soil/cement barriers are installed around waste area to isolate waste materials. This low permeable barrier restricts lateral contaminant migration via groundwater.	Groundwater is not significantly impacted by site contaminants.	No
Horizontal Barrier	Grout Injection	Pressure injection of cement at depth through closely spaced drill holes to reduce contaminant migration to groundwater.	Groundwater is not significantly impacted by site contaminants.	No

TABLE 4-1

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR WASTE
SITE 1 – INCINERATOR LANDFILL
MCRD PARRIS ISLAND, SOUTH CAROLINA

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
GENERAL RESPONSE ACTION: REMOVAL				
Bulk Excavation	Bulk Excavation	Mechanical removal of solid materials using common construction equipment such as bulldozers and highlifts.	Not typically retained if the presumptive remedy for landfills is applied; however, it is an appropriate technology to be considered for the development of an unrestricted landuse alternative.	Yes
GENERAL RESPONSE ACTION: IN-SITU AND EX-SITU TREATMENT				
In-Situ and Ex-Situ Treatment	Physical, Chemical, and Biological Treatment Processes	Physical, chemical, and biological treatment processes are employed to reduce the toxicity, mobility, and/or volume of contaminates.	Not evaluated if the presumptive remedy for landfills is applied.	No
GENERAL RESPONSE ACTION: DISPOSAL				
Disposal	On-site Consolidation/ Disposal	Soil is excavated and characterized as required. Soil is then disposed of/consolidated on site.	Consolidate waste from outside the final perimeter of landfill cover system.	Yes
	Off-site Landfill	Soil is excavated and characterized as required. Hazardous wastes are treated to meet either RCRA or non-RCRA treatment standards prior to land disposal. Soil is then disposed of in a secure, off-site, RCRA-permitted facility.	Not typically retained if the presumptive remedy for landfills is applied; however, it is an appropriate technology to be considered for the development of an unrestricted landuse alternative.	Yes

TABLE 4-2

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SEDIMENT
SITE 1 – INCINERATOR LANDFILL
MCRD PARRIS ISLAND, SOUTH CAROLINA

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
GENERAL RESPONSE ACTION: NO ACTION				
No Action	No Action	No activities conducted to address contamination.	Required as baseline for comparison.	Yes
GENERAL RESPONSE ACTION: INSTITUTIONAL CONTROLS				
Institutional Controls (Land Use Controls)	Limited Site Access	Physical barrier used to restrict access to the site.	Only effective in reducing direct contact regarding human exposure. Does not reduce contaminant exposure to ecological receptors.	Yes
	Site Development Restrictions	Administrative action used to restrict future site use.	Administrative action is used to reduce direct contact regarding human exposure. Does not reduce contaminant exposure to ecological receptors.	Yes
Monitoring	Monitoring	Sampling and analysis of environmental media to assess contaminant migration and future environmental impacts.	Effective only to assess contaminant levels on site and migration off site. Can be used to determine if conditions are changing and to determine whether remedial actions/corrective measures are effective.	Yes
GENERAL RESPONSE ACTION: CONTAINMENT				
Soil Cover	Native Soil	Layer of native soil is placed over sediment to reduce human and ecological exposure to impacted sediment. The soil layer also reduces migration of contaminants.	The sediments are present in an environmentally sensitive area. Barriers placed at the site would destroy the wetlands and the cover would not be permanent in the long term because of erosion.	No
Capping	Clay Cap/Synthetic Membrane/ Asphalt/ Concrete	Use of low permeability materials constructed over the site to provide a barrier to water infiltration and also reduce direct contact with and ingestion of chemicals, as well as migration to surface water.	The sediments are present in an environmentally sensitive area. Barriers placed at the site would destroy the wetlands and the cover would not be permanent in the long term because of erosion.	No
GENERAL RESPONSE ACTION: REMOVAL				
Bulk Excavation	Bulk Excavation	Mechanical removal of solid materials using common construction equipment such as bulldozers and highlifts.	Effective in removing contaminated sediment; however, some method must be implemented to control or dewatering the sediments during excavation activities.	Yes
Dredging	Dredging	Use of mechanical, hydraulic, or pneumatic dredge to remove sediments or saturated soils.	Effective in removing contaminated sediments. A cofferdam system would likely need to be implemented to reduce contaminant migration during dredging.	No

TABLE 4-2

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SEDIMENT
SITE 1 – INCINERATOR LANDFILL
MCRD PARRIS ISLAND, SOUTH CAROLINA

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
GENERAL RESPONSE ACTION: IN-SITU TREATMENT				
Biological	Monitored Natural Recovery	In-situ degradation of organics using microorganisms in an aerobic/anaerobic environment.	PAHs in sediment would be reduced through biodegradation over moderate periods of time. Pesticides in sediment would biodegrade, but at a much slower rate than the PAHs. Not applicable to inorganics.	Yes
	Enhanced Biodegradation	In-situ degradation of organics using microorganisms in an aerobic/anaerobic environment. Nutrients are injected into the sediment to promote biological activity.	Low permeability of sediment may impede distribution of nutrients and decrease the effectiveness of this technology. Also, not applicable to inorganics.	No
Thermal	Vitrification	Electrodes for applying electricity are used to melt contaminated sediment, producing a glass and crystalline structure with very low leaching characteristics and destroys organics.	High water content of sediment would make vitrification or any other thermal treatment technology impractical.	No
Physical/ Chemical	Stabilization/ Solidification	Pressure injection or mechanical mixing of cement/pozzolanic materials to form an impermeable solid and immobilize contaminants.	Solidified/stabilized mass would be in contact with brackish surface water which may compromise the integrity of the solidified mass. Potential issues with loss of salt marsh area with stabilized mass.	No
GENERAL RESPONSE ACTION: EX-SITU TREATMENT				
Physical/ Chemical	Stabilization/ Solidification	Excavated sediment is mixed with cement lime, fly ash, or other pozzolanic materials to immobilize contaminants.	The concentrations of inorganics in sediments are too low to consider this technology for sediments. In addition, the presence of organic compounds may reduce the effectiveness of this technology.	No
	Soil Washing/ Solvent Extraction	Separating hazardous contaminants from sediments by using an organic chemical as a solvent, thereby reducing the volume of the hazardous waste.	The target contaminant groups for soil washing are SVOCs, fuels, and heavy metals. The technology can be used on selected VOCs and pesticides. The technology offers the ability for recovery of metals and can clean a wide range of organic and inorganic contaminants from coarse-grained soil/sediment; however, soil washing has limited effectiveness where soil/sediment is composed of large percentages of silt and clay.	No
Thermal	Thermal Desorption	Application of heat at high temperature (200 to 1,000 °F) to remove organics from excavated sediment by volatilization. Vapor phase, typically is treated by incineration or carbon adsorption.	Technology targets remediation of high concentrations of PAHs, PCBs, and pesticides. The concentration of organics in sediments is too low to consider this technology. Most inorganics remain in the sediment and may require further treatment. Requires dewatering of sediment prior to treatment.	No

TABLE 4-2

PRELIMINARY SCREENING OF REMEDIATION TECHNOLOGIES FOR SEDIMENT
SITE 1 – INCINERATOR LANDFILL
MCRD PARRIS ISLAND, SOUTH CAROLINA

TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS	OPTION RETAINED
GENERAL RESPONSE ACTION: EX SITU TREATMENT (continued)				
Thermal (continued)	Incineration	Sediment is excavated and treated by on-site or off-site incinerator that employs thermal decomposition via thermal oxidation at high temperature to destroy organics.	Potentially applicable. An effective technology for PAHs, pesticides, and PCBs; however, the concentration of organics in sediments is too low to consider this technology. Additional treatment may be required for inorganics. Dewatering of sediments would be required prior to treatment.	No
	Vitrification	Excavated sediment is melted at high temperature to form a glass and crystalline structure with very low leaching characteristics and destroys organics.	The concentration of organics in sediments is too low to consider this technology. Dewatering of sediments would be required prior to treatment.	No
GENERAL RESPONSE ACTION: DISPOSAL				
Landfill	On-site Disposal/ Consolidation	Sediment is excavated and characterized as required. Sediment is then disposed of/consolidated on site.	Potentially Applicable.	Yes
	Off-site Landfill	Sediment is excavated and characterized as required. Hazardous wastes are treated to meet either RCRA or non-RCRA treatment standards prior to land disposal. Sediment is then disposed of in a secure, off-site, RCRA-permitted facility.	Potentially Applicable.	Yes

5.0 EVALUATION OF REMEDIAL ACTION/CORRECTIVE MEASURES ALTERNATIVES

This section presents a detailed description of each remedial action/corrective measures alternative developed in Section 4.0, the rationale used to evaluate each alternative, and the results of the evaluation for each specific evaluation standard. The evaluation of alternatives is conducted in accordance with the U.S. EPA Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (U.S. EPA, 1988) and the RCRA Corrective Action Plan (Final) (U.S. EPA, 1994).

5.1 REMEDIAL ACTION/CORRECTIVE MEASURES ALTERNATIVES

This section describes in detail the remedial action/correctives measure alternatives developed in Section 4.0. The following alternatives have been developed for Site 1:

- Alternative 1 - No Action (This alternative is developed in accordance with the NCP to provide a baseline for comparison to other alternatives).

- Alternative 2a – Excavation and Consolidation of Pesticide and Inorganic Contaminated Sediment in Excess of Ecological RGOs and Containment of Waste (follows the presumptive remedy evaluation).

- Alternative 2b – Excavation and Consolidation of All Contaminated Sediment and Containment of Waste (follows the presumptive remedy evaluation).

- Alternative 3 – Excavation and Off-Site Disposal of Waste and Sediment (follows unrestricted land use evaluation).

These alternatives are described in the following sections.

5.1.1 <u>Alternative 1 - No Action</u>

The No Action alternative maintains the site at current levels of impact and environmental condition. This alternative is retained to provide a baseline for comparison to other alternatives and, therefore, does not address the wastes that are present or impacted surface soil and sediment. There would be no reduction in toxicity, mobility, or volume of the COCs at Site 1 other than that which would result from natural dispersion, dilution, or other attenuating factors.

5.1.2 Alternative 2a – Excavation and Consolidation of Pesticide and Inorganic Contaminated Sediment in Excess of Ecological RGOs and Containment of Waste

Alternative 2a consists of the following components:

- Excavation of sediment with concentrations of pesticides and inorganic chemicals above the RGOs for ecological receptors and consolidation of the excavated sediment within the limits of the proposed cap system.
- Monitored natural recovery for PAHs for the protection of ecological and human receptors.
- Excavation of waste and sediment/waste materials outside of the limits of the proposed cap system and consolidation of the waste within the limits of the proposed cap system.
- Installation of a low-permeability cap system over the consolidated and regraded waste and sediment.
- Use of slope stabilization and erosion controls.
- Restoration of salt marsh area where excavation was performed.
- Implementation of land use controls for the limits of the proposed cap and the areas of sediment contaminated with arsenic and PAHs, long-term monitoring of the groundwater and the PAH-contaminated sediments, 5-year review of the site, and operation and maintenance of the landfill cap system.

Alternative 2a constitutes the application of the presumptive remedy for landfills. A conceptual design of the alternative is presented in Figure 5-1. The figure depicts the limits of the proposed cap system, as well as the estimated limits of excavation of sediment, sediment/waste, and waste material. The details of each of the components of this alternative are presented below:

Component 1 – Excavation of sediment with concentrations of pesticides and inorganic chemicals above the RGOs for ecological receptors and consolidation of the sediments within the limits of the proposed cap system

Sediments would be excavated to an average depth of approximately 1-foot to the horizontal extent indicated on Figure 5-1. Actual excavation depths may vary depending on the results of the verification

sampling. It is estimated that approximately 2,100 cubic yards of sediment will require excavation under Alternative 2a (see Appendix A). The sediment excavation would also include the removal of any visible waste/debris in the area. Sediments impacted with pesticides and inorganic chemicals (excluding arsenic) that have concentrations above the RGOs for protection of ecological receptors would be excavated. Any existing monitoring wells that are located within the areas of sediment to be excavated would be properly abandoned prior to excavation.

A temporary cofferdam system (e.g., Water Structures® or Portadam®) would be installed around the excavation area to eliminate daily flooding of the areas due to the tidal cycle. These structures are relatively easy to install and remove, and they would have generally no impacts on the marsh. Some of the factors that should be considered during selection of the temporary cofferdam system include the following: depth of water to be retained, wave height, wave action, bedding material, length of system, time system will be required, and the potential for storm events. The cofferdam system would be installed and removed in phases around the areas to be excavated.

All impacted sediment within Area I would be excavated. Area I is defined by the presence of sediment impacted with pesticides and inorganics. Area II, which is defined by sediment impacted with arsenic above the RGO for human receptors, would not be excavated under this alternative. In Area II, where sediment is impacted with arsenic due to human health risks, the residual risk to human exposure would be managed with land use controls. Furthermore, sediment within the majority of Area III that is defined by exceedances of ecological and human receptor RGOs for PAHs, would not be excavated. A small portion of Area III (adjacent to the landfill) would be excavated based on the presence of inorganics above the ecological RGOs and debris.

Overexcavation of sediment may be performed as a value engineering decision in order to minimize the potential for extensive and repeated sampling and excavation cycles. After the initial excavation is completed, verification sampling and laboratory analysis would be completed to ensure that material above the ecological RGO criteria was removed. This verification sampling would be performed prior to completion of the cap system to allow for additional excavation and consolidation, if required. A post removal assessment would be performed after sediment and waste excavation and consolidation of the materials within the landfill cap system. The ecological and human health RGOs would be used to confirm that any residual impacted materials remaining would not pose an unacceptable risk to receptors. The evaluation would be based on both individual sample results and an overall evaluation of the remaining sediment.

Excavated sediment would be transported and consolidated within the limits of the proposed cap system. The cap system design may consider the placement of the sediment within a confined location away from

the side slopes of the landfill to maintain the stability of the landfill. The sediment may have to be dewatered and/or mixed with waste materials, soils, or other binding agents to improve stability.

Component 2 – Monitored natural recovery for PAHs above the RGOs for ecological and human receptors

Sediments that have concentrations of PAHs above the RGOs for protection of ecological and human receptors would be left in place under Alternative 2a. These contaminants would be allowed to naturally attenuate. The monitoring of the natural recovery would be part of the long-term monitoring and assessment activities. Final attainment of PAH RGOs might take in excess of 10 years, although degradation trends should be confirmable within 3 to 5 years. It is anticipated that sediments would be tested annually. Additional details would be developed during the remedial design and remedial action.

Component 3 – Excavation of waste and sediment/waste materials outside of the limits of the proposed cap system and consolidation of the waste within the limits of the proposed cap system

Similar to the excavated sediments, any sediment/waste and waste material outside the proposed limits of the landfill cap system would be excavated and consolidated to areas within the cap system. However, excavation would be performed based on visual identification of waste instead of analytical results. It is estimated that approximately 11,600 cubic yards of sediment/waste and waste would require excavation and consolidation under Alternative 2a. Post-excavation sampling would be performed and the data used in a post-removal assessment. This sampling would be performed prior to the cap system completion to allow for additional excavation and consolidation, if required. The expected depth of waste excavation outside the limits of the landfill cap system is approximately 2 feet. Any existing monitoring wells that are located within the areas of sediment/waste and waste to be excavated would be properly abandoned prior to excavation.

Component 4 – Installation of a low-permeability cap system over the consolidated and regraded waste and sediments

A low-permeability cap system that meets or exceeds the requirements of the Federal and state solid waste and hazardous waste landfill closure requirements would be placed over approximately 6.3 acres of consolidated and graded waste and sediment materials. The cover may consist of components similar to those shown on Figure 5-2. These components from the landfill waste up are as follows:

- Intermediate cover/gas collection layer (12-inches)
- Geosynthetic clay liner

- Geomembrane liner
- Geosynthetic drainage layer
- Cover soil (18-inches)
- Vegetative layer (6-inches)

The cap system would be placed over waste and impacted sediment to eliminate the potential for human and ecological exposure. The system would also eliminate the migration of waste and impacted sediment to surface water and groundwater due to surface water runoff, wind, wave action and tidal influence, and infiltration. The permeability of the cap system would be 1×10^{-7} cm/sec.

A temporary cofferdam would be installed to protect the toe of the landfill during construction. A dam similar to the one discussed under Component 1 would be adequate. The cofferdam system would be installed and removed in phases to accommodate construction of the landfill.

The available groundwater data do not show any significant impacts; therefore, a component was not included to address groundwater containment. If groundwater containment is determined to be necessary because of the results of the groundwater monitoring program, a contingency plan would be to install sumps within the interior of the landfill to allow for pumping of groundwater and an impermeable vertical barrier along the toe of the final cap system. The sumps would only be installed after the cap has been in place and long-term monitoring demonstrates the need to further address the groundwater. A treatment system would also be necessary to treat the groundwater that is removed from the sumps. If implemented, standard engineering practices would be used to reseal the cap. Furthermore, due to the limited groundwater data available, the design of the landfill cap should investigate the possible influence and gradient of groundwater flow through the site from the southern side of the site.

Landfill gas generation may be possible at the site, but based on the age of the landfill (i.e., 40 plus years), as well as the type of waste disposed in the landfill, gas formation is expected to be minimal. However, as a good engineering practice, the cap design would incorporate a minimum passive gas venting system (i.e., one vent per acre).

Slope stability analysis of the proposed landfill cap system would be performed during the design of the cap. Some issues that need to be addressed in the cap design are the stability of the cap system interface at the toe of the landfill, tidal influence and effect on the cap, stability and placement of sediments within the landfill, and consolidation of the underlying salt marsh soils and lower strata of disposed ash.

The need for a biotic barrier should also be evaluated during the design of the cap. The type of animals present at MCRD Parris Island and their burrowing habits would be considered during the design. Typically, a biotic barrier would consist of a layer of cobbles or coarse gravel beneath the top layer of the cap system.

Component 5 – Use of slope stabilization and erosion controls

Slope stabilization and erosion control measures would be implemented along the toe and sideslopes of the landfill cap system to minimize the potential for failure of the sideslopes and to reduce the erosion rate of the cover due to surface water runoff, waves, and/or wind. Rip-rap would be installed along the toe and side slopes to an approximate high, high water elevation of 7 feet. The 100-year flood elevation in this area is 15 feet.

Component 6 – Restoration of salt marsh area where excavation was performed

The areas where sediment, sediment/waste, and waste would be excavated would be restored with clean fill added as needed to establish a natural grade. The fill would be temporarily stabilized to minimize erosion and vegetated with a common local plant.

Contingencies for the salt marsh restoration may be considered that would be enacted based on inadequate vegetative establishment. Also, if verification testing indicates that residual sediment contamination remains, covering with soils may provide a barrier to reduce contact with contaminated sediment.

Component 7 – Implementation of land use controls, long-term monitoring, 5-year reviews, and operation and maintenance

Land use controls would be implemented to control or eliminate pathways of exposure to COCs at the site. Site restrictions would be enacted to prohibit unauthorized intrusive activity within the landfill boundary, to restrict access to areas with arsenic and PAH contaminated sediment, and to ban the use of the groundwater as a drinking water supply. Signs would also be posted to alert users of the property about the presence of the landfill.

A system of six new groundwater monitoring well clusters (shallow/deep) would be installed after installation of the cap to allow for long-term groundwater monitoring. For the first year after completion of the remedial actions, quarterly groundwater sampling and inspections of the landfill would be performed to ensure the integrity and effectiveness of the cap system and slope stabilization and erosion control

measures. After the first year, the groundwater data will be evaluated. This evaluation will consider seasonal variability in results, positive detections to groundwater and surface water criteria, and any data trends. Based on this evaluation, the need and frequency for continuing long groundwater monitoring will be determined. For the purpose of the CMS cost estimate, annual monitoring beyond the first year is assumed. Areas of sediment contaminated with PAHs would be monitored annually to evaluate natural recovery processes. A total of six sediment samples would be collected during each sampling event. Sampling and inspection results would be reported to the regulatory agencies annually.

Because waste would be left on site under this alternative, unrestricted reuse of the site would not be allowed via the LUCAP and the Base Master Plan. A re-evaluation of the site would be performed every 5 years to determine whether changes to the land use controls, monitoring, and/or remedial action would be required.

Operation and maintenance may be required to prevent cap erosion and maintain the integrity of the cap system. Routine inspection and vegetative maintenance of the cap system, perimeter/toe areas and condition of slope protection, restored salt marsh areas, and other items will be performed, and occasional repairs to the cap system and toe stabilization protection may be needed.

5.1.3 Alternative 2b – Excavation and Consolidation of All Contaminated Sediment and Containment of Waste

Alternative 2b consists of the following components:

- Excavation of sediment with concentrations of inorganic chemicals, pesticides, and PAHs above the RGOs for the protection of ecological and human receptors and consolidation of the excavated sediments within the limits of the proposed cap.

- Excavation of waste and sediment/waste materials outside of the limits of the proposed cap system and consolidation of the waste within the limits of the proposed cap system.

- Installation of a low-permeability cap system over the consolidated and regraded waste and sediments.

- Use of slope stabilization and erosion controls.

- Restoration of salt marsh area where excavation was performed.

- Implementation of land use controls for the limits of the proposed cap, long-term monitoring of the groundwater, 5-year reviews of the site, and operation and maintenance of the landfill cap system.

Alternative 2b constitutes the application of the presumptive remedy for landfills. A conceptual design of the alternative is presented in Figure 5-3. The figure depicts the limits of the proposed cap system, as well as the estimated limits of excavation of waste and sediment material. The details of each of the components of this alternative are presented below:

Component 1 – Excavation of sediment with concentrations of pesticides, inorganic chemicals, and PAHs above the RGOs for protection of ecological and human receptors and consolidation of the sediment within the limits of the proposed cap

Sediment would be excavated to a depth of approximately 1 foot to the horizontal extent indicated on Figure 5-3. Actual excavation depths may vary depending on the results of the verification sampling. It is estimated that approximately 6,100 cubic yards of sediment will require excavation under Alternative 2b (see Appendix A). The sediment excavation would also include the removal of any visible waste/debris in the area. Sediments impacted with concentrations of pesticides, inorganics (including arsenic), and PAHs that have concentrations above the RGOs for ecological and human receptors would be excavated. In particular, Area I would be excavated due to the presence of pesticides and inorganics. Area II would include the area impacted by arsenic (risk to human health only). The impacts in Area III are due to ecological and human health exposure to sediment impacted with inorganics and PAHs. Any existing monitoring wells that are located within the areas of sediment to be excavated would be properly abandoned prior to excavation.

A temporary cofferdam system (e.g., Water Structures® or Portadam®) would be installed around the excavation area to eliminate daily flooding of the areas due to the tidal cycle. These structures are relatively easy to install and remove and they would have generally no impacts on the marsh. Some of the factors that should be considered during selection of the temporary cofferdam system include the following: depth of water to be retained, wave height, wave action, bedding material, length of system, time the system would be required, and the potential for storm events. The cofferdam system would be installed and removed in phases around the areas to be excavated.

Overexcavation of sediment may be performed as a value engineering decision in order to minimize the potential of extensive and repeated sampling and excavation cycles. After the initial excavation is completed, verification sampling and laboratory analysis would be completed to ensure that material above the ecological and human health RGOs was removed. This verification sampling would be performed prior to the cap system completion to allow for additional excavation and consolidation, if

required. A post removal assessment would be performed after sediment and waste excavation and consolidation of the materials within the landfill cap system. The ecological and human health RGOs would be used to confirm that any residual impacted materials remaining would not pose a risk to receptors. The evaluation would be based on both individual sample results and an overall evaluation of the remaining sediments.

Excavated sediment would be transported and consolidated within the limits of the proposed cap system. The cap system design may consider the placement of the sediment within a confined location away from the sideslopes of the landfill to maintain the stability of the landfill. The sediments may have to be dewatered and/or mixed with waste materials, soils, or other binding agents to improve stability.

Component 2 – Excavation of waste and sediment/waste materials outside the limits of the proposed cap system and consolidation of the waste within the limits of the proposed cap system

Similar to the excavated sediments, any sediment/waste and waste material outside the proposed limits of the landfill cap system would be excavated and consolidated to areas within the cap system. However, excavation would be performed based on visual identification of waste instead of analytical results. It is estimated that approximately 9,000 cubic yards of sediment/waste and waste would require excavation and consolidation under Alternative 2b. A temporary cofferdam system would be installed around the excavation area as necessary to eliminate daily flooding of the areas due to the tidal cycle. Post-excavation sampling would be performed and the data used in a post-removal assessment. This sampling would be performed prior to the cap system completion to allow for additional excavation and consolidation, if required. The expected depth of waste excavation outside the limits of the landfill cap system is approximately 2 feet. Any existing monitoring wells that are located within the areas of sediment/waste and waste to be excavated would be properly abandoned prior to excavation.

Component 3 – Installation of a low-permeability cap system over the consolidated and regraded waste and sediments

A low-permeability cap system that meets or exceeds the requirements of the Federal and State solid waste and hazardous waste landfill closure requirements would be placed over the 7.2 acres of consolidated and graded waste and sediment materials. The cover may consist of components similar to those shown on Figure 5-2. These components from the landfill waste up are as follows:

- Intermediate cover/gas collection layer (12 inches)
- Geosynthetic clay liner
- Geomembrane liner

- Geosynthetic drainage layer
- Cover soil (18 inches)
- Vegetative layer (6 inches)

The cap system would be placed over waste and impacted sediment to eliminate the potential for human and ecological exposure. The system would also eliminate the migration of waste and impacted sediment to surface water and groundwater due to surface water runoff, wind, wave action and tidal influence, and infiltration. The permeability of the cap system would be 1×10^{-7} cm/sec.

A temporary cofferdam would be installed to protect the toe of the landfill during construction. A dam similar to the one discussed under Component 1 would be adequate. The cofferdam system would be installed and removed in phases to accommodate construction of the landfill.

The available groundwater data do not show any significant impacts; therefore, a component was not included to address groundwater containment. If groundwater containment is determined to be necessary because of the results of the groundwater monitoring program, a contingency plan would be to install sumps within the interior of the landfill to allow for pumping of groundwater and an impermeable vertical barrier along the toe of the final cap system. The sumps would only be installed after the camp has been in place and long-term monitoring demonstrates the need to further address the groundwater. A treatment system would also be necessary to treat the groundwater that is removed from the sumps. If implemented, standard engineering practices would be used to reseal the cap. Furthermore, due to the limited groundwater data available, the design of the landfill cap should investigate the possible influence and gradient of groundwater flow through the site from the southern side of the site.

Landfill gas generation may be possible at the site, but based on the age of the landfill (i.e., 40 plus years), as well as the type of waste disposed in the landfill, gas formation is expected to be minimal. However, as a good engineering practice, the cap design would incorporate a minimum passive gas venting system (i.e., one vent per acre).

Slope stability analysis of the proposed landfill cap system would be performed during the design of the cap. Some issues that need to be addressed in the cap design are the stability of the cap system interface at the toe of the landfill, tidal influence and effect on the cap, stability and placement of sediments within the landfill, and consolidation of the underlying salt marsh soils and lower strata of disposed ash.

The need for a biotic barrier should also be evaluated during the design of the cap. The type of animals present at MCRD Parris Island and their burrowing habits would be considered during the design.

Typically, a biotic barrier would consist of a layer of cobbles or coarse gravel beneath the top layer of the cap system.

Component 4 – Use of slope stabilization and erosion controls

Slope stabilization and erosion control measures would be implemented along the toe and sideslopes of the landfill cap system to minimize the potential for failure of the sideslopes and to reduce the erosion rate of the cover due to surface water runoff, waves, and/or wind. Rip-rap would be installed along the toe and side slopes to an approximate high, high water elevation of 7 feet. The 100-year flood elevation in this area is 15 feet.

Component 5 – Restoration of salt marsh area where excavation was performed

The areas where sediment, sediment/waste, and waste would be excavated would be restored with clean fill added as needed to establish a natural grade. The fill would be temporarily stabilized to minimize erosion and vegetated with a common local plant.

Contingencies for the salt marsh restoration may be considered that would be enacted based on inadequate vegetative establishment. Also, if verification testing indicates that residual sediment contamination remains, covering with soils may provide a barrier to reduce contact with contaminated sediment.

Component 6 – Implementation of land use controls, long-term monitoring, 5-year reviews, and operation and maintenance

Land use controls would be implemented to control or eliminate pathways of exposure to COCs at the site. Site restrictions would be enacted to prohibit unauthorized intrusive activity within the landfill boundary and to ban the use of the groundwater as a drinking water supply. Signs would also be posted to alert users of the property as to the presence of the landfill.

A system of six new groundwater monitoring well clusters (shallow/deep) would be installed after installation of the cap to allow for long-term groundwater monitoring. For the first year after completion of the remedial actions, quarterly groundwater sampling and inspections of the landfill would be performed to ensure the integrity and effectiveness of the cap system and slope stabilization and erosion control measures. After the first year, the groundwater data will be evaluated. This evaluation will consider seasonal variability in results, positive detections to groundwater and surface water criteria, and any data trends. Based on this evaluation, the need and frequency for continuing long-term groundwater

monitoring will be determined. For the purposes of the CMS cost estimate, annual monitoring beyond the first year is assumed. Sampling and inspection results would be reported to the regulatory agencies annually.

Because waste would be left on site under this alternative, unrestricted reuse of the site would not be allowed via the LUCAP and the Base Master Plan. A re-evaluation of the site would be performed every 5 years to determine whether changes to the land use controls, monitoring, and/or remedial action would be required.

Operation and maintenance may be required to prevent cap erosion and to maintain the integrity of the cap system. Routine inspection and vegetative maintenance of the cap system, perimeter/toe areas and condition of slope protection, restored salt marsh areas, and other items would be performed, and occasional repairs to the cap system and toe stabilization protection may be needed.

5.1.4 Alternative 3 – Excavation and Off-Site Disposal of Waste and Sediment

Alternative 3 allows for the unrestricted use of the site after completion of the remedial actions. Alternative 3 consists of the following components:

- Excavation of sediments with concentrations of inorganics, pesticides, and PAHs that have concentrations above the RGOs for ecological and human receptors.
- Excavation of waste and sediment/waste materials associated with the landfill area.
- Transportation and disposal of sediment and waste materials to approved off-site disposal facilities.
- Restoration of salt marsh and landfill areas.

A conceptual design of the alternative is presented in Figure 5-4. The figure depicts the limits of the excavation of sediment and waste materials. The details of each of the components of this alternative are presented below:

Component 1 – Excavation of sediments with concentrations of pesticides, inorganic chemicals, and PAHs that have concentrations above the RGOs for protection of ecological and human receptors

Similar to the containment alternatives, sediments would be excavated to a depth of approximately 1 foot to the horizontal extent indicated on Figure 5-4. Actual excavation depths may vary depending on the

results of the verification sampling. It is estimated that approximately 6,100 cubic yards of sediment will require excavation under Alternate 3 (see Appendix A). The sediment excavation will also include the removal of any visible waste/debris in the area. Any existing monitoring wells that are located within the areas of sediment to be excavated would be properly abandoned prior to excavation.

Similar in extent to Alternative 2b, sediments impacted with concentrations of inorganics (including arsenic), pesticides, and PAHs that have concentrations above the RGOs for ecological and human receptors would be excavated. In particular, Area I would be excavated due to the presence of pesticides and inorganics. Area II would include the area impacted by arsenic (risk to human health). The impacts in Area III are due to ecological and human health exposure to sediment impacted with inorganics and PAHs.

A temporary cofferdam system (e.g., Water Structures® or Portadam®) would be installed around the excavation areas to eliminate daily flooding of the areas due to the tidal cycle. These structures are relatively easy to install and remove, and they would have generally no impacts on the marsh. Some of the factors that should be considered during selection of the temporary cofferdam system include the following: depth of water to be retained, wave height, wave action, bedding material, length of system, time the system would be required, and the potential for storm events. The cofferdam system would be installed and removed in phases around the areas to be excavated.

Overexcavation of sediment may be performed as a value engineering decision in order to minimize the potential for extensive and repeated sampling and excavation cycles. After the initial excavation is completed, verification sampling and laboratory analysis would be completed to ensure that material above the ecological and human health RGOs was removed. A post-removal assessment would be performed after sediment and waste excavation and consolidation of the materials within the landfill cap system. The ecological and human health RGOs would be used to confirm that any residual impacted materials remaining would not pose a risk to receptors. The evaluation would be based on both individual sample results and an overall evaluation of the remaining sediments.

Excavated sediment would be loaded and transported to an appropriate off-site disposal facility. It is assumed that the sediment would require dewatering on site prior to loading and transport to the off-site facility. A dewatering pad and loadout area may be incorporated into the site plans.

Component 2 – Excavation of waste and sediment/waste materials associated with the landfill area

All waste and sediment/waste material at Site 1 would be excavated and transported with the excavated sediments to an appropriate off-site disposal facility. It is estimated that approximately 56,000 cubic yards of waste and sediment/waste plus 5,000 cubic yards of underlying and surrounding soils would be excavated and disposed off site under Alternative 3. Excavation of waste would be performed based on visual identification instead of analytical results. Post-excavation sampling would be performed and the data would be used in a post-removal assessment. The expected depth of waste excavation ranges from 2 feet at the perimeter of the existing landfill to approximately 12 feet. The average depth of waste is 5 feet. Any existing monitoring wells that are located within the areas of waste and waste/sediment to be excavated would be properly abandoned prior to excavation.

Similar to Component 1, a temporary cofferdam system may need to be installed around the areas of waste and sediment/waste to be excavated to eliminate daily flooding of the areas due to the tidal cycle. Some of the factors that should be considered during selection of the temporary cofferdam system include the following: depth of water to be retained, wave height, wave action, bedding material, length of system, time the system would be required, and the potential for storm events. The cofferdam system would be installed and removed in phases around the areas to be excavated.

Material separation and sorting processes may be implemented if significant quantities of debris are excavated. Furthermore, recycling of metal debris can be incorporated into the remedy if sufficient quantities of materials are present.

Component 3 – Transportation and disposal of sediment and waste materials to approved off-site disposal facilities

All excavated sediments and waste material would be loaded and transported to an approved off-site disposal facility. It would require approximately 6,000 truck loads (20-ton truck loads) to transport all of the sediment and waste material for off-site disposal. It is assumed that the sediment and some waste material will require dewatering on site prior to loading and transport to the off-site facility. A dewatering pad and loadout area may be incorporated into the site plans. Characterization of sediment and waste material would be required prior to disposal. It was assumed that 99 percent of the material would be non-hazardous and 1 percent would be hazardous.

Component 4 – Restoration of salt marsh and landfill areas

The areas where sediment, sediment/waste, and waste would be excavated would be restored with clean fill added as needed to establish a natural grade. The fill would be temporarily stabilized to minimize erosion and vegetated with a common local plant.

Contingencies for the salt marsh restoration may be considered that would be enacted based on inadequate vegetative establishment. Also, if verification testing indicates that residual sediment contamination remains, covering with soils may provide a barrier to reduce contact with contaminated sediment.

The interface of the landfill material and the original slope along the southern side of the landfill would be restored to match the existing grades of the embankments to the east and west of the landfill. This area would be backfilled to match grades and then toe protection would be installed. Finally, the area would be vegetated.

5.2 CRITERIA FOR DETAILED ANALYSIS

The following criteria will be used for the detailed analysis for each alternative:

1. Overall protection of human health and the environment
2. Compliance with ARARs/media cleanup standards
3. Source control
4. Waste management standards
5. Other factors (long-term reliability and effectiveness; reduction in toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; cost)
6. State and U.S. EPA acceptance
7. Community acceptance

The first five criteria are specifically addressed in this FS/CMS. State and U.S. EPA acceptance will be evaluated after the state of South Carolina and U.S. EPA Region 4 have reviewed and commented on the draft FS/CMS Report. Community acceptance will be addressed in the Record of Decision/Response To Comments that will be finalized after the public comment period for the FS/CMS and Proposed Plan/Statement of Basis. State, U.S. EPA, and community acceptance must be considered during remedy selection. The following contains a description of each of the evaluation criteria.

5.2.1 Overall Protection of Human Health and the Environment

The purpose of this evaluation criterion is to assess whether each alternative provides adequate protection of human health and the environment. Evaluation of the overall protectiveness of an alternative focuses on whether a specific alternative achieves adequate protection and should describe how site risks posed through each pathway being addressed by the FS/CMS are eliminated, reduced, or controlled through treatment, engineering, or institutional/land use controls. This evaluation also allows for consideration of whether an alternative poses any unacceptable short-term impacts. Overall protection draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs/media cleanup standards.

5.2.2 Compliance with ARARs/Media Cleanup Standards

The purpose of this evaluation criterion is to assess whether each alternative will meet federal and state ARAR/media cleanup standards identified in Section 3.2. Each alternative will also be compared to the TBCs identified in Section 3.2. Compliance with ARARs/media cleanup standards is one of the statutory requirements for remedy selection. In the detailed analysis, requirements that are applicable or relevant and appropriate to an alternative will be summarized. Additionally, the detailed analysis will contain a description of how the alternative would meet ARARs/media cleanup standards and TBCs. Alternatives are developed and refined throughout the FS/CMS process to ensure that they will meet all their respective ARARs/media cleanup standards or that there is good rationale for obtaining a variance or exemption.

5.2.3 Source Control

The purpose of this criterion is to evaluate how the alternative addresses the source of the release, so as to reduce or eliminate, to the extent practicable, further releases that may pose a threat to human health and the environment. This criterion addresses whether source control measures are necessary and what type of source control actions would be appropriate. In addition, for any source control measure proposed, a discussion is provided on how well the method is expected to work given the site situation and previous experiences of the specific technology.

5.2.4 Waste Management Standards

The purpose of this criterion is to evaluate how the alternative would comply with applicable standards for the management of wastes. This includes a description of how the specific waste management activities would be conducted in order to maintain compliance with all applicable state and federal regulations.

5.2.5 Other Factors

In addition to the first four standards, there are five general factors that are to be addressed as part of the evaluation of alternatives. The five general decision factors to be considered under this standard are

- Long-term reliability and effectiveness
- Reduction in toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost

5.2.5.1 Long-Term Reliability and Effectiveness

The purpose of this criterion is to ensure protection of human health and the environment in the future, as well as in the near term. In evaluating alternatives for their long-term effectiveness and the degree of permanence they afford, the analysis should focus on the residual risks that will remain at the site after the completion of the remedial action. This analysis should include consideration of the following:

- Degree of threat posed by treatment residuals or untreated waste remaining at the site.

- Adequacy and reliability of any controls (e.g., engineering and institutional controls) used to manage the hazardous substances remaining at the site.

- Potential impacts on human health and the environment should the remedy fail.

- Whether the alternative would have the flexibility to address uncontrollable changes at the site (e.g., heavy rainstorms, seismic tremors, etc.)

- The overall useful life of the alternative.

5.2.5.2 Reduction in Toxicity, Mobility, or Volume Through Treatment

This criterion addresses the statutory preference for remedies that employ treatment as a principal element by ensuring that the relative performance of the various treatment alternatives in reducing toxicity, mobility, or volume will be assessed. Specifically, the analysis examines the

- Treatment process and remedy
- Amount of hazardous material destroyed or treated

- Reduction in toxicity, mobility, or volume
- Irreversibility of the treatment
- Type and quantity of treatment residual
- Statutory preference for treatment as a principal element

There may be some situations (e.g., large, municipal-type landfills) where achieving substantial reductions in toxicity, mobility, or volume may not be practical or desirable (U.S. EPA, 1993 and 1994).

5.2.5.3 Short-Term Effectiveness

This purpose of this criterion is to examine the short-term impacts of the alternatives (i.e., impacts of the implementation) on the neighboring community, the on-site workers, or the surrounding environment, including the potential threat to human health and the environment associated with excavation, treatment, and transportation of hazardous substances. The time to achieve protection of human health and the environment is also evaluated.

5.2.5.4 Implementability

Implementability considerations include the technical and administrative feasibility of the alternatives, as well as the availability of the goods and services (e.g., treatment, storage, or disposal capacity) on which the viability of the alternative depends. Implementability considerations often affect the timing of various remedial alternatives (e.g., limitations on the season in which the remedy can be implemented, the number and complexity of materials-handling steps that must be followed, the need to obtain permits for off-site activities, and the need to secure technical services such as well drilling and excavation).

5.2.5.5 Cost

Cost encompasses all capital costs and operation and maintenance costs incurred over the life of the project. The focus during the detailed analysis is on the net present value of these costs. Costs were used to select the least expensive (or most cost-effective) alternative that will achieve the remedial action objectives. For purposes of calculating the present worth for the annual operating and maintenance costs, a 30-year maintenance life and a 7 percent annual discount factor are used. Maintenance of the landfill beyond 30 years may be required.

5.2.6 State and U.S. EPA Acceptance

This criterion, which is an ongoing concern throughout the remediation process, reflects the statutory requirement to provide for substantial and meaningful state involvement.

5.2.7 Community Acceptance

This criterion refers to the community's comments on the remedial alternatives under consideration, where "community" is broadly defined to include all interested parties. These comments are taken into account throughout the FS/CMS process. However, only preliminary assessment of community acceptance can be conducted during the development of the FS/CMS, since formal public comment will not be received until after the public comment period for the preferred alternative is held.

5.3 EVALUATION OF ALTERNATIVES

This section presents the results of the evaluation conducted for each alternative based on the specific standards described in Section 5.2.

5.3.1 Alternative 1 - No Action

5.3.1.1 Overall Protection of Human Health and the Environment

The No Action alternative would not be protective of human health and the environment. An ongoing release of contaminants through erosion would be expected under this alternative. The source of the contaminants at the site is waste material in the landfill. The waste materials are mostly covered with soil and vegetation. However, the existing cover material at the site would continue to erode and waste materials would continue to migrate to the adjacent sediment and surface water. Elevated concentrations of metals, PAHs, and pesticides are currently present in the adjacent site sediments. Exposed waste is also visible in some areas that are exposed to the normal tidal cycle. Since the waste materials were not characterized during the RI, the exact magnitude of the potential impact cannot be determined. However, based on recent surface soil, sediment, and surface water data, there are potentially significant risks to human health, with the adolescent recreational user and potential future resident risk estimates exceeding an ILCR of $1x10^{-4}$, which is higher than the acceptable risk range established by the U.S. EPA. Site access is limited from the base side of the site and residential development is unlikely. However, access via boat is possible from the Archer Creek side of the site.

In addition, pesticides, several metals (e.g. copper, lead, and mercury), PAHs, and phthalates are present in site soil and sediment at concentrations that represent potential risks to soil and sediment macroinvertebrates. Terrestrial and aquatic upper food-chain receptors may also be affected by the pesticides and metals at the site. Under current conditions, PAHs and phthalates are not anticipated to have a significant impact on upper food-chain receptors.

Several contaminants such as PAHs, phthalate, and pesticides would naturally degrade over time and resulting risks to human health and the environment would decrease, although long periods of time would be required. However, metals at the site would not degrade, and would only slowly attenuate through dispersion into the sediments and dissolution to the surface water.

5.3.1.2 Compliance with ARARs /Media Cleanup Standards

Alternative 1 attains all chemical-specific ARARs/media cleanup standards with two exceptions. For surface water, AWQCs promulgated under the Clean Water Act and Surface Water Standards contained in the South Carolina Regulation 61-68 are exceeded. For groundwater, the action level for lead and the MCL for thallium are exceeded. Also, several soil, sediment, surface water, and groundwater chemical-specific TBCs would not be met, including the Dutch Soil Clean-up Act ecological soil screening values, Region 9 PRGs for soil and groundwater, and U.S. EPA's ecological screening values for soil, sediment, and surface water.

Under the No Action alternative, the incinerator landfill would not meet Federal and state regulations regarding the final cover requirements of landfills. These ARARs consist of final cover regulations under RCRA Subtitle C and D and South Carolina Regulations regarding Solid Waste Management: Construction, Demolition, and Land Clearing Debris Landfills, Solid Waste Management: Municipal Solid Waste Landfills, and Sanitary Landfill Design, Construction, and Operation, as outlined in the ARAR discussion.

5.3.1.3 Source Control

Alternative 1 would not provide any source control.

5.3.1.4 Waste Management Standards

No actions would be implemented for Alternative 1 and, therefore, no waste would be generated.

5.3.1.5 Other Factors

<u>Long-Term Reliability and Effectiveness</u>

In the long term, Alternative 1 would not be reliable and may not be effective. The potential risks would not be reduced through removal or treatment. Risks would only be reduced through natural processes.

Risks that remain are attributed to the following:

- The potential future erosion of the existing soils covering the landfill. This occurrence would result in a continuing uncontrolled release of landfill material into the surrounding sediment and surface water.

- The migration of surface soil COCs to nearby salt marsh sediment and surface water and sediment COCs to surface water.

- The continued and potentially increased risk to human and ecological receptors.

There would be no long-term management controls under the No Action alternative; therefore, the adequacy and reliability of controls are not applicable.

Reduction in Toxicity, Mobility, and Volume

Alternative 1 would involve no reduction in toxicity, mobility, or volume of the COCs other than that which would result from natural dispersion, dilution, or other attenuating factors. There would be no treatment processes employed and therefore no materials would be treated or destroyed.

Short-Term Effectiveness

There would be no actions performed under Alternative 1; therefore, there would not be short-term risks to the nearby community and on-site workers attributable to remedial actions. Similarly, environmental impacts would not result from remedial actions.

Alternative 1 would not eliminate the migration of COCs from the landfill waste to groundwater, surface water, and sediment and would not comply with ARARs. The RAOs/CAOs would not be achieved.

Implementability

Since no actions would occur, Alternative 1 would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable.

Cost Analysis

There would be no costs associated with the No Action alternative.

5.3.2 Alternative 2a – Excavation and Consolidation of Pesticide and Inorganic Contaminated Sediment in Excess of Ecological RGOs and Containment of Waste

5.3.2.1 Overall Protection of Human Health and the Environment

Alternative 2a features components that are protective of human health and the environment. Under Alternative 2a, a low-permeability cap system would be placed over consolidated sediments and the regraded landfill waste material. This action would minimize human and ecological exposure to impacted sediments as well as human health exposure to landfill material. The cap system would also prevent the exposure of ecological receptors (macroinvertebrates, site-specific food-chain receptors, and terrestrial plants) to surface soil where concentrations of COCs are in excess of the RGOs that represent a risk to ecological receptors.

Excavation of approximately 1.4 acres of contaminated wetlands would occur for Alternative 2a. After remediation, these wetlands will be re-established.

Verification sampling of the excavated areas would be performed under Alternative 2a. A post-removal assessment would be performed after sediment and waste excavation and consolidation of the materials within the landfill cap system. The ecological and human health RGOs would be used to confirm that any residual impacted materials remaining would not pose an unacceptable risk to receptors. The evaluation would be based on both individual sample results and an overall evaluation of the remaining sediments.

Monitored natural recovery would be used to remediate remaining sediments within the salt marsh that are impacted with PAHs above ecological and human RGOs. The PAHs represent a potential threat to macroinvertebrates living within the impacted sediment but not to upper food-chain receptors. In absence of a continuing source of the PAHs, the PAHs will biodegrade, although based on conservative biodegradation rates, over 10 years may be required until the PAH RGOs are achieved.

Sampling of sediment and groundwater is included to determine the long-term effectiveness of the remedy and assess any impacts to human and ecological receptors. Periodic review and maintenance of the site would be necessary to determine that the remedy is effective.

Land use controls would be implemented to control or eliminate pathways of exposure to COCs at the site. Site restrictions would be enacted to prohibit unauthorized intrusive activity within the landfill boundary, restrict access to areas with arsenic and PAH contaminated sediment, and ban the use of the groundwater as a drinking water supply. Signs would also be posted to alert users of the property about the presence of the landfill.

5.3.2.2 Compliance with ARARs/Media Cleanup Standards

Alternative 2a would attain all chemical-specific ARARs/media cleanup standards with two exceptions. For surface water, the AWQCs promulgated under the Clean Water Act and Surface Water Standards contained in South Carolina Regulation 61-68 that are exceeded are bis(2-ethylhexyl)phthalate, chrysene, pentachlorophenol, arsenic, copper, lead, mercury, and zinc. For groundwater, the action level for lead and the MCL for thallium are exceeded. Also, several soil, sediment, surface water, and groundwater chemical-specific TBCs would not be met in the short term, including PRGs for residential soil and tapwater and U.S. EPA's ecological screening values for sediment. Over time, these values should be achieved. The excavation, consolidation, cap system, and erosion control measures are expected to control the source of contamination to these media and eliminate the transport of impacted surface soil to sediment and surface water and mobile contaminants to groundwater and surface water. These measures, along with monitored natural recovery, are expected to reduce the concentration of chemicals in sediment, surface water, and groundwater over time.

All location-specific and action-specific ARARs/media cleanup standards and TBCs would be attained.

5.3.2.3 Source Control

The source control would be implemented with the cap system, as described in the previous detailed description. The cap system would be effective in providing source control and would minimize infiltration of precipitation and therefore reduce impacts to groundwater. The cap system would also prevent erosion of waste material and the subsequent impact to sediments and surface water along the perimeter of the landfill area.

5.3.2.4 Waste Management Standards

Minimal waste would be expected to be generated during remedial activities for Alternative 2a, and any inherently hazardous waste-like material would be taken off site for disposal. The cover system proposed under this alternative would comply with ARARs under federal and South Carolina regulations concerning final covers for landfills.

5.3.2.5 Other Factors

<u>Long-Term Reliability and Effectiveness</u>

In the long term, this alternative would be reliable and effective. Slope stabilization and erosion control measures would be installed to the approximate high, high water elevation [i.e., 7 feet above mean sea level (msl)] to minimize the potential failure of the sideslopes of the landfill cap system and potential

release of the landfill waste into the surrounding sediment and surface water. However, under a severe storm event (i.e., 100-year storm elevation of 15 feet above msl), the proposed erosion control measures may not be completely effective or may fail completely.

The cap system would prevent concentrations of COCs in waste material from migrating to groundwater, sediment, and surface water. In the long term, minimal repair to slope stabilization and erosion control measures would be expected, except possibly after large storm events. Such repair needs would be identified during inspections which would be performed periodically and after large storm events.

The controls used in this alternative are adequate and reliable. Containment, slope stabilization, and erosion control measures are commonly used as components of remedies.

The reliability and effectiveness of the remedy would be assessed through the long-term media monitoring program (groundwater and sediment), inspection of slope stabilization and erosion control measures, land use controls, and 5-year reviews. If it should be discovered during these actions that control measures have failed, actions to correct the remedy (i.e., replace an eroded portion of a cap system) would be easily implemented.

Additional geotechnical study would be required to determine whether the slope stabilization measures would be adequate in the long term to avoid failure of the sideslopes of the cap system due to factors such as normal storm events, hurricane-like weather patterns, the additional weight of the soil cover, and minor seismic events that occasionally occur in the area. These issues would be addressed during the remedial design.

Reduction in Toxicity, Mobility, and Volume

The containment components that comprise Alternative 2a would prevent the migration of the contents of the landfill. Alternative 2a would not reduce the toxicity or volume of the waste material COCs other than that which would result from natural dispersion, dilution, or other attenuating factors. No treatment processes are employed, and therefore no materials would be treated or destroyed. Approximately 56,000 cubic yards of waste material and 2,100 cubic yards of sediment would be contained with this remedy.

Although a statutory preference for treatment exists for CERCLA Remedial Actions, the Presumptive Remedy for CERCLA Municipal Landfill Sites (U.S. EPA, 1993) establishes containment as the presumptive remedy for CERCLA municipal landfills because the volume and heterogeneity of the waste in municipal landfills generally make treatment impracticable.

Short-Term Effectiveness

Alternative 2a would be effective in the short term. Work areas would be marked and monitored to prevent entry by unauthorized personnel. Site workers would receive the appropriate health and safety training and would wear the required PPE during implementation. The workers would also follow a site-specific Health and Safety Plan. The time needed to complete remedial actions is anticipated to be within 11 months.

During implementation of the alternative, vegetation within the existing landfill would be removed. Measures would be conducted to minimize the impact of excavation on the salt marsh.

Prior to the consolidation and grading of the sediments within the landfill, the structural properties of the sediments would be evaluated to determine the methods for confinement within the landfill or other appropriate management. Soft materials (muds and silts) in this area are not acceptable as a base material and would have to be removed. This concern is more significant in areas where rock fills (riprap or gabions) would be used to stabilize relatively high banks.

Use of excavation techniques would be relatively efficient at removing sediments. The area of impacted sediment is relatively small. Therefore, excavation would result in minimal short-term ecological impacts.

Additionally, Alternative 2a would eliminate the migration of COCs from the waste material to groundwater, surface water, and sediment and would comply with ARARs.

Implementability

Alternative 2a would be implementable. Contractors and equipment are readily available for conducting excavation and consolidation activities and installing the cap system, slope stabilization, and erosion control measures. In the long-term, minimal repair to the cap system, slope stabilization, and erosion control measures may be required; however, such repair actions would be easy to implement.

This alternative is administratively feasible. The MCRD Parris Island Partnering Team consists of representatives of the U.S. EPA, SCDHEC, South Carolina Department of Natural Resources (SCDNR), National Oceanic and Atmospheric Administration (NOAA), and USFWS, as well as the U.S. Navy and Marine Corps. Regulatory approval/permitting requirements could be coordinated via this partnering mechanism.

Cost Analysis

The following costs are estimated for Alternative 2a. The cost estimate is provided in Appendix B.

Estimated capital costs:	$6,166,000
Estimated O&M costs:	$23,000 to $70,000 per year
Estimated 30-year present worth:	$6,513,000

5.3.3 Alternative 2b – Excavation and Consolidation of All Contaminated Sediment and Containment of Waste

5.3.3.1 Overall Protection of Human Health and the Environment

Alternative 2b features components that are protective of human health and the environment. Under Alternative 2b, a low-permeability cap system would be placed over consolidated sediments and the regraded landfill waste material. This action would minimize human and ecological exposure to impacted sediments, as well as human health exposure to landfill material. The cap system would also prevent the exposure of ecological receptors (macroinvertebrates, site-specific food-chain receptors, and terrestrial plants) to surface soil where concentrations of COCs are in excess of the RGOs that represent a risk to ecological receptors.

Excavation of approximately 5.6 acres of contaminated wetlands would occur. After remediation, these wetlands would be re-established.

Verification sampling of the excavated areas would be performed under Alternative 2b. A post-removal assessment would be performed after sediment and waste excavation and consolidation of the materials within the landfill cap system. The ecological and human health RGOs would be used to confirm that any residual impacted materials remaining would not pose an unacceptable risk to receptors. The evaluation would be based on both individual sample results and an overall evaluation of the remaining sediments.

Sampling of groundwater is included to determine the long-term effectiveness of the remedy and assess any impacts to human and ecological receptors. Periodic review and maintenance of the site would be necessary to determine that the remedy is effective.

Land use controls would be implemented to control or eliminate pathways of exposure to COCs at the site. Site restrictions would be enacted to prohibit unauthorized intrusive activity within the landfill boundary and the use of the groundwater as a drinking water supply. Signs would also be posted to alert users of the property about the presence of the landfill.

5.3.3.2 Compliance with ARARs/Media Cleanup Standards

Alternative 2b would attain all chemical-specific ARARs/media cleanup standards and TBCs with two exceptions. For surface water, AWQCs promulgated under the Clean Water Act and Surface Water Standards contained in South Carolina Regulation 61-68 are exceeded. For groundwater, the action level for lead and the MCL for thallium are exceeded. Over time, these values should be achieved. The excavation, consolidation, cap system, and erosion control measures are expected to control the source of contamination to these media and eliminate the transport of impacted surface soil to sediment and surface water and mobile contaminants to groundwater and surface water. These measures are expected to reduce the concentration of chemicals in surface water and groundwater.

All location-specific and action-specific ARARs/media cleanup standards and TBCs would be attained.

5.3.3.3 Source Control

The source control would be implemented with the cap system, as described in the previous detailed description. The cap system would be effective in providing source control and would minimize infiltration of precipitation and therefore reduce impacts to groundwater. The cap system would also prevent erosion of waste material and the subsequent impact to sediments and surface water along the perimeter of the landfill area.

5.3.3.4 Waste Management Standards

Minimal waste would be expected to be generated during remedial activities for Alternative 2b and any inherently hazardous waste-like material would be taken off site for disposal. The cover system proposed under this alternative would comply with ARARs under Federal and South Carolina regulations concerning final covers for landfills.

5.3.3.5 Other Factors

<u>Long-Term Reliability and Effectiveness</u>

In the long term, this alternative would be reliable and effective. Slope stabilization and erosion control measures would installed to the approximate high, high water elevation (i.e., 7 feet above msl) to minimize the potential failure of the sideslopes of the landfill cap system and potential release of the landfill waste into the surrounding sediment and surface water. However, under a severe storm event (i.e., 100-year storm elevation of 15 feet above msl), the proposed erosion control measures may not be completely effective or may fail completely.

The cap system would prevent concentrations of COCs in waste material from migrating to groundwater, sediment, and surface water. In the long term, minimal repair to slope stabilization and erosion control measures would be expected, except possibly after large storm events. Such repair needs would be identified during inspections which would be performed periodically and after large storm events.

The controls used in this alternative are adequate and reliable. Containment, slope stabilization, and erosion control measures are commonly used as components of remedies.

The reliability and effectiveness of the remedy would be assessed through the long-term media monitoring program (groundwater), inspection of slope stabilization and erosion control measures, site restrictions, and 5-year reviews. If it should be discovered during these actions that control measures have failed, actions to correct the remedy (i.e., replace an eroded portion of a cap system) would be easily implemented.

Additional geotechnical study would be required to determine whether the slope stabilization measures would be adequate in the long term to avoid failure of the sideslopes of the cap system due to factors such as normal storm events, hurricane-like weather patterns, the additional weight of the soil cover, and minor seismic events that occasionally occur in the area. These issues would be addressed during the remedial design.

Reduction in Toxicity, Mobility, and Volume

The containment components that comprise Alternative 2b would prevent the migration of the contents of the landfill. Alternative 2b does not reduce the toxicity or volume of the surface soil COCs other than that which would result from natural dispersion, dilution, or other attenuating factors. There are no treatment processes employed, and therefore no materials would be treated or destroyed. Approximately 56,000 cubic yards of landfill material and 6,100 cubic yards of sediment would be contained with this remedy.

Although a statutory preference for treatment exists for CERCLA Remedial Actions, the Presumptive Remedy for CERCLA Municipal Landfill Sites (U.S. EPA, 1993) establishes containment as the presumptive remedy for CERCLA municipal landfills because the volume and heterogeneity of the waste in municipal landfills generally make treatment impracticable.

This alternative does not reduce the toxicity, mobility, or volume of the sediment COCs other than that which would result from natural dispersion, dilution, or other attenuating factors. There are no treatment processes employed, and therefore no materials would be treated or destroyed.

Short-Term Effectiveness

Alternative 2b would be effective in the short term. Work areas would be marked and monitored to prevent entry by unauthorized personnel. Site workers would receive the appropriate health and safety training and would wear the required PPE during implementation. The workers would also follow a site-specific Health and Safety Plan. The time needed to complete remedial actions is anticipated to be within 1 year.

During implementation of the alternative, vegetation within the existing incinerator landfill would be removed. Measures would be conducted to minimize the impact of excavation on the salt marsh.

Prior to the consolidation and grading of the sediments within the landfill, the structural properties of the sediments would be evaluated to determine the methods for confinement within the landfill or other appropriate management. Soft materials (muds and silts) in this area are not acceptable as a base material and would have to be removed. This concern is more significant in areas where rock fills (rip rap or gabions) would be used to stabilize relatively high banks.

Use of dredging or excavation techniques would be relatively efficient at removing sediments. The area of impacted sediment is relatively small. Therefore, excavation would result in minimal short-term ecological impacts.

Additionally, Alternative 2b would eliminate the migration of COCs from the fill material to groundwater, surface water, and sediment and would comply with ARARs.

Implementability

Alternative 2b would be implementable. Contractors and equipment are readily available for conducting excavation and consolidation activities and installing the cap system, slope stabilization, and erosion control measures. In the long-term, minimal repair to the cap system, slope stabilization, and erosion control measures may be required; however, such repair actions would be easy to implement.

This alternative is administratively feasible. The MCRD Parris Island Partnering Team consists of representatives of the U.S. EPA, SCDHEC, SCDNR, NOAA, and USFWS, and the U.S. Navy and Marine Corps. Regulatory approval/permitting requirements could be coordinated via this partnering mechanism.

Cost Analysis

The following costs are estimated for Alternative 2b. The cost estimate is provided in Appendix B.

Estimated capital costs:	$7,069,000
Estimated O&M costs:	$21,000 to 70,000 per year
Estimated 30-year present worth:	$7,391,000

5.3.4 Alternative 3 – Excavation and Off-Site Disposal of Waste and Sediment

5.3.4.1 Overall Protection of Human Health and the Environment

Alternative 3 would be protective of human health and the environment. Under Alternative 3, all impacted sediment and waste material would be excavated and placed within an appropriate off-site disposal facility. This action would prevent exposure to human and ecological receptors. Additionally, Alternative 3 would eliminate the migration of COCs from the waste material to groundwater, surface water, and sediment and would comply with ARARs.

Verification sampling of the excavated areas would be performed under Alternative 3. A post-removal assessment would be performed after sediment and waste excavation activities are completed to evaluate any residual contamination within the former sediment or landfill areas. The ecological and human health RGOs would be used to confirm that any residual impacted materials remaining would not pose an unacceptable risk to receptors. The evaluation would be based on both individual sample results and an overall evaluation of the remaining sediments.

5.3.4.2 Compliance with ARARs/Media Cleanup standards

Alternative 3 would attain all chemical-specific ARARs/media cleanup standards and TBCs. The excavation and off-site disposal of impacted sediment and waste material constitutes the complete removal of the sources of contamination to the groundwater, surface water, and sediment and eliminates any future transport of impacted waste material to any media, which is expected to reduce the concentrations of chemicals in surface water and groundwater.

All location-specific and action-specific ARARs/media cleanup standards and TBCs would be attained.

5.3.4.3 Source Control

The source of impacts to sediment, surface water, and groundwater would be eliminated with the implementation of this alternative. All impacted sediment and waste material would be removed from the site.

5.3.4.4 Waste Management Standards

Waste and impacted sediment would be sampled, handled, loaded, transported, and disposed in accordance with appropriate regulations. It is expected that the material from Site 1 would generally be classified as nonhazardous material. It was assumed that 99 percent of the material would be nonhazardous and 1 percent would be hazardous. The quantity of material that may be classified as hazardous may be higher (e.g., 10 percent).

5.3.4.5 Other Factors

Long-Term Reliability and Effectiveness

In the long term, this alternative would be reliable and effective. The complete removal of impacted material from the site would prevent any future releases from the existing source area.

The reliability and effectiveness of the remedy would not require any long-term programs, site restrictions, or 5-year reviews.

Reduction in Toxicity, Mobility, and Volume

The toxicity, mobility, and volume of contaminants at the site are eliminated with Alternative 3.

Short-Term Effectiveness

Alternative 3 would be effective in the short term. There would be some short-term effects to the on-base community during excavation and transportation of sediment and waste materials. Work areas would be marked and monitored to prevent entry by unauthorized personnel. Site workers would receive the appropriate health and safety training and would wear the required PPE during implementation.

Use of excavation techniques would also be relatively efficient at removing sediments.

The time needed to complete remedial actions is anticipated to be 1 year. These would be short-term impacts to the local community during Alternative 3. Approximately 6,000 truck loads of contaminated

media would be transported offsite within a 10-month period. Traffic control and routine road maintenance would be required during this time.

Implementability

Alternative 3 would be implementable. Contractors and equipment are readily available for conducting excavation, loading, and transportation activities.

This alternative is administratively feasible. The MCRD Parris Island Partnering Team consists of representatives of the U.S. EPA, SCDHEC, SCDNR, NOAA, and USFWS, and the U.S. Navy and Marine Corps. Regulatory approval/permitting requirements could be coordinated via this partnering mechanism.

Cost Analysis

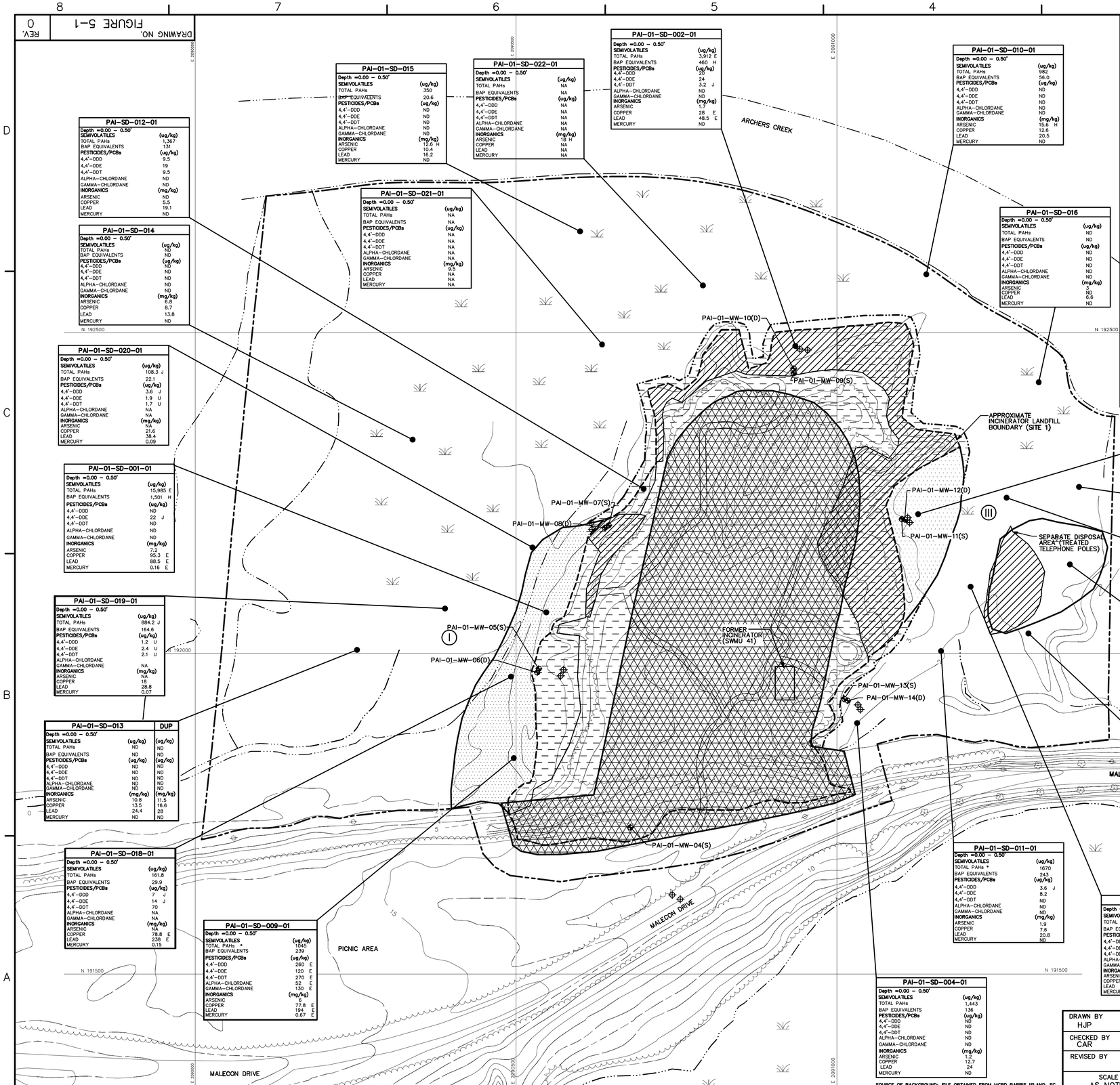
The following costs are estimated for Alternative 3. The cost estimate is provided in Appendix B. Because the quantity of potentially hazardous waste is uncertain, two estimates are provided. The first estimate assumes that 10 percent of the waste would be classified as hazardous. The second estimate assumes that 1 percent of the waste would be classified as hazardous.

Assuming 10 percent hazardous waste:

Estimated capital costs:	$14,737,000
Estimated O&M costs:	$0 per year
Estimated 30-year present worth:	$14,737,000

Assuming 1 percent hazardous waste:

Estimated capital costs:	$13,422,000
Estimated O&M costs:	$0 per year
Estimated 30-year present worth:	$13,422,000



RGO TABLE

COCs	MAXIMUM CONCENTRATION	BACKGROUND/ TYPICAL FACILITY SEDIMENT CONCENTRATION(1)	REGION 9 RESIDENTIAL SOIL PRG(2)	SELECTED SITE 1 HUMAN HEALTH SEDIMENT RGO	REGION 4 ESV(3)	SELECTED SITE 1 ECOLOGICAL RGO
SEMIVOLATILES (ug/kg)						
BENZO(A)PYRENE EQUIVALENTS(4)	3821	NR	434(7)	434	NA	NR
TOTAL PAHs(5)	29455	NR	NA	NR	1684	1684
PESTICIDES (ug/kg)						
4,4'-DDD	260	33.6	2400	NR	3.3	33.6
4,4'-DDE	120	31.6	1700	NR	3.3	31.6
4,4'-DDT	270	34.5	1700	NR	3.3	34.5
DDTR(6)	650	99.8	5800(6)	NR	3.3(6)	99.8
ALPHA CHLORDANE	52	13.9	1600(8)	NR	1.7(8)	13.9
GAMMA CHLORDANE	130	13.2	1600(8)	NR	1.7(8)	13.2
INORGANICS (mg/kg)						
ARSENIC	18.8	12	0.39	12.4(10)	7.24	NR
COPPER	95.3	10	2900	NR	18.7	18.7
LEAD	238	21	400(9)	NR	30.2	30.2
MERCURY	0.67	0.09	23	NR	0.13	0.13

(1) BACKGROUND/TYPICAL FACILITY SEDIMENT CONCENTRATIONS TAKEN FROM SITE 1 RI/RFI (TTNUS, 2001). PESTICIDE VALUES ARE TYPICAL FACILITY CONCENTRATIONS.

(2) U.S. EPA REGION 9 PRG RESIDENTIAL SOIL TABLE (U.S. EPA, 2000)

(3) U.S. EPA REGION 4 ECOLOGICAL SCREENING VALUES (U.S. EPA, 1998)

(4) BAP EQUIVALENTS = BENZO(A)ANTHRACENE(0.1) + BENZO(A)PYRENE(1.0) + BENZO(B)FLUORANTHENE(0.1) + BENZO(K)FLUORANTHENE(0.01) + CHRYSENE(0.001) + DIBENZO(A,H)ANTHRACENE(1.0) + INDENO(1,2,3-CD)PYRENE (0.1).

(5) TOTAL PAHS = LOW MOLECULAR WEIGHT PAHS + HIGH MOLECULAR WEIGHT PAHS
* LOW MOLECULAR WEIGHT PAHs = 2-METHYLNAPHTHALENE + ACENAPHTHENE + ACENAPHTHYLENE + ANTHRACENE + FLUORENE + NAPHTHALENE + PHENANTHRENE

* HIGH MOLECULAR WEIGHT PAHs = BENZO(A)ANTHRACENE + BENZO(A)PYRENE + CHRYSENE + DIBENZO(A,H)ANTHRACENE + FLUORANTHENE + PYRENE

* IF A PAH IS DETECTED, 1/2 OF THE DETECTION LIMIT SHOULD BE USED FOR NONDETECTED PAHS TO CALCULATE TOTAL PAHS AND BAP EQUIVALENTS.

(6) DDTR = DDD + DDE + DDT.

(7) CALCULATED AS 7 X BENZO(A)PYRENE REGION 9 PRG.

(8) BASED ON TOTAL CHLORDANE.

(9) OSWER SOIL SCREENING LEVEL FOR RESIDENTIAL LAND USE (U.S. EPA, 1994).

(10) RGO IS PRG + BACKGROUND PER U.S. EPA GUIDANCE.

NA = NOT AVAILABLE
NR = NOT RELEVANT

PAH = POLYNUCLEAR AROMATIC HYDROCARBON
BAP = BENZO (A) PYRENE
PRG = PRELIMINARY REMEDIATION GOAL
RGO = REMEDIAL GOAL OPTION

PAI-01-SD-015

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	350
BAP EQUIVALENTS	20.6
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	12.6 H
COPPER	10.4
LEAD	16.2
MERCURY	ND

PAI-01-SD-022-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	NA
BAP EQUIVALENTS	NA
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	18 H
COPPER	NA
LEAD	NA
MERCURY	NA

PAI-01-SD-002-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	3,912 E
BAP EQUIVALENTS	460 H
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	20
4,4'-DDE	24
4,4'-DDT	3.2 J
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	1.7
COPPER	28 E
LEAD	48.5 E
MERCURY	ND

PAI-01-SD-010-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	982
BAP EQUIVALENTS	56.0
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	15.6 H
COPPER	12.6
LEAD	20.5
MERCURY	ND

PAI-01-SD-012-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	1,367
BAP EQUIVALENTS	131
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	9.5
4,4'-DDE	19
4,4'-DDT	9.5
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	ND
COPPER	5.5
LEAD	19.1
MERCURY	ND

PAI-01-SD-021-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	NA
BAP EQUIVALENTS	NA
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	9.5
COPPER	NA
LEAD	NA
MERCURY	NA

PAI-01-SD-016

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	ND
BAP EQUIVALENTS	ND
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	3
COPPER	10
LEAD	6.6
MERCURY	ND

PAI-01-SD-014

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	ND
BAP EQUIVALENTS	ND
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	6.8
COPPER	8.7
LEAD	13.8
MERCURY	ND

PAI-01-SD-020-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	108.3 J
BAP EQUIVALENTS	22.1
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	3.6 J
4,4'-DDE	1.9 U
4,4'-DDT	1.7 U
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	21.6
LEAD	38.4
MERCURY	0.09

PAI-01-SD-001-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	15,985 E
BAP EQUIVALENTS	1,501 H
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	22 J
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	7.2
COPPER	95.3 E
LEAD	88.5 E
MERCURY	0.16 E

PAI-01-SD-019-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	884.2 J
BAP EQUIVALENTS	164.6
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	1.2 U
4,4'-DDE	2.4 U
4,4'-DDT	2.1 U
ALPHA-CHLORDANE	
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	18
LEAD	28.8
MERCURY	0.07

PAI-01-SD-013 / DUP

Depth =0.00 – 0.50'		
SEMIVOLATILES	(ug/kg)	(ug/kg)
TOTAL PAHs	ND	ND
BAP EQUIVALENTS	ND	ND
PESTICIDES/PCBs	(ug/kg)	(ug/kg)
4,4'-DDD	ND	ND
4,4'-DDE	ND	ND
4,4'-DDT	ND	ND
ALPHA-CHLORDANE	ND	ND
GAMMA-CHLORDANE	ND	ND
INORGANICS	(mg/kg)	(mg/kg)
ARSENIC	10.8	11.5
COPPER	13.5	16.6
LEAD	24.4	28
MERCURY	ND	ND

PAI-01-SD-018-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	161.8
BAP EQUIVALENTS	29.9
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	7 J
4,4'-DDE	14 J
4,4'-DDT	70
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	78.8 E
LEAD	238 E
MERCURY	0.15

PAI-01-SD-009-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	1045
BAP EQUIVALENTS	239
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	260 E
4,4'-DDE	120 E
4,4'-DDT	270 E
ALPHA-CHLORDANE	52 E
GAMMA-CHLORDANE	130 E
INORGANICS	(mg/kg)
ARSENIC	6
COPPER	77.8 E
LEAD	194 E
MERCURY	0.67 E

PAI-01-SD-004-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	1,443
BAP EQUIVALENTS	1.36
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	1.2
COPPER	12.7
LEAD	24
MERCURY	ND

PAI-01-SD-011-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs *	1670
BAP EQUIVALENTS	243
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	3.6 J
4,4'-DDE	8.2
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	1.9
COPPER	7.6
LEAD	20.8
MERCURY	ND

PAI-01-SD-003-01 / DUP

Depth =0.00 – 0.50'		
SEMIVOLATILES	(ug/kg)	(ug/kg)
TOTAL PAHs	8,695 E	5,459 E
BAP EQUIVALENTS	1,126 H	777 H
PESTICIDES/PCBs	(ug/kg)	(ug/kg)
4,4'-DDD	ND	ND
4,4'-DDE	ND	5.5 J
4,4'-DDT	ND	9.4
ALPHA-CHLORDANE	ND	ND
GAMMA-CHLORDANE	ND	ND
INORGANICS	(mg/kg)	(mg/kg)
ARSENIC	3.6	4.8
COPPER	58.3 E	105 E
LEAD	138 E	201 E
MERCURY	ND	ND

PAI-01-SD-023-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	44.0
BAP EQUIVALENTS	11.1
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	4.5
LEAD	8.6
MERCURY	0.01

PAI-01-SD-024-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	41.2
BAP EQUIVALENTS	10.4
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	3
LEAD	6.2
MERCURY	0.01

PAI-01-SD-017

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	29,455 E
BAP EQUIVALENTS	3,821 H
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	4.7
COPPER	18.3
LEAD	16.5
MERCURY	ND

PAI-01-SD-026-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	1008.0
BAP EQUIVALENTS	215.3
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	13.7
LEAD	17.5
MERCURY	0.04

PAI-01-SD-025-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	60.5
BAP EQUIVALENTS	15.2
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	7.8
LEAD	12.1
MERCURY	0.03

LEGEND

- RI/RFI SEDIMENT SAMPLE LOCATION
- EXISTING MONITORNG WELLS (TO BE ABANDONED)
- NEW GROUNDWATER MONITORING WELL CLUSTERS
- UNVEGETATED AREAS WITH WASTE MATERIAL
- LIMIT OF SEDIMENT EXCAVATION
- LIMIT OF WASTE & SEDIMENT/WASTE EXCAVATION
- LIMIT OF PROPOSED LANDFILL CAP SYSTEM
- SURFACE WATER BODY
- BOUNDARY OF LAND USE CONTROL IMPLEMENTATION PLAN (LUCIP)
- LIMIT OF SEDIMENT WITH COCs GREATER THAN ECOLOGICAL RGOs
- 10 EXISTING CONTOUR
- OVER-EXCAVATION LIMITS
- LIMIT OF LANDFILL
- UG/KG MICROGRAMS PER KILOGRAM
- MG/KG MILLIGRAMS PER KILOGRAM
- ND NOT DETECTED ABOVE DETECTION LIMIT
- H EXCEEDS HUMAN HEALTH RGO
- E EXCEEDS ECOLOGICAL RGO
- J INDICATES THAT THE VALUE WAS ESTIMATED
- U INDICATES THAT THE ANALYTE WAS NOT DETECTED
- * CALCULATED USING THE MDL AS THE DETECTION LIMIT

0 80 160
SCALE IN FEET

SOURCE OF BACKGROUND: FILE OBTAINED FROM MCRD PARRIS ISLAND, SC

DRAWN BY HJP	DATE 1/24/01	
CHECKED BY CAR	DATE 6/21/01	
REVISED BY	DATE	
SCALE AS NOTED		

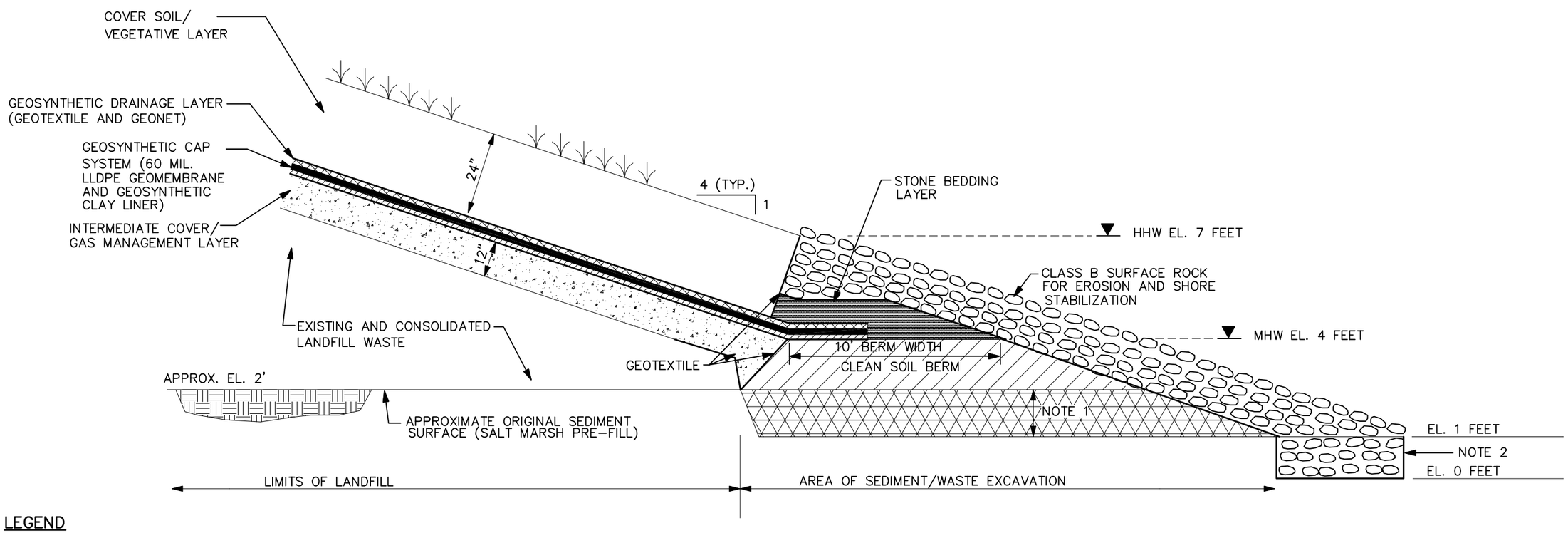
DEPARTMENT OF THE NAVY — SOUTHERN DIVISION, NAVAL FACILITIES ENGINEERING COMMAND

ALTERNATIVE 2A
SITE 1 – INCINERATOR LANDFILL AND
SWMU 41 – FORMER INCINERATOR
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7394
OWNER NO.
APPROVED BY DATE
DRAWING NO. FIGURE 5-1
REV. 0

DRAWING NO. FIGURE 5-1
REV. 0

AC4D: 7394GT37.dwg 11/14/01 HJB



LEGEND

HHW – HIGH WATER

MHW – MEAN HIGH WATER

NOTES

1. THIS SUBSURFACE AREA INCLUDES STRUCTURAL FILL WHERE SEDIMENT/WASTE EXCAVATION IS PERFORMED WITHIN LIMITS OF CAP SYSTEM
2. KEY TOE INTO SEDIMENT A MINIMUM OF 1'

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 5/14/01

CHECKED BY DATE

COST/SCHED-AREA

SCALE NOT TO SCALE

TYPICAL CAP SYSTEM SECTION
ALTERNATIVES 2A AND 2B
SITE 1 – INCINERATOR LANDFILL AND
SWMU 41 – FORMER INCINERATOR
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7394

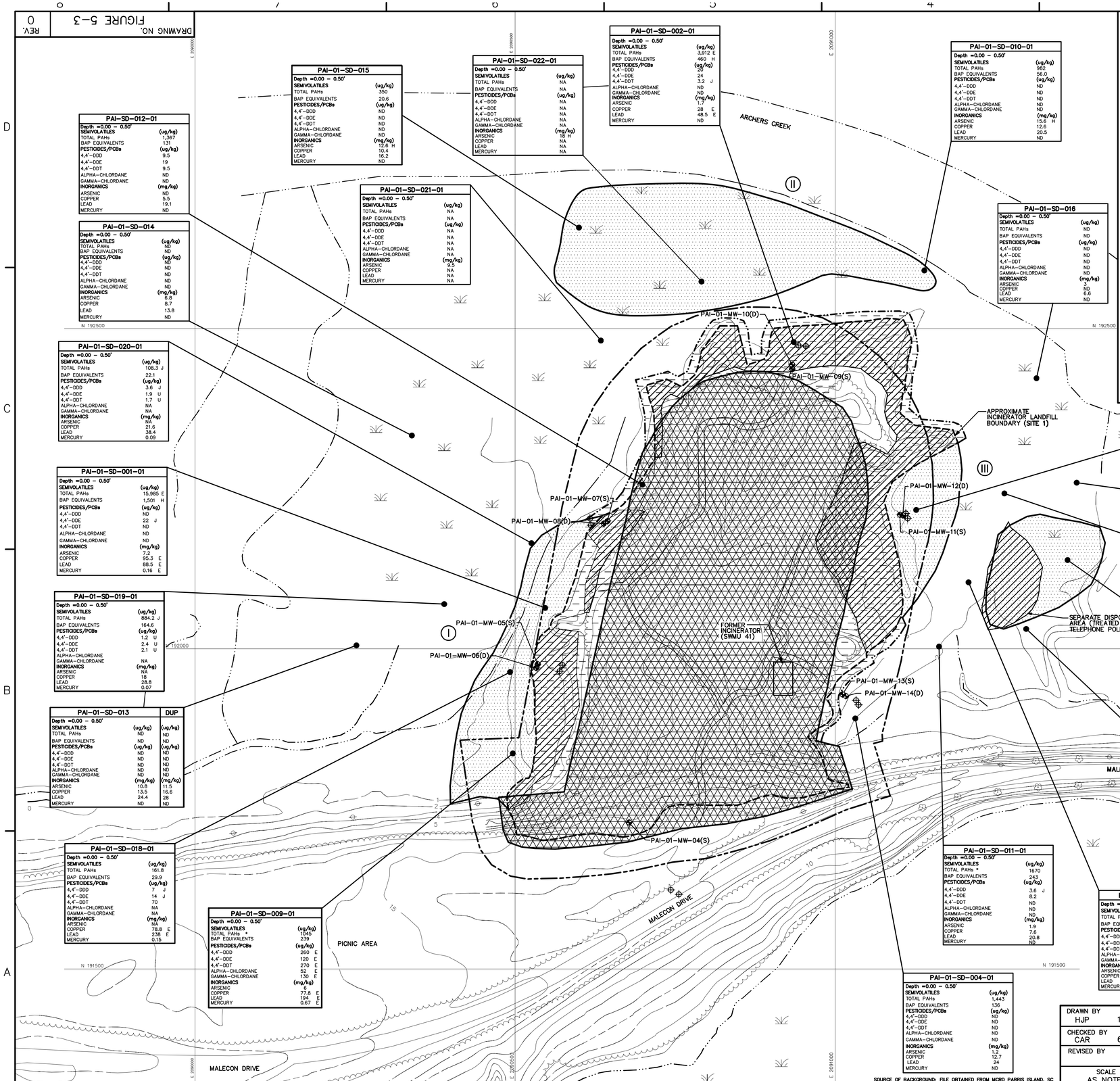
APPROVED BY DATE

APPROVED BY DATE

DRAWING NO. FIGURE 5–2

REV. 0

DRAWING NO. FIGURE 5-3 REV. 0



RGO TABLE

COCs	MAXIMUM CONCENTRATION	BACKGROUND/ TYPICAL FACILITY SEDIMENT CONCENTRATION(1)	REGION 9 RESIDENTIAL SOIL PRG(2)	SELECTED SITE 1 HUMAN HEALTH SEDIMENT RGO	REGION 4 ESV(3)	SELECTED SITE 1 ECOLOGICAL RGO
SEMIVOLATILES (ug/kg)						
BENZO(A)PYRENE EQUIVALENTS(4)	3821	NR	434(7)	434	NA	NR
TOTAL PAHs(5)	29455	NR	NA	NR	1684	1684
PESTICIDES (ug/kg)						
4,4'-DDD	260	33.6	2400	NR	3.3	33.6
4,4'-DDE	120	31.6	1700	NR	3.3	31.6
4,4'-DDT	270	34.5	1700	NR	3.3	34.5
DDTR(6)	650	99.8	5800(6)	NR	3.3(6)	99.8
ALPHA CHLORDANE	52	13.9	1600(8)	NR	1.7(8)	13.9
GAMMA CHLORDANE	130	13.2	1600(8)	NR	1.7(8)	13.2
INORGANICS (mg/kg)						
ARSENIC	18.8	12	0.39	12.4(10)	7.24	NR
COPPER	95.3	10	2900	NR	18.7	18.7
LEAD	238	21	400(9)	NR	30.2	30.2
MERCURY	0.67	0.09	23	NR	0.13	0.13

(1) BACKGROUND/TYPICAL FACILITY SEDIMENT CONCENTRATIONS TAKEN FROM SITE 1 RI/RFI (TTNUS, 2001). PESTICIDE VALUES ARE TYPICAL FACILITY CONCENTRATIONS.

(2) U.S. EPA REGION 9 PRG RESIDENTIAL SOIL TABLE (U.S. EPA, 2000)

(3) U.S. EPA REGION 4 ECOLOGICAL SCREENING VALUES (U.S. EPA, 1998)

(4) BAP EQUIVALENTS = BENZO(A)ANTHRACENE(0.1) + BENZO(A)PYRENE(1.0) + BENZO(B)FLUORANTHENE(0.1) + BENZO(K)FLUORANTHENE(0.01) + CHRYSENE(0.001) + DIBENZO(A,H)ANTHRACENE(1.0) + INDENO(1,2,3-CD)PYRENE (0.1).

(5) TOTAL PAHS = LOW MOLECULAR WEIGHT PAHS + HIGH MOLECULAR WEIGHT PAHS

* LOW MOLECULAR WEIGHT PAHs = 2-METHYLNAPHTHALENE + ACENAPHTHENE + ACENAPHTHYLENE + ANTHRACENE + FLUORENE + NAPHTHALENE + PHENANTHRENE

* HIGH MOLECULAR WEIGHT PAHS = BENZO(A)ANTHRACENE + BENZO(A)PYRENE + CHRYSENE + DIBENZO(A,H)ANTHRACENE + FLUORANTHENE + PYRENE

* IF A PAH IS DETECTED, 1/2 OF THE DETECTION LIMIT SHOULD BE USED FOR NONDETECTED PAHS TO CALCULATE TOTAL PAHS AND BAP EQUIVALENTS.

(6) DDTR = DDD + DDE + DDT.

(7) CALCULATED AS 7 X BENZO(A)PYRENE REGION 9 PRG.

(8) BASED ON TOTAL CHLORDANE.

(9) OSWER SOIL SCREENING LEVEL FOR RESIDENTIAL LAND USE (U.S. EPA, 1994).

(10) RGO IS PRG + BACKGROUND PER U.S. EPA GUIDANCE.

NA = NOT AVAILABLE
NR = NOT RELEVANT

PAH = POLYNUCLEAR AROMATIC HYDROCARBON
BAP = BENZO(A) PYRENE
PRG = PRELIMINARY REMEDIATION GOAL
RGO = REMEDIAL GOAL OPTION

PAI-01-SD-015
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	350
BAP EQUIVALENTS	20.6
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	12.6 H
COPPER	10.4
LEAD	16.2
MERCURY	ND

PAI-01-SD-022-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	NA
BAP EQUIVALENTS	NA
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	18 H
COPPER	NA
LEAD	NA
MERCURY	NA

PAI-01-SD-002-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	3,912 E
BAP EQUIVALENTS	460 H
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	20
4,4'-DDE	24
4,4'-DDT	3.2 J
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	1.7
COPPER	28 E
LEAD	48.5 E
MERCURY	ND

PAI-01-SD-010-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	982
BAP EQUIVALENTS	56.0
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	15.6 H
COPPER	12.6
LEAD	20.5
MERCURY	ND

PAI-01-SD-012-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	1,367
BAP EQUIVALENTS	131
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	9.5
4,4'-DDE	19
4,4'-DDT	9.5
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	ND
COPPER	5.5
LEAD	19.1
MERCURY	ND

PAI-01-SD-021-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	NA
BAP EQUIVALENTS	NA
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	9.5
COPPER	NA
LEAD	NA
MERCURY	NA

PAI-01-SD-016
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	ND
BAP EQUIVALENTS	ND
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	3
COPPER	ND
LEAD	6.6
MERCURY	ND

PAI-01-SD-014
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	ND
BAP EQUIVALENTS	ND
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	6.8
COPPER	8.7
LEAD	13.8
MERCURY	ND

PAI-01-SD-020-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	108.3 J
BAP EQUIVALENTS	22.1
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	3.6 J
4,4'-DDE	1.9 U
4,4'-DDT	1.7 U
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	21.6
LEAD	38.4
MERCURY	0.09

PAI-01-SD-001-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	15,985 E
BAP EQUIVALENTS	1,501 H
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	22 J
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	7.2
COPPER	95.3 E
LEAD	88.5 E
MERCURY	0.16 E

PAI-01-SD-019-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	884.2 J
BAP EQUIVALENTS	164.6
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	1.2 U
4,4'-DDE	2.4 U
4,4'-DDT	2.1 U
ALPHA-CHLORDANE	
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	18
LEAD	28.8
MERCURY	0.07

PAI-01-SD-013

Depth =0.00 – 0.50'		DUP
SEMIVOLATILES	(ug/kg)	(ug/kg)
TOTAL PAHs	ND	ND
BAP EQUIVALENTS	ND	ND
PESTICIDES/PCBs	(ug/kg)	(ug/kg)
4,4'-DDD	ND	ND
4,4'-DDE	ND	ND
4,4'-DDT	ND	ND
ALPHA-CHLORDANE	ND	ND
GAMMA-CHLORDANE	ND	ND
INORGANICS	(mg/kg)	(mg/kg)
ARSENIC	10.8	11.5
COPPER	13.5	16.6
LEAD	24.4	28
MERCURY	ND	ND

PAI-01-SD-003-01

Depth =0.00 – 0.50'		DUP
SEMIVOLATILES	(ug/kg)	(ug/kg)
TOTAL PAHs	8,695 E	5,459 E
BAP EQUIVALENTS	1,126 H	777 H
PESTICIDES/PCBs	(ug/kg)	(ug/kg)
4,4'-DDD	ND	ND
4,4'-DDE	ND	5.5 J
4,4'-DDT	ND	9.4
ALPHA-CHLORDANE	ND	ND
GAMMA-CHLORDANE	ND	ND
INORGANICS	(mg/kg)	(mg/kg)
ARSENIC	3.6	4.8
COPPER	58.3 E	105 E
LEAD	138 E	201 E
MERCURY	ND	ND

PAI-01-SD-023-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	44.0
BAP EQUIVALENTS	11.1
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	4.5
LEAD	8.6
MERCURY	0.01

PAI-01-SD-024-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	41.2
BAP EQUIVALENTS	10.4
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	3
LEAD	6.2
MERCURY	0.01

PAI-01-SD-017
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	29,455 E
BAP EQUIVALENTS	3,821 H
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	4.3
COPPER	18.3
LEAD	16.5
MERCURY	ND

PAI-01-SD-018-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	161.8
BAP EQUIVALENTS	29.9
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	7 J
4,4'-DDE	14 J
4,4'-DDT	70
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	78.8 E
LEAD	238 E
MERCURY	0.15

PAI-01-SD-009-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs *	1045
BAP EQUIVALENTS	239
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	260 E
4,4'-DDE	120 E
4,4'-DDT	270 E
ALPHA-CHLORDANE	52 E
GAMMA-CHLORDANE	130 E
INORGANICS	(mg/kg)
ARSENIC	6
COPPER	77.8 E
LEAD	194 E
MERCURY	0.67 E

PAI-01-SD-011-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs *	1670
BAP EQUIVALENTS	243
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	3.6 J
4,4'-DDE	8.2
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	1.9
COPPER	7.6
LEAD	20.8
MERCURY	ND

PAI-01-SD-026-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	1008.0
BAP EQUIVALENTS	215.3
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	13.7
LEAD	17.5
MERCURY	0.04

PAI-01-SD-025-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	60.5
BAP EQUIVALENTS	15.2
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	7.8
LEAD	12.1
MERCURY	0.03

PAI-01-SD-004-01
Depth =0.00 – 0.50'

SEMIVOLATILES	(ug/kg)
TOTAL PAHs	1,443
BAP EQUIVALENTS	136
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	1.2
COPPER	12.7
LEAD	24
MERCURY	ND

SOURCE OF BACKGROUND: FILE OBTAINED FROM MCRD PARRIS ISLAND, SC

LEGEND

- RI/RFI SEDIMENT SAMPLE LOCATION
- EXISTING MONITORNG WELLS (TO BE ABANDONED)
- NEW GROUNDWATER MONITORING WELL CLUSTERS
- UNVEGETATED AREAS WITH WASTE MATERIAL
- LIMIT OF SEDIMENT EXCAVATION
- LIMIT OF WASTE & SEDIMENT/WASTE EXCAVATION
- LIMIT OF PROPOSED LANDFILL CAP SYSTEM
- SURFACE WATER BODY
- BOUNDARY OF LAND USE CONTROL IMPLEMENTATION PLAN (LUCIP)
- LIMIT OF SEDIMENT WITH COCs GREATER THAN ECOLOGICAL RGOs
- 10 EXISTING CONTOUR
- OVER-EXCAVATION LIMITS
- LIMIT OF LANDFILL

UG/KG	MICROGRAMS PER KILOGRAM
MG/KG	MILLIGRAMS PER KILOGRAM
ND	NOT DETECTED ABOVE DETECTION LIMIT
H	EXCEEDS HUMAN HEALTH RGO
E	EXCEEDS ECOLOGICAL RGO
J	INDICATES THAT THE VALUE WAS ESTIMATED
U	INDICATES THAT THE ANALYTE WAS NOT DETECTED
*	CALCULATED USING THE MDL AS THE DETECTION LIMIT

0 80 160
SCALE IN FEET

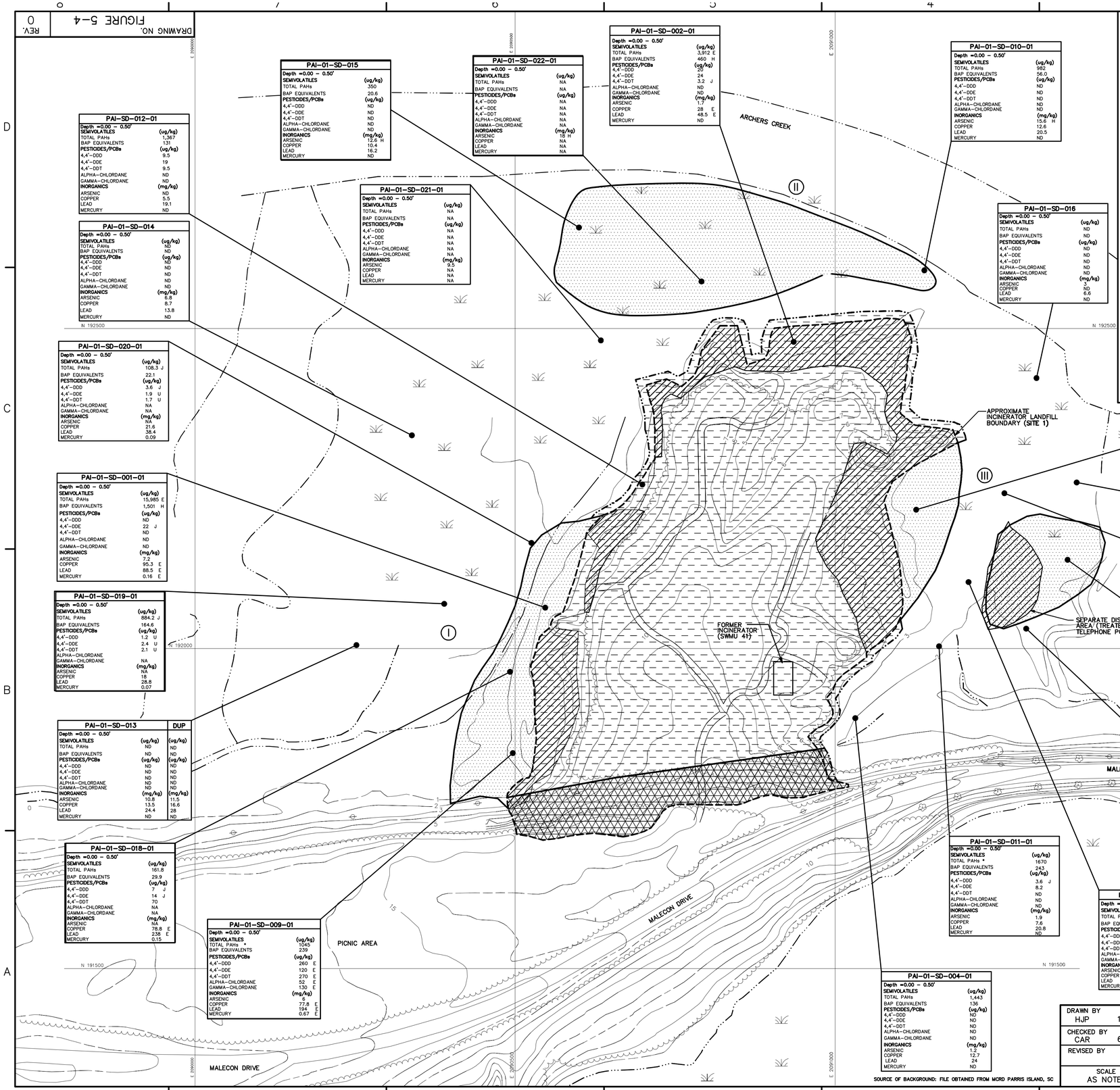
DRAWN BY HJP	DATE 1/24/01	
CHECKED BY CAR	DATE 6/21/01	
REVISED BY	DATE	
SCALE AS NOTED		

DEPARTMENT OF THE NAVY — NAVFAC ENGINEERING COMMAND

ALTERNATIVE 2B
SITE 1 – INCINERATOR LANDFILL AND
SWMU 41 – FORMER INCINERATOR
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7394
OWNER NO.
APPROVED BY DATE
DRAWING NO. FIGURE 5-3 REV. 0

ACAD: 7394GT36.dwg 11/14/01 HJB



PAI-01-SD-015

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	350
BAP EQUIVALENTS	20.6
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	12.6 H
COPPER	10.4
LEAD	16.2
MERCURY	ND

PAI-01-SD-022-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	NA
BAP EQUIVALENTS	NA
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	18 H
COPPER	NA
LEAD	NA
MERCURY	NA

PAI-01-SD-002-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	3,912 E
BAP EQUIVALENTS	460 H
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	20
4,4'-DDE	24
4,4'-DDT	3.2 J
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	1.7
COPPER	28 E
LEAD	48.5 E
MERCURY	ND

PAI-01-SD-010-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	982
BAP EQUIVALENTS	56.0
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	15.6 H
COPPER	12.6
LEAD	20.5
MERCURY	ND

PAI-01-SD-012-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	1,367
BAP EQUIVALENTS	131
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	9.5
4,4'-DDE	19
4,4'-DDT	9.5
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	ND
COPPER	5.5
LEAD	19.1
MERCURY	ND

PAI-01-SD-021-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	NA
BAP EQUIVALENTS	NA
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	9.5
COPPER	NA
LEAD	NA
MERCURY	NA

PAI-01-SD-014

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	ND
BAP EQUIVALENTS	ND
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	6.8
COPPER	8.7
LEAD	13.8
MERCURY	ND

PAI-01-SD-016

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	ND
BAP EQUIVALENTS	ND
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	3
COPPER	ND
LEAD	6.6
MERCURY	ND

PAI-01-SD-020-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	108.3 J
BAP EQUIVALENTS	22.1
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	3.6 J
4,4'-DDE	1.9 U
4,4'-DDT	1.7 U
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	21.6
LEAD	38.4
MERCURY	0.09

PAI-01-SD-001-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	15,985 E
BAP EQUIVALENTS	1,501 H
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	22 J
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	7.2
COPPER	95.3 E
LEAD	88.5 E
MERCURY	0.16 E

PAI-01-SD-019-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	884.2 J
BAP EQUIVALENTS	164.6
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	1.2 U
4,4'-DDE	2.4 U
4,4'-DDT	2.1 U
ALPHA-CHLORDANE	
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	18
LEAD	28.8
MERCURY	0.07

PAI-01-SD-013

Depth =0.00 – 0.50'		DUP
SEMIVOLATILES	(ug/kg)	(ug/kg)
TOTAL PAHs	ND	ND
BAP EQUIVALENTS	ND	ND
PESTICIDES/PCBs	(ug/kg)	(ug/kg)
4,4'-DDD	ND	ND
4,4'-DDE	ND	ND
4,4'-DDT	ND	ND
ALPHA-CHLORDANE	ND	ND
GAMMA-CHLORDANE	ND	ND
INORGANICS	(mg/kg)	(mg/kg)
ARSENIC	10.8	11.5
COPPER	13.5	16.6
LEAD	24.4	28
MERCURY	ND	ND

PAI-01-SD-018-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	161.8
BAP EQUIVALENTS	29.9
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	7 J
4,4'-DDE	14 J
4,4'-DDT	70
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	78.8 E
LEAD	238 E
MERCURY	0.15

PAI-01-SD-009-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs *	1045
BAP EQUIVALENTS	239
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	260 E
4,4'-DDE	120 E
4,4'-DDT	270 E
ALPHA-CHLORDANE	52 E
GAMMA-CHLORDANE	130 E
INORGANICS	(mg/kg)
ARSENIC	8
COPPER	77.8 E
LEAD	194 E
MERCURY	0.67 E

PAI-01-SD-011-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs *	1670
BAP EQUIVALENTS	243
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	3.6 J
4,4'-DDE	8.2
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	1.9
COPPER	7.6
LEAD	20.8
MERCURY	ND

PAI-01-SD-004-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	1,443
BAP EQUIVALENTS	136
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	1.2
COPPER	12.7
LEAD	24
MERCURY	ND

SOURCE OF BACKGROUND: FILE OBTAINED FROM MCRD PARRIS ISLAND, SC

PAI-01-SD-003-01 / DUP

Depth =0.00 – 0.50'		DUP
SEMIVOLATILES	(ug/kg)	(ug/kg)
TOTAL PAHs	8,695 E	5,459 E
BAP EQUIVALENTS	1,126 H	777 H
PESTICIDES/PCBs	(ug/kg)	(ug/kg)
4,4'-DDD	ND	ND
4,4'-DDE	ND	5.5 J
4,4'-DDT	ND	9.4
ALPHA-CHLORDANE	ND	ND
GAMMA-CHLORDANE	ND	ND
INORGANICS	(mg/kg)	(mg/kg)
ARSENIC	3.6	4.8
COPPER	58.3 E	105 E
LEAD	138 E	201 E
MERCURY	ND	ND

PAI-01-SD-023-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	44.0
BAP EQUIVALENTS	11.1
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	4.5
LEAD	8.6
MERCURY	0.01

PAI-01-SD-024-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	41.2
BAP EQUIVALENTS	10.4
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	3
LEAD	6.2
MERCURY	0.01

PAI-01-SD-017

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	29,455 E
BAP EQUIVALENTS	3,821 H
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	ND
4,4'-DDE	ND
4,4'-DDT	ND
ALPHA-CHLORDANE	ND
GAMMA-CHLORDANE	ND
INORGANICS	(mg/kg)
ARSENIC	4.3
COPPER	18.3
LEAD	16.5
MERCURY	ND

PAI-01-SD-026-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	1008.0
BAP EQUIVALENTS	215.3
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	13.7
LEAD	17.5
MERCURY	0.04

PAI-01-SD-025-01

Depth =0.00 – 0.50'	
SEMIVOLATILES	(ug/kg)
TOTAL PAHs	60.5
BAP EQUIVALENTS	15.2
PESTICIDES/PCBs	(ug/kg)
4,4'-DDD	NA
4,4'-DDE	NA
4,4'-DDT	NA
ALPHA-CHLORDANE	NA
GAMMA-CHLORDANE	NA
INORGANICS	(mg/kg)
ARSENIC	NA
COPPER	7.8
LEAD	12.1
MERCURY	0.03

RGO TABLE

COCs	MAXIMUM CONCENTRATION	BACKGROUND/ TYPICAL FACILITY SEDIMENT CONCENTRATION(1)	REGION 9 RESIDENTIAL SOIL PRG(2)	SELECTED SITE 1 HUMAN HEALTH SEDIMENT RGO	REGION 4 ESV(3)	SELECTED SITE 1 ECOLOGICAL RGO
SEMIVOLATILES (ug/kg)						
BENZO(A)PYRENE EQUIVALENTS(4)	3821	NR	434(7)	434	NA	NR
TOTAL PAHs(5)	29455	NR	NA	NR	1684	1684
PESTICIDES (ug/kg)						
4,4'-DDD	260	33.6	2400	NR	3.3	33.6
4,4'-DDE	120	31.6	1700	NR	3.3	31.6
4,4'-DDT	270	34.5	1700	NR	3.3	34.5
DDTR(6)	650	99.8	5800(6)	NR	3.3(6)	99.8
ALPHA CHLORDANE	52	13.9	1600(8)	NR	1.7(8)	13.9
GAMMA CHLORDANE	130	13.2	1600(8)	NR	1.7(8)	13.2
INORGANICS (mg/kg)						
ARSENIC	18.8	12	0.39	12.4(10)	7.24	NR
COPPER	95.3	10	2900	NR	18.7	18.7
LEAD	238	21	400(9)	NR	30.2	30.2
MERCURY	0.67	0.09	23	NR	0.13	0.13

(1) BACKGROUND/TYPICAL FACILITY SEDIMENT CONCENTRATIONS TAKEN FROM SITE 1 RI/RFI (TTNUS, 2001). PESTICIDE VALUES ARE TYPICAL FACILITY CONCENTRATIONS.

(2) U.S. EPA REGION 9 PRG RESIDENTIAL SOIL TABLE (U.S. EPA, 2000)

(3) U.S. EPA REGION 4 ECOLOGICAL SCREENING VALUES (U.S. EPA, 1998)

(4) BAP EQUIVALENTS = BENZO(A)ANTHRACENE(0.1) + BENZO(A)PYRENE(1.0) + BENZO(B)FLUORANTHENE(0.1) + BENZO(K)FLUORANTHENE(0.01) + CHRYSENE(0.001) + DIBENZO(A,H)ANTHRACENE(1.0) + INDENO(1,2,3-CD)PYRENE (0.1).

(5) TOTAL PAHS = LOW MOLECULAR WEIGHT PAHS + HIGH MOLECULAR WEIGHT PAHS

* LOW MOLECULAR WEIGHT PAHs = 2-METHYLNAPHTHALENE + ACENAPHTHENE + ACENAPHTHYLENE + ANTHRACENE + FLUORENE + NAPHTHALENE + PHENANTHRENE

* HIGH MOLECULAR WEIGHT PAHS = BENZO(A)ANTHRACENE + BENZO(A)PYRENE + CHRYSENE + DIBENZO(A,H)ANTHRACENE + FLUORANTHENE + PYRENE

* IF A PAH IS DETECTED, 1/2 OF THE DETECTION LIMIT SHOULD BE USED FOR NONDETECTED PAHS TO CALCULATE TOTAL PAHS AND BAP EQUIVALENTS.

(6) DDTR = DDD + DDE + DDT.

(7) CALCULATED AS 7 X BENZO(A)PYRENE REGION 9 PRG.

(8) BASED ON TOTAL CHLORDANE.

(9) OSWER SOIL SCREENING LEVEL FOR RESIDENTIAL LAND USE (U.S. EPA, 1994).

(10) RGO IS PRG + BACKGROUND PER U.S. EPA GUIDANCE.

NA = NOT AVAILABLE
NR = NOT RELEVANT

PAH = POLYNUCLEAR AROMATIC HYDROCARBON
BAP = BENZO(A) PYRENE
PRG = PRELIMINARY REMEDIATION GOAL
RGO = REMEDIAL GOAL OPTION

LEGEND

- SEDIMENT SAMPLE LOCATION
- UNVEGETATED AREAS WITH WASTE MATERIAL
- LIMIT OF SEDIMENT EXCAVATION
- LIMIT OF WASTE & SEDIMENT/WASTE EXCAVATION
- LIMIT OF WASTE EXCAVATION AND BACKFILL/ GRADING
- SURFACE WATER BODY
- LIMIT OF SEDIMENT WITH COCs GREATER THAN ECOLOGICAL RGOs
- 10 — EXISTING CONTOUR
- OVER-EXCAVATION LIMITS
- LIMIT OF LANDFILL
- UG/KG — MICROGRAMS PER KILOGRAM
- MG/KG — MILLIGRAMS PER KILOGRAM
- ND — NOT DETECTED ABOVE DETECTION LIMIT
- H — EXCEEDS HUMAN HEALTH RGO
- E — EXCEEDS ECOLOGICAL RGO
- J — INDICATES THAT THE VALUE WAS ESTIMATED
- U — INDICATES THAT THE ANALYTE WAS NOT DETECTED
- * — CALCULATED USING THE MDL AS THE DETECTION LIMIT

0 80 160
SCALE IN FEET

DRAWN BY HJP	DATE 1/24/01
CHECKED BY CAR	DATE 6/21/01
REVISED BY	DATE
SCALE AS NOTED	

DEPARTMENT OF THE NAVY — SOUTHERN DIV. FACILITIES ENGINEERING COMMAND

ALTERNATIVE 3
SITE 1 – INCINERATOR LANDFILL AND
SWMU 41 – FORMER INCINERATOR
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7394	
OWNER NO.	
APPROVED BY	DATE
DRAWING NO. FIGURE 5-4	REV. 0

ACAD: 7394GT35.dwg 11/14/01 HJB

DRAWING NO. FIGURE 5-4 REV. 0

6.0 COMPARATIVE ANALYSIS OF REMEDIAL ACTION/CORRECTIVE MEASURES ALTERNATIVES

6.1 INTRODUCTION

This section presents a comparison of the remedial action/corrective measures alternatives to each evaluation criterion. The criteria used for comparison are identical to those used for the detailed analysis of individual alternatives.

The following alternatives are compared in this section:

- Alternative 1 - No Action: This alternative is developed per the NCP to provide a baseline for comparison to other alternatives.

- Alternative 2a – Excavation and Consolidation of Pesticide and Inorganic Contaminated Sediment in Excess of Ecological RGOs and Containment of Waste (follows the presumptive remedy evaluation).

- Alternative 2b – Excavation and Consolidation of All Contaminated Sediment and Containment of Waste (follows the presumptive remedy evaluation).

- Alternative 3 – Excavation and Off-Site Disposal of Waste and Sediment (follows unrestricted land use evaluation).

6.2 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section presents a comparative discussion of the alternatives versus the evaluation criteria presented in Section 5.0. A summary of this comparative analysis is presented in Table 6-1.

6.2.1 Overall Protection of Human Health and the Environment

Alternative 3 would provide the most overall protection as compared to Alternatives 1, 2a, and 2b. The complete removal of all sediment, sediment/waste, and waste from the site and their disposal at an appropriate off-site facility would be effective and permanent. Alternatives 2a and 2b are equivalent to one another with respect to the long-term protection of human health and the environment. Both of these containment options rely on the placement of the most contaminated sediment within a capped landfill and constructing and maintaining the integrity of the cap system and long-term O&M. Alternative 2a is somewhat less protective in the short-term than Alternative 2b because PAHs in sediment, which

represent a potential threat to macroinvertebrates and humans, and arsenic, which represents a potential threat to humans, would remain at the site. Natural recovery factors, such as biodegradation and dispersion, may require in excess of 10 years to be fully protective. Alternative 1 is not protective of human health and the environment. In addition, site risks may increase as waste material continues to erode.

6.2.2 Compliance with ARARs/Media Clean Up Standards

Alternative 1 would not meet federal and state regulations regarding the final cover requirements of landfills. These ARARs consist of final cover regulations under RCRA Subtitle C and D and South Carolina Regulations regarding Solid Waste Management: Construction, Demolition, and Land Clearing Debris Landfills (R.61-107.11), Solid Waste Management: Municipal Solid Waste Landfills (R.61-107.258), and Sanitary Landfill Design, Construction, and Operation (R.61-70). Alternatives 2a, 2b, and 3 would attain all action-specific ARARs.

Alternative 1 would not attain AWQCs promulgated under the CWA and Surface Water Standards contained in the South Carolina Regulation 61-68 in the short term. The MCL for thallium and the action level for lead would not be attained in groundwater under Alternative 1. With Alternative 1, no action would be taken to reduce the release of the landfill waste material into groundwater and surrounding sediment and surface water; consequently, this alternative may not attain AWQCs or MCLs in the long term. With Alternatives 2a and 2b, however, actions would be included to eliminate the release of the landfill contents into the groundwater and surrounding sediment and surface water through containment measures are included.

Alternative 2a includes partial sediment removal, and Alternative 2b removes all impacted sediment. Alternative 2a relies on monitored natural recovery for the reduction of PAHs within sediment and land use controls for arsenic within sediment. Therefore, Alternative 2b would attain the chemical-specific ARARs in a shorter and more assured manner than Alternative 2a.

The potential transport of COCs from sediment and waste to groundwater and surface water is eliminated under Alternatives 3. The complete excavation and off-site disposal would meet all chemical-specific ARARs.

Alternatives 1, 2a, 2b, and 3 would attain all location-specific ARARs.

6.2.3 Source Control

Alternative 1 would not include source control measures. Alternatives 2a and 2b would provide source control through the containment of the landfill waste materials. The containment of the waste material would limit the infiltration of precipitation and would minimize the impact of contaminants on groundwater quality. The complete removal of all waste in Alternative 3 would be the most effective remedy for source control.

6.2.4 Waste Management Standards

Alternative 1 would not include removal of any waste materials; therefore, the management of waste material ARARs would not apply. Final cover requirements of several Federal and state of South Carolina regulations would not be met. Alternatives 2a and 2b would comply with ARARs under Federal and South Carolina regulations concerning final covers for landfills. Alternative 3 would also comply with waste management standards in the total removal of waste material from the site.

6.2.5 Long-Term Reliability and Effectiveness

Alternative 1 would not be reliable and effective. Residual risks would remain, attributed to exposure to sediment, sediment/waste, and waste where COCs exceed RGOs for human receptors and ecological receptors. Impact to groundwater from the landfill source area would continue.

Under Alternative 2a, potential residual risks would result from ecological (macroinvertebrate) exposure to sediment where concentrations exceed the RGOs for PAHs. However, monitored natural recovery would reduce the concentrations of these PAHs over the long term. Under Alternative 2b, all risks attributable to human and ecological exposure to sediment containing COCs at concentrations greater than the RGOs would be removed and consolidated in the landfill cap system. Therefore, Alternatives 2a and 2b would be equivalent in the long-term. Both of these alternatives rely on the long-term effectiveness of the cap system.

Alternative 3 provides the most effective long-term remediation option. All impacted sediment, sediment/waste, and waste would be removed from the site. The complete removal would eliminate monitoring and related long-term issues. Issues related to cap system integrity would not be a concern with this option, as compared to Alternatives 2a and 2b. The long-term reliability and effectiveness of slope stabilization and erosion control measures are a potential concern for these two alternatives under a severe storm event.

6.2.6 Reduction in the Toxicity, Mobility, or Volume through Treatment

Alternatives 1, 2b, and 3 would not include treatment technologies. Alternative 2a would include the use of monitored natural recovery for the reduction of PAHs in sediments. These alternatives would not reduce the toxicity or volume of the waste material or sediment COCs other than that which would result from natural dispersion, dilution, or other attenuating factors. Approximately 58,100 and 62,100 cubic yards of landfill material and sediment would be contained within the cap systems in Alternatives 2a and 2b, respectively. Alternative 3 does not involve any treatment. Under Alternative 3, approximately 68,100 cubic yards of waste material and sediment would be excavated and disposed at an appropriate off-site facility.

6.2.7 Short-Term Effectiveness

This criterion is not applicable to Alternative 1. Alternatives 2a, 2b, and 3 would not pose environmentally significant short-term effects to the neighboring off-base community. Under Alternative 3, there would be short-term impacts to traffic conditions because of the 6,000 truck loads of waste material that would be transported offsite under this alternative. The time required to complete remedial actions under these alternatives is anticipated to be within 1 year. Health and safety training and proper PPE usage would minimize any effects to site workers during implementation of these alternatives.

Under Alternatives 2a, 2b, and 3, vegetation on the landfill area and portions of the salt marsh would be removed. Additionally, the implementation of slope stabilization measures would encroach on wetlands. Measures would be conducted to either minimize the reduction of wetlands or to create wetland areas elsewhere. Under Alternative 3, approximately 5 to 7 acres of salt water marsh will be added to the approximately 4,000 acres of salt water marsh currently at MCRD Parris Island. No endangered species are known to live within the boundaries of Site 1.

Under Alternatives 2a, 2b, and 3, aquatic receptors that inhabit the area of impacted sediment would be subject to short-term effects resulting from excavation or covering; however, these areas would be expected to re-establish to natural conditions after implementation.

6.2.8 Implementability

This criterion is not applicable to Alternative 1. The implementation of Alternatives 2a, 2b, and 3 would be technically feasible and relatively simple. Contractors, equipment, and materials are readily available for conducting soil-moving/excavation activities and installing slope stabilization and erosion control measures. Existing exposure pathways of residual risks can be monitored easily.

The implementation of Alternatives 2a, 2b, and 3 is administratively feasible. The MCRD Parris Island Partnering Team consists of representatives of the U.S. EPA, SCDHEC, SCDNR, NOAA, and USFWS, and the U.S. Navy and Marine Corps. Regulatory approval/permitting requirements could be coordinated via this partnering mechanism.

6.2.9 Cost

A cost estimate of each alternative includes both capital and operation and maintenance costs. Capital costs include both direct and indirect costs. Operation and maintenance costs are post-construction activities that are necessary to ensure the continued effectiveness of the alternative.

Alternative	Capital ($)	Operating ($/year)	30-Year Present Worth ($)
1	0	0	0
2a	6,166,000	23,000 to 70,000	6,513,000
2b	7,069,000	21,000 to 70,000	7,391,000
3*	14,737,000	0	14,737,000
3**	13,422,000	0	13,422,000

* assumes 10 percent hazardous waste
** assumes 1 percent hazardous waste

The cost estimates presented in this section are based on several assumptions and include the following.

The estimate for leaving waste on site assumes that operation and maintenance costs remain constant for 30 years. Actual costs may be higher or lower based on the results of the groundwater monitoring, effectiveness of the cap in containing wastes, and the long-term degradation and/or stability of the contaminants present. In addition, MCRD Parris Island will be responsible for maintaining the integrity of the landfill beyond 30 years. Costs beyond 30 years are not factored into Feasibility Studies.

Cost estimates for off-site disposal were determined for both 10 percent and 1 percent of the waste materials disposed of as hazardous waste. The actual percentage of waste requiring hazardous waste disposal may be higher or lower.

The cost estimate for off-site disposal assumes that the MCRD Parris Island will have no future liability for wastes taken off site. In the event that the private off-site landfill is not ability to maintain the integrity of the landfill, MCRD Parris Island may be required to again address these wastes, as well as potential wastes disposed of by other generators.

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TABLE 6-1

COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 1 – INCINERATOR LANDFILL AND SWMU 41 - FORMER INCINERATOR UNIT
MCRD PARRIS ISLAND, SOUTH CAROLINA

Criterion	Alternative 1	Alternative 2a	Alternative 2b	Alternative 3
Overall Protection of Human Health and the Environment	Not Protective	Protective	More protective than Alternative 2a	Most protective of any alternative.
Compliance with ARARs/Media Cleanup Standards	Does not comply.	Compliance with AWQCs and MCLs in the future. Complies with federal and state solid waste and hazardous waste landfill closure requirements.	Compliance with AWQCs and MCLs in the future. Complies with federal and state solid waste and hazardous waste landfill closure requirements.	Compliance when remedial action is complete.
Source Control	No source control	Source control through presumptive remedy of containment. Limited sediment excavation and consolidation under the cap system.	Source control through presumptive remedy of containment. Total sediment excavation and consolidation under the cap system.	Source control through excavation and off-site disposal.
Waste Management Standards	Not applicable	Complies with federal and state solid waste and hazardous waste landfill closure requirements.	Complies with federal and state solid waste and hazardous waste landfill closure requirements.	Complies with federal and state solid waste and hazardous waste handling, transportation and disposal requirements.
Long-term Reliability and Effectiveness	Not effective or permanent	Effective and permanent with proper O&M and land use controls. Long-term monitoring and 5-year reviews are required.	More effective and permanent than 2a. Proper O&M required and land use controls. Long-term monitoring and 5-year reviews are required.	More effective and permanent than 2a and 2b. No O&M, land use controls, long-term monitoring, or 5-year reviews are required.
Reduction in toxicity, mobility, or volume through treatment	None	Reduction in contaminant mobility through excavation, consolidation, and capping. No enhanced treatment other than natural biological degradation.	Reduction in contaminant mobility through excavation, consolidation, and capping. No treatment.	Source removed and disposed off-site. No treatment.

TABLE 6-1

COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 1 – INCINERATOR LANDFILL AND SWMU 41 - FORMER INCINERATOR UNIT
MCRD PARRIS ISLAND, SOUTH CAROLINA

Criterion	Alternative 1	Alternative 2a	Alternative 2b	Alternative 3
Short-term Effectiveness	Not applicable	Short-term impacts to ecological habitat. Remedial actions completed in 1 year.	Short-term impacts to ecological habitat. Remedial actions completed in 1 year.	Short-term impacts to ecological habitat. Impacts to local community from transportation of waste material offsite. Remedial actions completed in 1 year.
Implementability	Not applicable	Readily Implementable	Readily Implementable	Readily Implementable
Cost	$0	Capital $6,166,000 O&M $23,000 to $70,000 Present Worth $6,513,000	Capital $7,069,000 O&M $21,000 to $70,000 Present Worth $7,391,000	Capital* $14,737,000 O&M $0 Present Worth* $14,737,000 Capital** $13,422,000 O&M $0 Present Worth** $13,422,000
State and U.S. EPA Acceptance	To be determined	To be determined	To be determined	To be determined
Community Acceptance	To be determined	To be determined	To be determined	To be determined

* Assumes 10 percent hazardous waste.
** Assumes 1 percent hazardous waste.

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APPENDIX A

CALCULATIONS

- **LANDFILL VOLUME**
- **IMPACTED SEDIMENT AREA AND VOLUME**
- **PAH CONCENTRATIONS FOR SEDIMENT**
- **PAH DEGRADATION**

CLIENT: PARRIS ISLAND, SOUTH CAROLINA		JOB NUMBER: 7394 - DRAFT FS	
SUBJECT: SITE 1 - INCINERATOR LANDFILL (EXCAVATION CALCULATION)			
BASED ON: Average End Method		DRAWING NUMBER: Figure 1	
BY: T.W.S. Date: 01/19/00	CHECKED BY: Date: DWB 12-26-01	APPROVED BY:	DATE:

Objective:

Calculate the volume of material in the Incinerator Landfill.

Assumptions:

1) Measurements taken from drawing provided as Attachment 1.
2) Drawing scale is 1" = 80'.
3) Volumes are calculated using the average end method.
4) Planimetered areas account for assumed pre-landfill grade conditions.

Calculations:

Scale: 1" = 80

Elevation (ft)	Planimeter Reading (si)	Area (sf)	Change in Elev (ft)	Volume (cf)	Volume (cy)
2	46.3141	296,410.24			
			1	293,409.28	10,867
3	45.3763	290,408.32			
			1	272,850.24	10,106
4	39.8894	255,292.16			
			1	231,756.80	8,584
5	32.5346	208,221.44			
			1	193,142.72	7,153
6	27.8225	178,064.00			
			1	160,133.76	5,931
7	22.2193	142,203.52			
			1	122,586.56	4,540
8	16.0890	102,969.60			
			1	91,115.20	3,375
9	12.3845	79,260.80			
			1	64,579.20	2,392
10	7.7965	49,897.60			
			1	39,432.00	1,460
11	4.5260	28,966.40			
			1	20,038.40	742
12	1.7360	11,110.40			
			1	8,233.28	305
13	0.8369	5,356.16			
			1	3,372.48	125
14	0.2170	1,388.80			

Total Volume of Cut = 55,580

CLIENT: MCRD PARRIS ISLAND		JOB NUMBER: 7394	
SUBJECT: SITE 1 INCINERATOR LANDFILL EXCAVATION REQUIRMENTS TO MEET HUMAN HEALTH AND ECOLOGICAL RGOs			
BASED ON: FIGURE 3-2		DRAWING NUMBER:	
BY: JL Date: 06-20-01	CHECKED BY: Date:	APPROVED BY:	DATE:

OBJECTIVE:

To calculate the excavation volumes of sediment with chemicals of concern (COCs) that exceed Human Health (HH) and Ecological (ECO) Remediation Goal Objectives (RGOs).

APPROACH:

1. Delineate the HH and ECO excavation areas (Reference 1) and measure the surface area with a planimeter.

2. Calculate the excavation volumes of each area assuming a 1-foot excavation depth.

REFERENCES:

1) Figure 3-2 Contaminated Sediment Delineation Map, Site 1 Incinerator Landfill, MCRD Parris Island, South Carolina.

CALCULATIONS:

1. Excavation Areas:

The HH and ECO excavation areas as measured with a planimeter are as follows:

Area	Receptor	COCs	Area (si)	Area (sf)	Area (acres)	Volume (cy)
I	HH	BAP Eq.	3.2860	21,030	0.48	779
		Arsenic	0	0	0	0
	ECO	Total PAHs	3.2860	21,030	0.48	779
		Pesticides	2.8985	18,550	0.43	687
		Inorganics	6.1845	39,581	0.91	1,466
II	HH	BAP Eq.	0	0	0	0
		Arsenic	12.8500	82,240	1.89	3,046
	ECO	Total PAHs	0	0	0	0
		Pesticides	0	0	0	0
		Inorganics	0	0	0	0
III	HH	BAP Eq.	6.6805	42,755	0.98	1,584
		Arsenic	0	0	0	0
	ECO	Total PAHs	6.6805	42,755	0.98	1,584
		Pesticides	0	0	0	0
		Inorganics	2.8520	18,253	0.42	676

CLIENT: MCRD PARRIS ISLAND		JOB NUMBER: 7394	
SUBJECT: SITE 1 INCINERATOR LANDFILL EXCAVATION REQUIRMENTS TO MEET HUMAN HEALTH AND ECOLOGICAL RGOs			
BASED ON: FIGURE 3-2		DRAWING NUMBER:	
BY: JL Date: 06-20-01	CHECKED BY: Date:	APPROVED BY:	DATE:

2. Excavation Volumes

The excavation volumes of each area are calculated assuming a 1-foot excavation depth:

Area	Excavation Area (sf)	Excavation Depth (ft)	Excavation Volume (cf)	Excavation Volume (cy)
I	39,581	1	39,581	1,466
II	82,240	1	82,240	3,046
III	42,755	1	42,755	1,584

EXCAVATION AREA = 164,576 sf
= 3.78 acres
EXCAVATION VOLUME = 164,576 cf
= 6,095 cy

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7394 - DRAFT FS/CMS
SUBJECT:	SITE 1 - INCINERATOR LANDFILL (TOTAL PAH AND BAP EQUIVALENT CALCULATION)		
BASED ON:	PAH data for Sediment Samples from Site 1 RFI/RI	DRAWING NUMBER:	
BY: JL Date: 06/20/01	CHECKED BY: CAR Date: 6/20/01	APPROVED BY: DWB	DATE: 6-25-01

Objective:

Using PAH data for sediment samples collected during the Site 1 RFI/RI and the April 2001 supplemental sampling event, calculate Total PAH and BAP Equivalent concentrations.

Assumptions:

(1) Total PAH concentrations will be used to compare against ecological RGOs to determine the extent of impacted sediment.

(2) BAP Equivalent concentrations will be used to compare against the human health RGO to determine the extent of impacted sediment.

(3) Total PAH #1 uses 1/2 the detection limit for nondetects, if at least one PAH is detected. Assume a value of zero, if all PAHs are nondetect.

(4) Total PAH #2 assumes a value of zero for nondetects.

(5) For Total PAHs #1 and #2 = Low Molecular Weight PAHs + High Molecular Weight PAHs.

(6) Low Molecular Weight PAHs = 2-methylnaphthalene + acenaphthene + acenaphthylene + anthracene + fluorene + naphthalene + phenanthrene.

(7) High Molecular Weight PAHs = benzo(a)anthracene + benzo(a)pyrene + chyrsene + dibenzo(a,h)anthracene + fluoranthene + pyrene.

(7) Reference for Total PAHs: MacDonald, D.D. 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. FDEP.

(8) BAP equivalents = benzo(a)anthracene(0.1) + benzo(a)pyrene(1.0) + benzo(b)fluoranthene(0.1) + benzo(k)fluoranthene(0.01) + chyrsene(0.001) + dibenzo(a,h)anthracene(1.0) + indeno(1,2,3-cd)pyrene (0.1)

Calculations:

PAH Chemicals	Sample PAI-01-SD-001-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	1200	U	600	0	
Acenaphthene	1200	U	600	0	
Acenaphthylene	1200	U	600	0	
Anthracene	770		770	770	
Benzo(a)anthracene	1200		1200	1200	120
Benzo(a)pyrene	980		980	980	980
Benzo(b)fluoranthene	940		0	0	94
Benzo(k)fluoranthene	410		0	0	4.1
Chrysene	1100		1100	1100	1.1
Dibenzo(a,h)anthracene	480	U	240	0	240
Fluoranthene	3200		3200	3200	
Fluorene	590	U	295	0	
Indeno(1,2,3-cd)pyrene	620		0	0	62
Naphthalene	1200	U	600	0	
Phenanthrene	2600		2600	2600	
Pyrene	3200		3200	3200	
		SUM	15985	13050	1501.2

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7394 - DRAFT FS/CMS
SUBJECT:	SITE 1 - INCINERATOR LANDFILL (TOTAL PAH AND BAP EQUIVALENT CALCULATION)		
BASED ON:	PAH data for Sediment Samples from Site 1 RFI/RI	DRAWING NUMBER:	
BY: JL Date: 06/20/01	CHECKED BY: CAR Date: 6/20/01	APPROVED BY: DWB	DATE: 6-25-01

PAH Chemicals	Sample PAI-01-SD-002-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	520	U	260	0	
Acenaphthene	1300	U	650	0	
Acenaphthylene	380	J	380	380	
Anthracene	47		47	47	
Benzo(a)anthracene	250		250	250	25
Benzo(a)pyrene	260		260	260	260
Benzo(b)fluoranthene	270		0	0	27
Benzo(k)fluoranthene	84		0	0	0.84
Chrysene	370		370	370	0.37
Dibenzo(a,h)anthracene	260	U	130	0	130
Fluoranthene	590		590	590	
Fluorene	130	U	65	0	
Indeno(1,2,3-cd)pyrene	170		0	0	17
Naphthalene	660	U	330	0	
Phenanthrene	160		160	160	
Pyrene	420		420	420	
		SUM	3912	2477	460.21

PAH Chemicals	Sample PAI-01-SD-003-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	650	U	325	0	
Acenaphthene	1600	U	800	0	
Acenaphthylene	810	U	405	0	
Anthracene	240		240	240	
Benzo(a)anthracene	730		730	730	73
Benzo(a)pyrene	770		770	770	770
Benzo(b)fluoranthene	720		0	0	72
Benzo(k)fluoranthene	240		0	0	2.4
Chrysene	1000		1000	1000	1
Dibenzo(a,h)anthracene	320	U	160	0	160
Fluoranthene	1500		1500	1500	
Fluorene	160	J	160	160	
Indeno(1,2,3-cd)pyrene	480		0	0	48
Naphthalene	810	U	405	0	
Phenanthrene	1100		1100	1100	
Pyrene	1100		1100	1100	
		SUM	8695	6600	1126.4

PAH Chemicals	Sample PAI-01-SD-003-D Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	780	U	390	0	
Acenaphthene	1900	U	950	0	
Acenaphthylene	970	U	485	0	
Anthracene	59		59	59	
Benzo(a)anthracene	360		360	360	36
Benzo(a)pyrene	470		470	470	470
Benzo(b)fluoranthene	410		0	0	41
Benzo(k)fluoranthene	130	J	0	0	1.3
Chrysene	490		490	490	0.49
Dibenzo(a,h)anthracene	390	U	195	0	195
Fluoranthene	680		680	680	
Fluorene	190	U	95	0	
Indeno(1,2,3-cd)pyrene	330		0	0	33
Naphthalene	970	U	485	0	
Phenanthrene	290		290	290	
Pyrene	510		510	510	
		SUM	5459	2859	776.79

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7394 - DRAFT FS/CMS
SUBJECT:	SITE 1 - INCINERATOR LANDFILL (TOTAL PAH AND BAP EQUIVALENT CALCULATION)		
BASED ON:	PAH data for Sediment Samples from Site 1 RFI/RI	DRAWING NUMBER:	
BY: JL Date: 06/20/01	CHECKED BY: CAR Date: 6/20/01	APPROVED BY: JNB	DATE: 6-25-01

PAH Chemicals	Sample PAI-01-SD-004-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	580	U	290	0	
Acenaphthene	730	U	365	0	
Acenaphthylene	360	U	180	0	
Anthracene	15	U	7.5	0	
Benzo(a)anthracene	30	J	30	30	3
Benzo(a)pyrene	50		50	50	50
Benzo(b)fluoranthene	52		0	0	5.2
Benzo(k)fluoranthene	16		0	0	0.16
Chrysene	60		60	60	0.06
Dibenzo(a,h)anthracene	150	U	75	0	75
Fluoranthene	80		80	80	
Fluorene	73	U	36.5	0	
Indeno(1,2,3-cd)pyrene	30	J	0	0	3
Naphthalene	360	U	180	0	
Phenanthrene	25	J	25	25	
Pyrene	64	J	64	64	
		SUM	1443	309	136.42

PAH Chemicals	Sample PAI-01-SD-009-01 (Calculated using the MDL as the detection limit). Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	523.8	U	261.9	0	
Acenaphthene	120	U	60	0	
Acenaphthylene	84	U	42	0	
Anthracene	2.64	U	1.32	0	
Benzo(a)anthracene	50	J	50	50	5
Benzo(a)pyrene	170		170	170	170
Benzo(b)fluoranthene	170		0	0	17
Benzo(k)fluoranthene	50		0	0	0.5
Chrysene	95		95	95	0.095
Dibenzo(a,h)anthracene	64.8	U	32.4	0	32.4
Fluoranthene	150		150	150	
Fluorene	20.4	U	10.2	0	
Indeno(1,2,3-cd)pyrene	140		0	0	14
Naphthalene	102	U	51	0	
Phenanthrene	61		61	61	
Pyrene	120	U	60	0	
		SUM	1044.82	526	238.995

PAH Chemicals	Sample PAI-01-SD-010-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	840	U	420	0	
Acenaphthene	420	U	210	0	
Acenaphthylene	210	U	105	0	
Anthracene	8.5	U	4.25	0	
Benzo(a)anthracene	21	U	10.5	0	1.05
Benzo(a)pyrene	21	U	10.5	0	10.5
Benzo(b)fluoranthene	8.1	J	0	0	0.81
Benzo(k)fluoranthene	8.5	U	0	0	0.0425
Chrysene	13	J	13	13	0.013
Dibenzo(a,h)anthracene	85	U	42.5	0	42.5
Fluoranthene	21	U	10.5	0	
Fluorene	42	U	21	0	
Indeno(1,2,3-cd)pyrene	21	U	0	0	1.05
Naphthalene	210	U	105	0	
Phenanthrene	17	U	8.5	0	
Pyrene	42	U	21	0	
		SUM	981.75	13	55.9655

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7394 - DRAFT FS/CMS
SUBJECT:	SITE 1 - INCINERATOR LANDFILL (TOTAL PAH AND BAP EQUIVALENT CALCULATION)		
BASED ON:	PAH data for Sediment Samples from Site 1 RFI/RI	DRAWING NUMBER:	
BY: JL Date: 06/20/01	CHECKED BY: CAR Date: 6/20/01	APPROVED BY: DATE: 6-25-01	

PAH Chemicals	Sample PAI-01-SD-011-01 (Calculated using the MDL as the detection limit) Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	253.8	U	126.9	0	
Acenaphthene	110	U	55	0	
Acenaphthylene	79.8	U	39.9	0	
Anthracene	30		30	30	
Benzo(a)anthracene	150		150	150	15
Benzo(a)pyrene	170		170	170	170
Benzo(b)fluoranthene	150		0	0	15
Benzo(k)fluoranthene	48		0	0	0.48
Chrysene	250		250	250	0.25
Dibenzo(a,h)anthracene	62.1	U	31.05	0	31.05
Fluoranthene	360		360	360	
Fluorene	18.7	U	9.35	0	
Indeno(1,2,3-cd)pyrene	110		0	0	11
Naphthalene	96.9	U	48.45	0	
Phenanthrene	160		160	160	
Pyrene	240		240	240	
		SUM	1670.65	1360	242.78

PAH Chemicals	Sample PAI-01-SD-012-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	470	U	235	0	
Acenaphthene	590	U	295	0	
Acenaphthylene	300	U	150	0	
Anthracene	11	J	11	11	
Benzo(a)anthracene	46		46	46	4.6
Benzo(a)pyrene	57		57	57	57
Benzo(b)fluoranthene	54		0	0	5.4
Benzo(k)fluoranthene	13		0	0	0.13
Chrysene	75		75	75	0.075
Dibenzo(a,h)anthracene	120	U	60	0	60
Fluoranthene	100		100	100	
Fluorene	59	U	29.5	0	
Indeno(1,2,3-cd)pyrene	39		0	0	3.9
Naphthalene	300	U	150	0	
Phenanthrene	70		70	70	
Pyrene	88		88	88	
		SUM	1366.5	447	131.105

PAH Chemicals	Sample PAI-01-SD-013-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	648	U*	648	648	
Acenaphthene	310	U	155	0	
Acenaphthylene	150	U	75	0	
Anthracene	6.2	U	3.1	0	
Benzo(a)anthracene	15	U	7.5	0	0.75
Benzo(a)pyrene	15	U	7.5	0	7.5
Benzo(b)fluoranthene	6.2	U	0	0	0.31
Benzo(k)fluoranthene	6.2	U	0	0	0.031
Chrysene	15	U	7.5	0	0.0075
Dibenzo(a,h)anthracene	25	U	12.5	0	12.5
Fluoranthene	15	U	7.5	0	
Fluorene	31	U	15.5	0	
Indeno(1,2,3-cd)pyrene	15	U	0	0	0.75
Naphthalene	150	U	75	0	
Phenanthrene	12	U	6	0	
Pyrene	31	U	15.5	0	
			1035.6	648	21.8485
		SUM	1423.2	648	43.697

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7394 - DRAFT FS/CMS
SUBJECT:	SITE 1 - INCINERATOR LANDFILL (TOTAL PAH AND BAP EQUIVALENT CALCULATION)		
BASED ON:	PAH data for Sediment Samples from Site 1 RFI/RI	DRAWING NUMBER:	
BY: JL Date: 06/20/01	CHECKED BY: CAR 6/20/01 Date:	APPROVED BY: DWB	DATE: 6-25-01

PAH Chemicals	Sample PAI-01-SD-013-D Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	648	U*	648	648	
Acenaphthene	320	UJ	320	320	
Acenaphthylene	160	UJ	160	160	
Anthracene	6.5	UJ	6.5	6.5	
Benzo(a)anthracene	16	UJ	16	16	1.6
Benzo(a)pyrene	16	UJ	16	16	16
Benzo(b)fluoranthene	6.5	UJ	0	0	0.65
Benzo(k)fluoranthene	6.5	UJ	0	0	0.065
Chrysene	16	UJ	16	16	0.016
Dibenzo(a,h)anthracene	26	UJ	26	26	26
Fluoranthene	16	UJ	16	16	
Fluorene	32	UJ	32	32	
Indeno(1,2,3-cd)pyrene	16	UJ	0	0	1.6
Naphthalene	160	UJ	160	160	
Phenanthrene	13	UJ	13	13	
Pyrene	32	UJ	32	32	
		SUM	1461.5	1461.5	45.931

PAH Chemicals	Sample PAI-01-SD-014-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	648	U*	648	648	
Acenaphthene	230	U	115	0	
Acenaphthylene	120	U	60	0	
Anthracene	4.7	U	2.35	0	
Benzo(a)anthracene	12	U	6	0	0.6
Benzo(a)pyrene	12	U	6	0	6
Benzo(b)fluoranthene	4.7	U	0	0	0.235
Benzo(k)fluoranthene	4.7	U	0	0	0.0235
Chrysene	12	U	6	0	0.006
Dibenzo(a,h)anthracene	19	U	9.5	0	9.5
Fluoranthene	12	U	6	0	
Fluorene	23	U	11.5	0	
Indeno(1,2,3-cd)pyrene	12	U	0	0	0.6
Naphthalene	120	U	60	0	
Phenanthrene	9.3	U	4.65	0	
Pyrene	23	U	11.5	0	
		SUM	946.5	648	16.9645

PAH Chemicals	Sample PAI-01-SD-015-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	648	U*	648	648	
Acenaphthene	260	U	130	0	
Acenaphthylene	130	U	65	0	
Anthracene	5.2	U	2.6	0	
Benzo(a)anthracene	13	U	6.5	0	0.65
Benzo(a)pyrene	7.8	J	7.8	7.8	7.8
Benzo(b)fluoranthene	10		0	0	1
Benzo(k)fluoranthene	3.1	J	0	0	0.031
Chrysene	13	U	6.5	0	0.0065
Dibenzo(a,h)anthracene	21	U	10.5	0	10.5
Fluoranthene	25		25	25	
Fluorene	26	U	13	0	
Indeno(1,2,3-cd)pyrene	13	U	0	0	0.65
Naphthalene	130	U	65	0	
Phenanthrene	10	U	5	0	
Pyrene	26	U	13	0	
		SUM	997.9	680.8	20.6375

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7394 - DRAFT FS/CMS
SUBJECT:	SITE 1 - INCINERATOR LANDFILL (TOTAL PAH AND BAP EQUIVALENT CALCULATION)		
BASED ON:	PAH data for Sediment Samples from Site 1 RFI/RI	DRAWING NUMBER:	
BY: JL Date: 06/20/01	CHECKED BY: CAR 6/20/01 Date:	APPROVED BY: DAB	DATE: 6-25-01

PAH Chemicals	Sample PAI-01-SD-016-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	648	U*	648	648	
Acenaphthene	140	U	70	0	
Acenaphthylene	71	U	35.5	0	
Anthracene	2.8	U	1.4	0	
Benzo(a)anthracene	7.1	U	3.55	0	0.355
Benzo(a)pyrene	7.1	U	3.55	0	3.55
Benzo(b)fluoranthene	2.8	U	0	0	0.14
Benzo(k)fluoranthene	2.8	U	0	0	0.014
Chrysene	7.1	U	3.55	0	0.00355
Dibenzo(a,h)anthracene	11	U	5.5	0	5.5
Fluoranthene	7.1	U	3.55	0	
Fluorene	14	U	7	0	
Indeno(1,2,3-cd)pyrene	7.1	U	0	0	0.355
Naphthalene	71	U	35.5	0	
Phenanthrene	5.7	U	2.85	0	
Pyrene	14	U	7	0	
		SUM	826.95	648	9.91755

PAH Chemicals	Sample PAI-01-SD-017-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	648	U*	648	648	
Acenaphthene	7300	U	3650	0	
Acenaphthylene	3600	U	1800	0	
Anthracene	540		540	540	
Benzo(a)anthracene	2200		2200	2200	220
Benzo(a)pyrene	1700		1700	1700	1700
Benzo(b)fluoranthene	1800		0	0	180
Benzo(k)fluoranthene	850		0	0	8.5
Chrysene	2300		2300	2300	2.3
Dibenzo(a,h)anthracene	1600		1600	1600	1600
Fluoranthene	6600		6600	6600	
Fluorene	730	U	365	0	
Indeno(1,2,3-cd)pyrene	1100		0	0	110
Naphthalene	3600	U	1800	0	
Phenanthrene	1500		1500	1500	
Pyrene	5400		5400	5400	
		SUM	30103	22488	3820.8

PAH Chemicals	Sample PAI-01-SD-018-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	23.3		23.25	23.25	
Acenaphthene	21.9	U	10.9675	0	
Acenaphthylene	16.9	U	8.4665	0	
Anthracene	20.7	U	10.3525	0	
Benzo(a)anthracene	15.6	U	7.79	0	0.779
Benzo(a)pyrene	26.3	U	13.1405	0	13.1405
Benzo(b)fluoranthene	18.0	U	0	0	0.8979
Benzo(k)fluoranthene	18.2	U	0	0	0.09102
Chrysene	14.7	U	7.3595	0	0.0073595
Dibenzo(a,h)anthracene	23.9	U	11.931	0	11.931
Fluoranthene	24.1		24.12	24.12	
Fluorene	13.4	U	6.683	0	
Indeno(1,2,3-cd)pyrene	30.5		0	0	3.0463
Naphthalene	15.4	U	7.6875	0	
Phenanthrene	16.6	U	8.282	0	
Pyrene	21.8		21.77	21.77	
		SUM	161.8	69.14	29.8930795

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7394 - DRAFT FS/CMS
SUBJECT:	SITE 1 - INCINERATOR LANDFILL (TOTAL PAH AND BAP EQUIVALENT CALCULATION)		
BASED ON:	PAH data for Sediment Samples from Site 1 RFI/RI	DRAWING NUMBER:	
BY: JL Date: 06/20/01	CHECKED BY: CAL Date: 6/20/01	APPROVED BY: DMB	DATE: 6-25-01

PAH Chemicals	Sample PAI-01-SD-019-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	9.8	U	4.8945	0	
Acenaphthene	20.9	U	10.4325	0	
Acenaphthylene	16.1	U	8.0535	0	
Anthracene	39.5		39.5	39.5	
Benzo(a)anthracene	172.9		172.9	172.9	17.29
Benzo(a)pyrene	108.6		108.6	108.6	108.6
Benzo(b)fluoranthene	194.8		0	0	19.48
Benzo(k)fluoranthene	57.6		0	0	0.576
Chrysene	71.1		71.1	71.1	0.0711
Dibenzo(a,h)anthracene	22.7	U	11.349	0	11.349
Fluoranthene	201.2		201.2	201.2	
Fluorene	12.7	U	6.357	0	
Indeno(1,2,3-cd)pyrene	72.3		0	0	7.23
Naphthalene	14.6	U	7.3125	0	
Phenanthrene	110.5		110.5	110.5	
Pyrene	132.0		132	132	
		SUM	884.199	835.8	164.5961

PAH Chemicals	Sample PAI-01-SD-020-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	8.0	U	4.016	0	
Acenaphthene	17.1	U	8.56	0	
Acenaphthylene	13.2	U	6.608	0	
Anthracene	16.2	U	8.08	0	
Benzo(a)anthracene	12.2	U	6.08	0	0.608
Benzo(a)pyrene	20.5	U	10.256	0	10.256
Benzo(b)fluoranthene	14.0	U	0	0	0.7008
Benzo(k)fluoranthene	14.2	U	0	0	0.07104
Chrysene	11.5	U	5.744	0	0.005744
Dibenzo(a,h)anthracene	18.6	U	9.312	0	9.312
Fluoranthene	16.6		16.64	16.64	
Fluorene	10.4	U	5.216	0	
Indeno(1,2,3-cd)pyrene	23.8	U	0	0	1.1888
Naphthalene	12.0	U	6	0	
Phenanthrene	12.9	U	6.464	0	
Pyrene	15.3		15.32	15.32	
		SUM	108.296	31.96	22.142384

PAH Chemicals	Sample PAI-01-SD-023-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	4.0	U	2.008	0	
Acenaphthene	8.6	U	4.28	0	
Acenaphthylene	6.6	U	3.304	0	
Anthracene	8.1	U	4.04	0	
Benzo(a)anthracene	6.1	U	3.04	0	0.304
Benzo(a)pyrene	10.3	U	5.128	0	5.128
Benzo(b)fluoranthene	7.0	U	0	0	0.3504
Benzo(k)fluoranthene	7.1	U	0	0	0.03552
Chrysene	5.7	U	2.872	0	0.002872
Dibenzo(a,h)anthracene	9.3	U	4.656	0	4.656
Fluoranthene	6.9	U	3.44	0	
Fluorene	5.2	U	2.608	0	
Indeno(1,2,3-cd)pyrene	11.9	U	0	0	0.5944
Naphthalene	6.0	U	3	0	
Phenanthrene	6.5	U	3.232	0	
Pyrene	4.8	U	2.376	0	
		SUM	43.984	0	11.071192

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7394 - DRAFT FS/CMS
SUBJECT:	SITE 1 - INCINERATOR LANDFILL (TOTAL PAH AND BAP EQUIVALENT CALCULATION)		
BASED ON:	PAH data for Sediment Samples from Site 1 RFI/RI	DRAWING NUMBER:	
BY: JL Date: 06/20/01	CHECKED BY: CAR Date: 6/20/01	APPROVED BY: DDB	DATE: 6-25-01

PAH Chemicals	Sample PAI-01-SD-024-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	3.8	U	1.8825	0	
Acenaphthene	8.0	U	4.0125	0	
Acenaphthylene	6.2	U	3.0975	0	
Anthracene	7.6	U	3.7875	0	
Benzo(a)anthracene	5.7	U	2.85	0	0.285
Benzo(a)pyrene	9.6	U	4.8075	0	4.8075
Benzo(b)fluoranthene	6.6	U	0	0	0.3285
Benzo(k)fluoranthene	6.7	U	0	0	0.0333
Chrysene	5.4	U	2.6925	0	0.0026925
Dibenzo(a,h)anthracene	8.7	U	4.365	0	4.365
Fluoranthene	6.5	U	3.225	0	
Fluorene	4.9	U	2.445	0	
Indeno(1,2,3-cd)pyrene	11.1	U	0	0	0.55725
Naphthalene	5.6	U	2.8125	0	
Phenanthrene	6.1	U	3.03	0	
Pyrene	4.5	U	2.2275	0	
		SUM	41.235	0	10.3792425

PAH Chemicals	Sample PAI-01-SD-025-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	5.5	U	2.761	0	
Acenaphthene	11.8	U	5.885	0	
Acenaphthylene	9.1	U	4.543	0	
Anthracene	11.1	U	5.555	0	
Benzo(a)anthracene	8.4	U	4.18	0	0.418
Benzo(a)pyrene	14.1	U	7.051	0	7.051
Benzo(b)fluoranthene	9.6	U	0	0	0.4818
Benzo(k)fluoranthene	9.8	U	0	0	0.04884
Chrysene	7.9	U	3.949	0	0.003949
Dibenzo(a,h)anthracene	12.8	U	6.402	0	6.402
Fluoranthene	9.5	U	4.73	0	
Fluorene	7.2	U	3.586	0	
Indeno(1,2,3-cd)pyrene	16.3	U	0	0	0.8173
Naphthalene	8.3	U	4.125	0	
Phenanthrene	8.9	U	4.444	0	
Pyrene	6.5	U	3.267	0	
		SUM	60.478	0	15.222889

PAH Chemicals	Sample PAI-01-SD-026-01 Concentration	Qualifier	Total PAH #1	Total PAH #2	BAP Equivalent
2-Methylnaphthalene	35.1	U	17.57	0	
Acenaphthene	74.9	U	37.45	0	
Acenaphthylene	57.8	U	28.91	0	
Anthracene	70.7	U	35.35	0	
Benzo(a)anthracene	53.2	U	26.6	0	2.66
Benzo(a)pyrene	89.7	U	44.87	0	44.87
Benzo(b)fluoranthene	136.6		0	0	13.66
Benzo(k)fluoranthene	42.8		0	0	0.4276
Chrysene	87.0		87.01	87.01	0.08701
Dibenzo(a,h)anthracene	81.5	U	40.74	0	40.74
Fluoranthene	66.6		66.58	66.58	
Fluorene	45.6	U	22.82	0	
Indeno(1,2,3-cd)pyrene	104.0	U	0	0	5.201
Naphthalene	52.5	U	26.25	0	
Phenanthrene	56.6	U	28.28	0	
Pyrene	50.3		50.33	50.33	
			512.76	203.92	107.64561
		SUM	1007.95	407.84	215.29122

CLIENT:	PARRIS ISLAND, SOUTH CAROLINA	JOB NUMBER:	7394 - DRAFT FS/CMS
SUBJECT:	SITE 1 - INCINERATOR LANDFILL (TOTAL PAH AND BAP EQUIVALENT CALCULATION)		
BASED ON:	PAH data for Sediment Samples from Site 1 RFI/RI	DRAWING NUMBER:	
BY: JL Date: 06/20/01	CHECKED BY: CAR Date: 6/20/01	APPROVED BY: DNB	DATE: 6-25-01

Conclusions:

(1) Use Total PAH #1 for delineation of impacted sediments (ecological).

(2) Use BAP Equivalent for delineation of impacted sediments (human health).

(*) These samples were not analyzed for 2-methylnapthalene. 1/2 of the MDL of the highest non detect value was used.

CLIENT: MCRD Parris Island		JOB NUMBER: N7394
SUBJECT: Degradation of PAHs in Sediment		
BASED ON:		DRAWING NUMBER:
DESIGN BY: JJB DATE: 01/03/02	CHECKED BY: DATE:	APPROVED BY: DATE: 1-8-02

PURPOSE:

To determine the period of time it will take before PAH concentrations sediment will biodegrade to below RGOs.

APPROACH:

Decay of individual PAHs will be modeled using the following equation, where:

$$C_t = C_0 e^{-\lambda t}$$ (Lindeburg, 1992)

Where

C_t = Concentration at time t (µg/kg)
C_o = Initial concentration (µg/kg)
λ = decay constant = 0.6931/(half life of chemical) [1/years]
t = time (in years)

A spreadsheet will be developed that takes the maximum concentration of each PAH and derives the estimated concentration after each year. For each year, the Total PAH value will be summed and compared to the ecological RGO for total PAHs (the USEPA Region 4 ecological screening value of 1,684 µg/kg).

ASSUMPTIONS:

- Calculations will be performed using the minimum and maximum reported half-life values for anaerobic soil degradation (Howard, 1991).
- The maximum PAH concentrations reported in the main text of this FS/CMS report (Table 3-4) will be used.

CALCULATIONS:

See attached sheet.

REFERENCES:

Howard, Phillip H., et al., 1991. Handbook of Environmental Degradation Rates. Lewis Publishers Inc, Chelsea, Michigan.

Lindeberg, Michael R, 1992, Engineer-In-Training Reference Manual. Professional Publications, Inc., Belment, California.

Degradation of PAHs in Sediment
Site 1 and SWMU 41, Parris Island, South Carolina

PAH	Maximum Concentration	Minimum Half Life	λ	1	2	3	4	5	6	7	8	9	10
Acenaphthylene	380	0.47	1.49	86	19	4	1	0	0	0	0	0	0
Anthracene	770	0.55	1.26	217	61	17	5	1	0	0	0	0	0
Benzo(a)anthracene	2200	1.12	0.62	1185	638	344	185	100	54	29	16	8	5
Benzo(a)pyrene	1700	0.62	1.11	560	185	61	20	7	2	1	0	0	0
Chrysene	2300	4.06	0.17	1939	1635	1378	1162	980	826	696	587	495	417
Dibenzo(a,h)anthracene	1600	3.96	0.18	1343	1127	946	794	667	560	470	394	331	278
Fluorene	160	0.48	2.10	20	2	0	0	0	0	0	0	0	0
Fluoranthene	6600	1.53	0.45	4196	2667	1696	1078	685	436	277	176	112	71
Phenanthrene	2600	0.18	3.95	50	1	0	0	0	0	0	0	0	0
Pyrene	5400	2.3	0.30	3995	2956	2187	1618	1197	885	655	485	359	265
Total PAH Concentration	23710			13591	9292	6633	4863	3636	2763	2128	1658	1305	1036

PAH	Maximum Concentration	Maximum Half Life	λ	1	2	3	4	5	6	7	8	9	10
Acenaphthylene	380	0.66	1.05	132	46	16	6	2	1	0	0	0	0
Anthracene	770	5.04	0.14	671	585	510	444	387	337	294	256	223	195
Benzo(a)anthracene	2200	7.45	0.09	2005	1826	1664	1516	1382	1259	1147	1045	952	868
Benzo(a)pyrene	1700	5.8	0.12	1509	1339	1188	1054	935	830	736	654	580	515
Chrysene	2300	11	0.06	2160	2028	1904	1788	1678	1576	1480	1389	1305	1225
Dibenzo(a,h)anthracene	1600	10.3	0.07	1496	1399	1308	1222	1143	1069	999	934	873	816
Fluorene	160	4.82	2.10	20	2	0	0	0	0	0	0	0	0
Fluoranthene	6600	3.8	0.18	5500	4583	3819	3182	2651	2209	1841	1534	1278	1065
Phenanthrene	2600	2.19	0.32	1895	1381	1006	733	534	389	284	207	151	110
Pyrene	5400	5.2	0.13	4726	4136	3620	3168	2773	2427	2124	1859	1627	1424
	23710			20112	17324	15034	13114	11486	10097	8905	7878	6989	6217

Degradation of PAHs in Sediment
Site 1 and SWMU 41, Parris Island, South Carolina

PAH	Maximum Concentration	Minimum Half Life	11	12	13	14	15	16	17	18	19	20	21	22	23
Acenaphthylene	380	0.47	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthracene	770	0.55	0	0	0	0	0	0	0	0	0	0	0	0	0
Benzo(a)anthracene	2200	1.12	2	1	1	0	0	0	0	0	0	0	0	0	0
Benzo(a)pyrene	1700	0.62	0	0	0	0	0	0	0	0	0	0	0	0	0
Chrysene	2300	4.06	352	297	250	211	178	150	126	106	90	76	64	54	45
Dibenzo(a,h)anthracene	1600	3.96	233	196	164	138	116	97	82	69	58	48	41	34	29
Fluorene	160	0.48	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluoranthene	6600	1.53	45	29	18	12	7	5	3	2	1	1	0	0	0
Phenanthrene	2600	0.18	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyrene	5400	2.3	196	145	107	79	59	43	32	24	18	13	10	7	5
Total PAH Concentration	23710		829	668	541	440	360	295	243	201	166	138	114	95	79

PAH	Maximum Concentration	Maximum Half Life	11	12	13	14	15	16	17	18	19	20	21	22	23
Acenaphthylene	380	0.66	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthracene	770	5.04	170	148	129	112	98	85	74	65	56	49	43	37	33
Benzo(a)anthracene	2200	7.45	791	720	656	598	545	497	452	412	376	342	312	284	259
Benzo(a)pyrene	1700	5.8	457	405	360	319	283	251	223	198	176	156	138	123	109
Chrysene	2300	11	1150	1080	1014	952	894	839	788	740	695	652	612	575	540
Dibenzo(a,h)anthracene	1600	10.3	763	714	667	624	583	545	510	477	446	417	389	364	340
Fluorene	160	4.82	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluoranthene	6600	3.8	888	740	616	514	428	357	297	248	206	172	143	119	99
Phenanthrene	2600	2.19	80	58	42	31	23	16	12	9	6	5	3	2	2
Pyrene	5400	5.2	1246	1091	955	836	731	640	560	490	429	376	329	288	252
	23710		5544	4956	4439	3985	3585	3231	2917	2638	2390	2168	1970	1793	1634

APPENDIX B

COST ESTIMATE

CLIENT: Site 1 - Parris Island		JOB NUMBER: 7394-AW0116030	
SUBJECT: FS/CMS Cost Estimate Calculation - Alternatives 2A, 2B, and 3			
BASED ON:		DRAWING NUMBER:	
BY: JSW / NJB Date: 06/21/01, 12/13/01	CHECKED BY: CAR/ JSW Date: 6/21/01 / 12/13/01	APPROVED BY:	DATE:

OBJECTIVE:

To calculate the quantities, volumes, and resulting estimated costs for Alternatives 2A, 2B, and 3.

APPROACH:

Using the assumptions and conclusions in this calculation, input the data into a spreadsheet and calculate the costs for the alternative.

Spreadsheet uses input data (volumes etc.) and formulas to calculate and total line items. Costs groups (materials, labor, etc.) and totaled and cost buildups are calculated based on percentages of the subtotals.

ASSUMPTIONS:

General Items

Various alternatives are depicted on Figures 5-1, 5-3, and 5-4. Areas and perimeters are taken from these preliminary plan views.

Perimeter cofferdams and interior dewatering will be used to control tidal inundation and groundwater infiltration during sediment, sediment/waste, and waste excavation.

Excavation within the sediment areas (salt flats) will require slower excavation due to saturated conditions.

The production rate used for the duration of the project is based on a comparison of the excavation production rate, site transportation, screening operation, and offsite disposal loading and transportation rates. See calculation below.

ALTERNATIVE 2A

Cost Item 1 (Site Preparation)

Subitem 1.1 - P.L.S. survey of the area prior to land disturbance to establish the pre-construction contours. Also includes on going construction surveying (grades, limits, features, etc.) as well as the final as-built record survey.

Subitem 1.2 - General facilities for contractor and oversight. Duration is based on length of excavation and capping plus two additional months.

Subitem 1.3 - General contractor heavy equipment mobilization (and demobilization).

Subitem 1.4 - Cost for general utilities for the trailers and associated facilities (such as portajohns, etc.)

Subitem 1.5 - Cost for abandonment of all existing monitoring wells (clusters) within the excavation and capping areas.

Subitem 1.6 - Clearing of trees and vegetation in the areas of excavation and capping as well as additional boarder that will be established during project planning.

Subitem 1.7 - Cost item for establishment of adequate site stabilized construction entrance and tire wash if needed.

CLIENT: Site 1 - Parris Island		JOB NUMBER: 7394-AW0116030	
SUBJECT: FS/CMS Cost Estimate Calculation - Alternatives 2A, 2B, and 3			
BASED ON:		DRAWING NUMBER:	
BY: JSW / NJB Date: 06/21/01, 12/13/01	CHECKED BY: CAR/ JSW Date: 6/21/01 / 12/13/01	APPROVED BY:	DATE:

Subitem 1.8 - Assume the use of temporary cofferdam structures around excavations and cap toe construction.

This item based on total perimeter length of excavations and cap toe length = 2,920 lf

Total length is then divided by 3 to account for the movement and reuse of the structures = 2,920 lf / 3 = 975 lf

Dewatering includes excavation dewatering, including pumps, lines, power, labor, etc. to operate standard dewatering sump/drawdown techniques.

Subitem 1.9 - Cost for establishment and operation of a large vehicle decon pad for demobilization of equipment.

Subitem 1.10 - General cost for standard E&S controls - such as silt fence. No sediment traps or extensive features should be required for this project.

Cost Item 2 (Sediment Excavation)

Subitem 2.1 - Cost for initial delineation of impacted sediment areas. Screening would be for COCs.

Subitem 2.2 - This item is the excavation of sediment within Area I. The volume is calculated below. This activity is costed with an excavator using swamp mats as needed. Excavated materials are placed in off road dumps for transportation to the landfill area. Quantity is based on the total estimated in-place volume above and is bulked up for the loose volume by a factor of 1.2 (20%).

Subitem 2.3 - This item is the excavation of sediment within Area III. The volume is calculated below. This activity is costed with an excavator using swamp mats as needed. Excavated materials are placed in off road dumps for transportation to the landfill area. Quantity is based on the total estimated in-place volume above and is bulked up for the loose volume by a factor of 1.2 (20%).

Subitem 2.4 - Verification sampling and analysis performed prior to backfilling and restoration activities. Assume one round of verification sampling activities.

Subitem 2.5 - Transportation of excavated material to the landfill area for consolidation.

Cost Item 3 (Sediment/Waste Excavation)

Subitem 3.1 - This item is the excavation of all sediment/waste and waste outside of the cap limits and not included with the sediment excavation. The volume is calculated below. This activity is costed with an excavator using swamp mats as needed. Excavated materials are placed in off road dumps for transportation to the landfill area. Quantity is based on the total estimated in-place volume above and is bulked up for the loose volume by a factor of 1.2 (20%).

Subitem 3.2 - Verification sampling and analysis performed prior to backfilling and restoration activities. Assume one round of VSP activities.

Subitem 3.3 - Transportation of excavated material to the landfill area for consolidation.

Cost Item 4 (Cap System)

Subitem 4.1 - Cost for placement and consolidation of sediment and sediment/waste within the limits of the cap system.

CLIENT: Site 1 - Parris Island		JOB NUMBER: 7394-AW0116030	
SUBJECT: FS/CMS Cost Estimate Calculation - Alternatives 2A, 2B, and 3			
BASED ON:		DRAWING NUMBER:	
BY: JSW / NJB Date: 06/21/01, 12/13/01	CHECKED BY: CAR/ JSW Date: 6/21/01 / 12/13/01	APPROVED BY:	DATE:

Subitem 4.2 - Cost for regrading of waste material within the existing limits of the landfill (cut and fill) to meet grading plan.

Subitem 4.3 - Importing and placement of general fill for grading above all consolidated sediment and waste prior to the installation of the cap system.

Subitem 4.4 - Importing and placement of intermeadiate cover layer for the cap system. This layer may be used for gas collection and venting with one passive vent per acre.

Subitem 4.5 - Import and installation of the cap system geosynthetic clay liner for the cap system.

Subitem 4.6 - Import and installation of the cap system geomembrane liner for the cap system.

Subitem 4.7 - Import and installation of the cap system geocomposite flow net for the cap system.

Subitem 4.8 - Import and placement of the cover soil layer for the cap system.

Subitem 4.9 - Import and placement of the cover topsoil layer (vegetative layer) for the cap system.

Subitem 4.10 - Import and placement of the cap system toe protection material. Assume that rip rap will be used from elevation 0' to high-high mean water level.

Cost Item 5 (Site Restoration)

NOTE: Sediment and sediment/waste excavations will be backfilled with off-site soil and vegetated.

Subitem 5.1 - New monitoring well clusters will be installed upgradinet and around the perimeter of the final landfill cap system. Assume all locations with two wells. One upgradient location and five perimeter locations.

Subitem 5.2 - Areas I and III will be restored with off-site sandy soil to provide re-establishment of wetland plants. Volume of off-site soil placed will equal the volume of sediment removed.

Subitem 5.3 - Areas I and III will be restored with wetland plants.

Subitem 5.4 - The entire cap area and disturbed areas (not including excavations within the salt flats) will be vegetated with grass and protected with mulch as required by the state erosion and sedimentation control plan. No additional tree planting, wetland planting, or specialized vegetation is necessary.

Subitem 5.5 - This item is for the implementation of Land Use Controls. Items including legal work, signage, and other measures are included in this cost item.

Cost Item 6 (Oversight)

Subitem 6.1 - This item is for contractor personnel that are not included as individual activities. The cost for five people including 1) site superintendent 2)foreman 3)project engineer 4)QC engineer and 5)Health and Safety officer at basic rates are included.

Subitem 6.2 - Costs for third-party oversight. This item includes the cost for one person to be at the site for an average of 30 hours per week for the duration of the project.

Cost Buildup Section

CLIENT: Site 1 - Parris Island		JOB NUMBER: 7394-AW0116030	
SUBJECT: FS/CMS Cost Estimate Calculation - Alternatives 2A, 2B, and 3			
BASED ON:		DRAWING NUMBER:	
BY: JSW / NJB Date: 06/21/01, 12/13/01	CHECKED BY: CAR/ JSW Date: 6/21/01 / 12/13/01	APPROVED BY:	DATE:

Percentages are used to calculate the cost buildups for the entire project. These percentages are applied to the direct costs to account for overhead, profit, indirect costs, contingency, and other costs as noted on the estimate.

Operation and Maintenance Costs

Cost Item 1 (Cap Maintenance - Years 1 to 30)

Subitem 1.1 - Cost for general cap repairs - such as soil erosion and depressions.

Subitem 1.2 - Cost for general vegetative replacement on the cap system and wetlands - such as barren areas requiring new vegetation or large plants/trees which need to be removed.

Cost Item 2 (Monitoring - Year 1)

Subitem 2.1 - Cost for quarterly monitoring trips to the site and the cost for sediment and groundwater sample collection.

Subitem 2.2 - This item is for the sediment laboratory analysis for COCs. Sediment samples are required to determine the effectiveness of the natural attenuation component of the alternative.

Subitem 2.3 - This item is for the groundwater laboratory analysis for COCs.

Subitem 2.4 - This item is for the compilation and reporting of the quarterly data collected as well as an analysis of the natural attenuation within the sediments.

Cost Item 3 (Monitoring - Years 2 to 30)

Subitem 3.1 - Cost for annual monitoring trips to the site and the cost for sediment and groundwater sample collection.

Subitem 3.2 - This item is for the sediment laboratory analysis for COCs. Sediment samples are required to determine the effectiveness of the natural attenuation component of the alternative.

Subitem 3.3 - This item is for the groundwater laboratory analysis for COCs.

Subitem 3.4 - This item is for the compilation and reporting of the annual data collected as well as an analysis of the natural attenuation within the sediments.

Cost Item 4 (Five-Year Review - Years 5, 10, 15, 20, 25, and 30))

Subitem 4.1 - Cost for review of the previous five-year data period and the preparation of the formal five-year review package.

ALTERNATIVE 2B

Cost Item 1 (Site Preparation)

Subitem 1.1 - P.L.S. survey of the area prior to land disturbance to establish the pre-construction contours. Also includes on going construction surveying (grades, limits, features, etc.) as well as the final as-built record survey.

CLIENT: Site 1 - Parris Island		JOB NUMBER: 7394-AW0116030	
SUBJECT: FS/CMS Cost Estimate Calculation - Alternatives 2A, 2B, and 3			
BASED ON:		DRAWING NUMBER:	
BY: JSW / NJB Date: 06/21/01, 12/13/01	CHECKED BY: CAR/ JSW Date: 6/21/01 / 12/13/01	APPROVED BY:	DATE:

Subitem 1.2 - General facilities for contractor and oversight. Duration is based on length of excavation and capping plus two additional months.

Subitem 1.3 - General contractor heavy equipment mobilization (and demobilization).

Subitem 1.4 - Cost for general utilities for the trailers and associated facilities (such as portajohns, etc.)

Subitem 1.5 - Cost for abandonment of all existing monitoring wells (clusters) within the excavation and capping areas.

Subitem 1.6 - Clearing of trees and vegetation in the areas of excavation and capping as well as additional boarder that will be established during project planning.

Subitem 1.7 - Cost item for establishment of adequate site stabilized construction entrance and tire wash if needed.

Subitem 1.8 - Assume the use of temporary cofferdam structures around excavations and cap toe construction.

This item based on total perimeter length of excavations and cap toe length = 4,744 lf

Total length is then divided by 3 to account for the movement and reuse of the structures = 4,744 lf / 3 = 1,585 lf

Dewatering includes excavation dewatering, including pumps, lines, power, labor, etc. to operate standard dewatering sump/drawdown techniques.

Subitem 1.9 - Cost for establishment and operation of a large vehicle decon pad for demobilization of equipment.

Subitem 1.10 - General cost for standard E&S controls - such as silt fence. No sediment traps or extensive features should be required for this project.

Cost Item 2 (Sediment Excavation)

Subitem 2.1 - Cost for initial delineation of impacted sediment areas. Screening would be for COCs.

Subitem 2.2 - This item is the excavation of sediment within Area I. The volume is calculated below. This activity is costed with an excavator using swamp mats as needed. Excavated materials are placed in off road dumps for transportation to the landfill area. Quantity is based on the total estimated in-place volume above and is bulked up for the loose volume by a factor of 1.2 (20%).

Subitem 2.3 - This item is the excavation of sediment within Area II. The volume is calculated below. This activity is costed with an excavator using swamp mats as needed. Excavated materials are placed in off road dumps for transportation to the landfill area. Quantity is based on the total estimated in-place volume above and is bulked up for the loose volume by a factor of 1.2 (20%).

Subitem 2.4 - This item is the excavation of sediment within Area III. The volume is calculated below. This activity is costed with an excavator using swamp mats as needed. Excavated materials are placed in off road dumps for transportation to the landfill area. Quantity is based on the total estimated in-place volume above and is bulked up for the loose volume by a factor of 1.2 (20%).

Subitem 2.5 - Verification sampling and analysis performed prior to backfilling and restoration activities. Assume one round of verification sampling activities.

Subitem 2.6 - Transportation of excavated material to the landfill area for consolidation.

CLIENT: Site 1 - Parris Island		JOB NUMBER: 7394-AW0116030	
SUBJECT: FS/CMS Cost Estimate Calculation - Alternatives 2A, 2B, and 3			
BASED ON:		DRAWING NUMBER:	
BY: JSW / NJB Date: 06/21/01, 12/13/01	CHECKED BY: CAR/ JSW Date: 6/21/01 / 12/13/01	APPROVED BY:	DATE:

Cost Item 3 (Sediment/Waste Excavation)

Subitem 3.1 - This item is the excavation of all sediment/waste and waste outside of the cap limits and not included with the sediment excavation. The volume is calculated below. This activity is costed with an excavator using swamp mats as needed. Excavated materials are placed in off road dumps for transportation to the landfill area. Quantity is based on the total estimated in-place volume above and is bulked up for the loose volume by a factor of 1.2 (20%).

Subitem 3.2 - Verification sampling and analysis performed prior to backfilling and restoration activities. Assume one round of VSP activities.

Subitem 3.3 - Transportation of excavated material to the landfill area for consolidation.

Cost Item 4 (Cap System)

Subitem 4.1 - Cost for placement and consolidation of sediment and sediment/waste within the limits of the cap system.

Subitem 4.2 - Cost for regrading of waste material within the existing limits of the landfill (cut and fill) to meet grading plan.

Subitem 4.3 - Importing and placement of general fill for grading above all consolidated sediment and waste prior to the installation of the cap system.

Subitem 4.4 - Importing and placement of intermeadiate cover layer for the cap system. This layer may be used for gas collection and venting with one passive vent per acre.

Subitem 4.5 - Import and installation of the cap system geosynthetic clay liner for the cap system.

Subitem 4.6 - Import and installation of the cap system geomembrane liner for the cap system.

Subitem 4.7 - Import and installation of the cap system geocomposite flow net for the cap system.

Subitem 4.8 - Import and placement of the cover soil layer for the cap system.

Subitem 4.9 - Import and placement of the cover topsoil layer (vegetative layer) for the cap system.

Subitem 4.10 - Import and placement of the cap system toe protection material. Assume that rip rap will be used from elevation 0' to high-high mean water level.

Cost Item 5 (Site Restoration)

NOTE: Sediment and sediment/waste excavations will be backfilled with off-site soil and vegetated.

Subitem 5.1 - New monitoring well clusters will be installed upgradinet and around the perimeter of the final landfill cap system. Assume all locations with two wells. One upgradient location and five perimeter locations.

Subitem 5.2 - Areas I, II and III will be restored with off-site sandy soil to provide re-establishment of wetland plants. Volume of off-site soil placed will equal the volume of sediment removed.

Subitem 5.3 - Areas I, II and III will be restored with wetland plants.

CLIENT: Site 1 - Parris Island		JOB NUMBER: 7394-AW0116030	
SUBJECT: FS/CMS Cost Estimate Calculation - Alternatives 2A, 2B, and 3			
BASED ON:		DRAWING NUMBER:	
BY: JSW / NJB Date: 06/21/01, 12/13/01	CHECKED BY: CAR/ JSW Date: 6/21/01 / 12/13/01	APPROVED BY:	DATE:

Subitem 5.4 - The entire cap area and disturbed areas (not including excavations within the salt flats) will be vegetated with grass and protected with mulch as required by the state erosion and sedimentation control plan. No additional tree planting, wetland planting, or specialized vegetation is necessary.

Subitem 5.5 - This item is for the implementation of Land Use Controls. Items including legal work, signage, and other measures are included in this cost item.

Cost Item 6 (Oversight)

Subitem 6.1 - This item is for contractor personnel that are not included as individual activities. The cost for five people including 1) site superintendent 2)foreman 3)project engineer 4)QC engineer and 5)Health and Safety officer at basic rates are included.

Subitem 6.2 - Costs for third-party oversight. This item includes the cost for one person to be at the site for an average of 30 hours per week for the duration of the project.

Cost Buildup Section

Percentages are used to calculate the cost buildups for the entire project. These percentages are applied to the direct costs to account for overhead, profit, indirect costs, contingency, and other costs as noted on the estimate.

Operation and Maintenance Costs

Cost Item 1 (Cap Maintenance - Years 1 to 30)

Subitem 1.1 - Cost for general cap repairs - such as soil erosion and depressions.

Subitem 1.2 - Cost for general vegetative replacement on the cap system and wetlands - such as barren areas requiring new vegetation or large plants/trees which need to be removed.

Cost Item 2 (Monitoring - Year 1)

Subitem 2.1 - Cost for quarterly monitoring trips to the site and the cost for groundwater sample collection.

Subitem 2.2 - This item is for the groundwater laboratory analysis for COCs.

Subitem 2.3 - This item is for the compilation and reporting of the quarterly data collected.

Cost Item 3 (Monitoring - Years 2 to 30)

Subitem 3.1 - Cost for annual monitoring trips to the site and the cost for groundwater sample collection.

Subitem 3.2 - This item is for the groundwater laboratory analysis for COCs.

Subitem 3.3 - This item is for the compilation and reporting of the annual data collected.

Cost Item 4 (Five-Year Review - Years 5, 10, 15, 20, 25, and 30))

Subitem 4.1 - Cost for review of the previous five-year data period and the preparation of the formal five-year review package.

CLIENT: Site 1 - Parris Island		JOB NUMBER: 7394-AW0116030	
SUBJECT: FS/CMS Cost Estimate Calculation - Alternatives 2A, 2B, and 3			
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BY: JSW / NJB Date: 06/21/01, 12/13/01	CHECKED BY: CAR/ JSW Date: 6/21/01 / 12/13/01	APPROVED BY:	DATE:

ALTERNATIVE 3

Cost Item 1 (Site Preparation)

Subitem 1.1 - P.L.S. survey of the area prior to land disturbance to establish the pre-construction contours. Also includes on going construction surveying (grades, limits, features, etc.) as well as the final as-built record survey.

Subitem 1.2 - General facilities for contractor and oversight. Duration is based on length of excavation plus two additional months.

Subitem 1.3 - General contractor heavy equipment mobilization (and demobilization).

Subitem 1.4 - Cost for general utilities for the trailers and associated facilities (such as portajohns, etc.)

Subitem 1.5 - Cost for abandonment of all existing monitoring wells (clusters) within the excavation areas.

Subitem 1.6 - Clearing of trees and vegetation in the areas of excavation well as additional boarder that will be established during project planning.

Subitem 1.7 - Cost item for establishment of adequate site stabilized construction entrance and tire wash if needed.

Subitem 1.8 - Assume the use of temporary cofferdam structures around excavation areas.

This item based on total perimeter length of excavations = 3,776 lf

Total length is then divided by 3 to account for the movement and reuse of the structures = 3,776 lf / 3 = 1,260 lf

Dewatering includes excavation dewatering, including pumps, lines, power, labor, etc. to operate standard dewatering sump/drawdown techniques.

Subitem 1.9 - Cost for establishment and operation of a large vehicle decon pad for demobilization of equipment.

Subitem 1.10 - General cost for standard E&S controls - such as silt fence. No sediment traps or extensive features should be required for this project.

Cost Item 2 (Sediment Excavation)

Subitem 2.1 - Cost for initial delineation of impacted sediment areas. Screening would be for COCs.

Subitem 2.2 - This item is the excavation of sediment within Area I. The volume is calculated below. This activity is costed with an excavator using swamp mats as needed. Excavated materials are placed in off road dumps for transportation to the landfill area. Quantity is based on the total estimated in-place volume above and is bulked up for the loose volume by a factor of 1.2 (20%).

Subitem 2.3 - This item is the excavation of sediment within Area II. The volume is calculated below. This activity is costed with an excavator using swamp mats as needed. Excavated materials are placed in off road dumps for transportation to the landfill area. Quantity is based on the total estimated in-place volume above and is bulked up for the loose volume by a factor of 1.2 (20%).

CLIENT: Site 1 - Parris Island		JOB NUMBER: 7394-AW0116030	
SUBJECT: FS/CMS Cost Estimate Calculation - Alternatives 2A, 2B, and 3			
BASED ON:		DRAWING NUMBER:	
BY: JSW / NJB Date: 06/21/01, 12/13/01	CHECKED BY: CAR/ JSW Date: 6/21/01 / 12/13/01	APPROVED BY:	DATE:

Subitem 2.4 - This item is the excavation of sediment within Area III. The volume is calculated below. This activity is costed with an excavator using swamp mats as needed. Excavated materials are placed in off road dumps for transportation to the landfill area. Quantity is based on the total estimated in-place volume above and is bulked up for the loose volume by a factor of 1.2 (20%).

Subitem 2.5 - Verification sampling and analysis performed prior to backfilling and restoration activities. Assume one round of verification sampling activities.

Subitem 2.6 - Transportation of excavated material to the loadout area.

Cost Item 3 (Excavation of Landfill Waste)

Subitem 3.1 - This item is the excavation of all sediment/waste and landfill waste not included with the sediment excavation. The volume is calculated below. This activity is costed with an excavator using swamp mats as needed at the base of the landfill material. Excavated materials are placed in off road dumps for transportation to the landfill area. Quantity is based on the total estimated in-place volume above and is bulked up for the loose volume by a factor of 1.2 (20%).

Subitem 3.2 - Verification sampling and analysis performed prior to backfilling and restoration activities. Assume one round of VSP activities.

Subitem 3.3 - Transportation of excavated material to the loadout area.

Cost Item 4 (Transporatation and Disposal)

Subitem 4.1 - Sampling and analysis for disposal characteristics for offsite disposal (and transportation).

Subitem 4.2 - For Alternative 3a, 90 percent of the total waste volume has been assumed to be characterized as "non-hazardous" for planning purposes. Cost item includes the transportation and disposal of non-hazardous waste and debris. The item is costed per weight. Conversion from CY to TONS is in calculation section. For Alternative 3b, 99 percent of the total waste volume is assumed to be "non-hazardous".

Subitem 4.3 - For Alternative 3a, the remaining 10 percent of the total waste volume has been assumed to be characterized as "hazardous" for planning purposes. This may result from unknown pockets of materials that may not be suitable for general non-hazardous debris disposal. Cost item includes the transportation and disposal of hazardous waste and debris. The item is costed per weight. Conversion from CY to TONS is in calculation section. For Alternative 3b, one percent of the total waste volume is assume to be "hazardous".

Cost Item 5 (Site Restoration)

NOTE: Sediment, sediment/waste, and landfill excavations will not be backfilled and vegetated. It is assumed that excavations in the low lying areas of the salt flats will be allowed to fill in and vegetate "naturally" via tidal deposition. However, the landfill material excvated from the bank of the original land mass will be restored to meet grades on both sides of the site.

Also - no monitoring wells will be replaced for this alternative.

Subitem 5.1 - Cost for import and placement of general structural fill for the restoration of the bank area.

CLIENT: Site 1 - Parris Island		JOB NUMBER: 7394-AW0116030	
SUBJECT: FS/CMS Cost Estimate Calculation - Alternatives 2A, 2B, and 3			
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BY: JSW / NJB Date: 06/21/01, 12/13/01	CHECKED BY: CAR/ JSW Date: 6/21/01 / 12/13/01	APPROVED BY:	DATE:

Subitem 5.2 - Cost for import and placement of topsoil for the restoration of the bank area.

Subitem 5.3 - The restored bank area and disturbed areas (not including excavations within the salt flats) will be vegetated with grass and protected with mulch as required by the state erosion and sedimentation control plan. No additional tree planting, wetland planting, or specialized vegetation is necessary.

Cost Item 6 (Oversight)

Subitem 6.1 - This item is for contractor personnel that are not included as individual activities. The cost for five people including 1) site superintendent 2)foreman 3)project engineer 4)QC engineer and 5)Health and Safety officer at basic rates are included.

Subitem 6.2 - Costs for third-party oversight. This item includes the cost for one person to be at the site for an average of 30 hours per week for the duration of the project.

Cost Buildup Section

Percentages are used to calculate the cost buildups for the entire project. These percentages are applied to the direct costs to account for overhead, profit, indirect costs, contingency, and other costs as noted on the estimate.

Note: For this estimate, the markup for the offsite transportation and disposal was calculated and listed separately from the typical G & A on subcontract item. This was done to because for a project intensive in offsite disposal costs, the markup for the subcontract items would be calculated at a rate higher than could be expected for the actual project.

Operation and Maintenance Costs

This section is for the additional calculation spreadsheet for long-term O & M and monitoring costs. There are no O & M or monitoring costs for this alternative.

CALCULATIONS:

VOLUME ESTIMATE

GENERAL AREA AND VOLUME ASSUMPTIONS:

6.8 (ACRE) Area of Site - Existing vegetation on landfill area

SOIL/SEDIMENT PROPERTIES:

120 In-Place Density (pcf)
100 Loose Density (pcf)
1.20 Bulking Factor - In-Place to Loose in Truck

CONTAMINATION CHARACTERISTICS:

Alternative 3a		*Alternative 3b*
10% Percentage of Hazardous in Total	or	1% Percentage of Hazardous in Total
90% Percentage of Non-Hazardous in Total		99% Percentage of Non-Hazardous in Total

ALTERNATIVE 2a: Excavation and Consolidation of Partial Sediment and Containment of Waste

From area measurements:

	Area (sf)	(COC)
Sediment Area I		
	39581	pesticides/inorganics (sf)

CLIENT: Site 1 - Parris Island		JOB NUMBER: 7394-AW0116030	
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Sediment Area III

subarea A 18253 inorganics (sf)

1 (feet) average depth of sediment excavation

Sediment/Waste and Waste Areas:

127770 Delineated area outside of cap but within limits of waste (sf)
28560 Buffer area outside of waste delineation - assume impacted - value decision (sf)

2 (feet) average depth of sediment/waste excavation

276492 Area of cap system (sf)
1696 Perimeter of Cap System - based on toe line (lf)

0.5 Average depth of existing landfill material regrading (not including consolidation) (ft)
0.5 Average depth of needed subgrade prior to cap (ft)
1 depth of intermediate cover material (ft)

276492 Area of GCL needed (sf)
276492 Area of geomembrane needed (sf)
276492 Area of geocomposite flow net needed (sf)

1.50 Depth of cover soil layer (ft)
0.50 Depth of topsoil layer (ft)

29 Width of Shoreline Protection (ft)
2 Depth of Shoreline Protection (ft)

1.3 Factor - Loose Yards (In Truck) to In-Place Volume Needed

9 Months for capping portion of project

ALTERNATIVE 2b: Excavation and Consolidation of All Sediment and Containment of Waste

From area measurements:

	Area (sf)	(COC)
Sediment Area I		
	39581	pesticides/inorganics (sf)
Sediment Area II		
	82240	arsenic (sf)
Sediment Area III		
subarea A	18253	inorganics/PAHs (sf)
subarea B	24522	PAHs (sf)

1 (feet) average depth of sediment excavation

Sediment/Waste and Waste Areas:

93943 Delineated area outside of cap but within limits of waste (sf)
26712 Buffer area outside of waste delineation - assume impacted - value decision (sf)

2 (feet) average depth of sediment/waste excavation

313273 Area of cap system (sf)
1720 Perimeter of Cap System - based on toe line (lf)

0.5 Average depth of existing landfill material regrading (not including consolidation) (ft)
0.5 Average depth of needed subgrade prior to cap (ft)
1 depth of intermediate cover material (ft)

CLIENT: Site 1 - Parris Island		JOB NUMBER: 7394-AW0116030	
SUBJECT: FS/CMS Cost Estimate Calculation - Alternatives 2A, 2B, and 3			
BASED ON:		DRAWING NUMBER:	
BY: JSW / NJB Date: 06/21/01, 12/13/01	CHECKED BY: CAR/ JSW Date: 6/21/01 / 12/13/01	APPROVED BY:	DATE:

313273 Area of GCL needed (sf)
313273 Area of geomembrane needed (sf)
313273 Area of geocomposite flow net needed (sf)
1.50 Depth of cover soil layer (ft)
0.50 Depth of topsoil layer (ft)

29 Width of Shoreline Protection (ft)
2 Depth of Shoreline Protection (ft)

1.3 Factor - Loose Yards (In Truck) to In-Place Volume Needed

10 Months for capping portion of project

ALTERNATIVE 3(a and b):

From area measurements:

	Area (sf)	(COC)
Sediment Area I		
	39581	pesticides/inorganics/PAH (sf)
Sediment Area II		
	82240	arsenic (sf)
Sediment Area III		
subarea A	18253	inorganics/PAH (sf)
subarea B	24522	PAH (sf)

1 (feet) average depth of sediment excavation

Sediment/Waste and Waste Areas:

332993 Delineated Area - including buffer area outside waste limits (sf)

5 (feet) average depth of sediment/waste excavation

1.62 tons per cubic yard conversion

Bank Restoration

496 Bank length of existing landfill needed for restoration (ft)
80 Average width needed for restoration (ft)
8 Average thickness of backfill needed for restoration (ft)
0.5 Average thickness of topsoil needed for restoration (ft)

COST CALCULATION

See spreadsheet for cost details and calculations.

CONCLUSIONS:

See spreadsheet for the cost summary and total for the alternative.

Table B-1
Capital Costs
Alternative 2a - Excavation and Consolidation of Pesticide and Inorganic Contaminated Sediment in Excess of Ecological RGOs and Containment of Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Item	Quantity	Unit	Unit Cost				Extended Cost				Total
			Subcontract	Materials	Labor	Equipment	Subcontract	Materials	Labor	Equipment	Cost
1 SITE PREPARATION											
1.1 Pre-construction/Construction/As-Built Survey	1	LS	$40,000.00				$40,000.00				$40,000.00
1.2 Site Facilities (Trailers, etc.)	11	MONTH	$800.00				$8,800.00				$8,800.00
1.3 Equipment Mobilization/Demobilization	1	LS	$5,000.00				$5,000.00				$5,000.00
1.4 Site Utilities	11	MONTH	$2,000.00				$22,000.00				$22,000.00
1.5 Abandonment of Existing Monitoring Wells	11	EACH	$2,500.00				$27,500.00				$27,500.00
1.6 Clearing and Grubbing	7	ACRE	$4,000.00				$28,000.00				$28,000.00
1.7 Site Access	1	LS		$2,500.00	$2,500.00	$1,000.00		$2,500.00	$2,500.00	$1,000.00	$6,000.00
1.8 Temporary Cofferdams and Dewatering	975	LF	$39.00	$12.00	$20.00	$15.00	$38,025.00	$11,700.00	$19,500.00	$14,625.00	$83,850.00
1.9 Decontamination Pad	1	LS		$4,000.00	$2,000.00	$2,000.00		$4,000.00	$2,000.00	$2,000.00	$8,000.00
1.10 Erosion and Sediment Controls	1	LS		$21,000.00	$18,000.00	$10,000.00		$21,000.00	$18,000.00	$10,000.00	$49,000.00
2 SEDIMENT EXCAVATION											
2.1 Delineation of Impacted Area	25	EACH	$400.00		$10.00	$15.00	$10,000.00		$250.00	$375.00	$10,625.00
2.2 Excavation of Impacted Sediment - Area I	1466	CY		$8.00	$2.00	$2.00		$11,727.70	$2,931.93	$2,931.93	$17,591.56
2.3 Excavation of Impacted Sediment - Area III	676	CY		$8.00	$2.00	$2.00		$5,408.30	$1,352.07	$1,352.07	$8,112.44
2.4 Verification Sampling and Analysis	10	EACH	$1,500.00		$10.00	$15.00	$15,000.00		$100.00	$150.00	$15,250.00
2.5 Transport of Sediment to Landfill	2570	CY		$5.85	$0.90	$0.90		$15,036.84	$2,313.36	$2,313.36	$19,663.56
3 SEDIMENT/WASTE EXCAVATION											
3.1 Excavation of Impacted Sediment/Waste	11580	CY		$8.00	$2.00	$2.00		$92,640.00	$23,160.00	$23,160.00	$138,960.00
3.2 Verification Sampling and Analysis	10	EACH	$1,500.00		$2.00	$2.00	$15,000.00		$20.00	$20.00	$15,040.00
3.3 Transport of Sediment/Waste to Landfill	13896	CY		$5.85	$0.90	$0.90		$81,291.60	$12,506.40	$12,506.40	$106,304.40
4 CAP SYSTEM											
4.1 Consolidation of Sediment and Waste	16466	CY			$3.00	$15.00			$49,399.20	$246,996.00	$296,395.20
4.2 Grade Existing Landfill Material	5120	CY			$3.00	$2.00			$15,360.67	$10,240.44	$25,601.11
4.3 Import and Place General Fill for Subgrade	5120	CY		$8.00	$2.00	$2.00		$40,961.78	$10,240.44	$10,240.44	$61,442.67
4.4 Import and Place Intermediate Cover/Gas Layer	10240	CY		$8.00	$2.00	$2.00		$81,923.56	$20,480.89	$20,480.89	$122,885.33
4.5 Placement of Geosynthetic Clay Liner	30721	SY		$5.85	$0.90	$0.90		$179,719.80	$27,649.20	$27,649.20	$235,018.20
4.6 Placement of Geomembrane Liner	30721	SY		$3.60	$4.50	$2.25		$110,596.80	$138,246.00	$69,123.00	$317,965.80
4.7 Placement of Geocomposite Drainage Layer	30721	SY		$4.50	$1.80	$0.90		$138,246.00	$55,298.40	$27,649.20	$221,193.60
4.8 Import and Place Cover Soil	15361	CY		$8.00	$2.00	$2.00		$122,885.33	$30,721.33	$30,721.33	$184,328.00
4.9 Import and Place Vegetative Layer	5120	CY		$20.00	$4.00	$4.00		$102,404.44	$20,480.89	$20,480.89	$143,366.22
4.10 Toe Stabilization/Protection	3643	CY		$24.00	$6.00	$4.00		$87,438.22	$21,859.56	$14,573.04	$123,870.81
5 SITE RESTORATION											
5.1 Installation of New Monitoring Wells	12	EACH	$3,200.00				$38,400.00				$38,400.00
5.2 Restore Areas I and III, Sand	2142	CY		$10.50	$2.00	$1.00		$22,491.00	$4,284.00	$2,142.00	$28,917.00
5.3 Restore Areas I and III, Vegetation	1.3	AC	$25,000.00				$33,192.15				$33,192.15
5.4 Vegetative Establishment - Cap	1	LS	$45,000.00				$45,000.00				$45,000.00
5.5 Land Use Controls	1	LS	$12,000.00				$12,000.00				$12,000.00
6 OVERSIGHT											
6.1 Field Personnel	11	MONTH			$26,000.00				$286,000.00		$286,000.00
6.2 Third-Party Field Oversight	11	MONTH			$3,900.00				$42,900.00		$42,900.00
SUBTOTAL DIRECT COST							$337,917.15	$1,131,971.37	$807,554.34	$550,730.20	$2,828,173.06

12/13/01

Table B-1a
Operation and Maintenance Costs
Alternative 2a - Excavation and Consolidation of Pesticide and Inorganic Contaminated Sediment in Excess of Ecological RGOs and Containment of Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Item	Quantity	Unit	Unit Cost				Extended Cost				Total
			Subcontract	Materials	Labor	Equipment	Subcontract	Materials	Labor	Equipment	Cost
1 CAP MAINTENANCE (Years 1 to 30)											
1.1 General Cap Repairs - Soil Erosion	1	LS	$4,000.00				$4,000.00				$4,000.00
1.2 Vegetation Replacement	1	LS	$1,000.00				$1,000.00				$1,000.00
										ANNUAL COST	**$5,000.00**
2 MONITORING (Year 1)											
2.1 Site Inspection and Sample Collection	4	EACH		$200.00	$1,440.00	$200.00		$800.00	$5,760.00	$800.00	$7,360.00
2.2 Sediment Laboratory Analysis - Annual Only	6	EACH	$450.00				$2,700.00				$2,700.00
2.3 Groundwater Laboratory Analysis	48	EACH	$900.00				$43,200.00				$43,200.00
2.4 Monitoring and Natural Attenuation Report	4	EACH		$100.00	$2,800.00			$400.00	$11,200.00		$11,600.00
										ANNUAL COST	**$64,860.00**
3 MONITORING (Years 2 to 30)											
3.1 Site Inspection and Sample Collection	1	EACH		$200.00	$1,440.00	$200.00		$200.00	$1,440.00	$200.00	$1,840.00
3.2 Sediment Laboratory Analysis	6	EACH	$450.00				$2,700.00				$2,700.00
3.3 Groundwater Laboratory Analysis	12	EACH	$900.00				$10,800.00				$10,800.00
3.4 Monitoring and Natural Attenuation Report	1	EACH		$100.00	$2,800.00			$100.00	$2,800.00		$2,900.00
										ANNUAL COST	**$18,240.00**
4 FIVE-YEAR REVIEW (Years 5, 10, 15, 20, 25, and 30)											
4.1 Report for Review of Data and Evaluation	1	EACH		$500.00	$6,400.00			$500.00	$6,400.00		$6,900.00
										ANNUAL COST	**$6,900.00**

Table B-1b
Present Worth Calculation
Alternative 2a - Excavation and Consolidation of Pesticide and Inorganic Contaminated Sediment in Excess of Ecological RGOs and Containment of Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Year	Maintenance Cost	Monitoring Cost		Subtotal of Annual O & M Cost	Annual Discount Rate	Annual Present Worth Cost
	(Years 1 - 30)	(Year 1)	(Years 2 - 30)		7.00%	
1	$5,000.00	$64,860.00		$69,860.00	0.935	$65,290
2	$5,000.00		$18,240.00	$23,240.00	0.873	$20,299
3	$5,000.00		$18,240.00	$23,240.00	0.816	$18,971
4	$5,000.00		$18,240.00	$23,240.00	0.763	$17,730
5	$5,000.00		$25,140.00	$30,140.00	0.713	$21,489
6	$5,000.00		$18,240.00	$23,240.00	0.666	$15,486
7	$5,000.00		$18,240.00	$23,240.00	0.623	$14,473
8	$5,000.00		$18,240.00	$23,240.00	0.582	$13,526
9	$5,000.00		$18,240.00	$23,240.00	0.544	$12,641
10	$5,000.00		$25,140.00	$30,140.00	0.508	$15,322
11	$5,000.00		$18,240.00	$23,240.00	0.475	$11,041
12	$5,000.00		$18,240.00	$23,240.00	0.444	$10,319
13	$5,000.00		$18,240.00	$23,240.00	0.415	$9,644
14	$5,000.00		$18,240.00	$23,240.00	0.388	$9,013
15	$5,000.00		$25,140.00	$30,140.00	0.362	$10,924
16	$5,000.00		$18,240.00	$23,240.00	0.339	$7,872
17	$5,000.00		$18,240.00	$23,240.00	0.317	$7,357
18	$5,000.00		$18,240.00	$23,240.00	0.296	$6,876
19	$5,000.00		$18,240.00	$23,240.00	0.277	$6,426
20	$5,000.00		$25,140.00	$30,140.00	0.258	$7,789
21	$5,000.00		$18,240.00	$23,240.00	0.242	$5,613
22	$5,000.00		$18,240.00	$23,240.00	0.226	$5,246
23	$5,000.00		$18,240.00	$23,240.00	0.211	$4,902
24	$5,000.00		$18,240.00	$23,240.00	0.197	$4,582
25	$5,000.00		$25,140.00	$30,140.00	0.184	$5,553
26	$5,000.00		$18,240.00	$23,240.00	0.172	$4,002
27	$5,000.00		$18,240.00	$23,240.00	0.161	$3,740
28	$5,000.00		$18,240.00	$23,240.00	0.150	$3,495
29	$5,000.00		$18,240.00	$23,240.00	0.141	$3,267
30	$5,000.00		$25,140.00	$30,140.00	0.131	$3,959

TOTAL OPERATION AND MAINTENANCE COST - PRESENT WORTH **$346,845.15**

12/13/01

Table B-2
Cost Summary
Alternative 2a - Excavation and Consolidation of Pesticide and Inorganic Contaminated Sediment in Excess of Ecological RGOs and Containment of Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Cost Buildup Items	Percentage	Extended Cost				Total Cost
		Subcontract	Materials	Labor	Equipment	
SUBTOTAL DIRECT COST		$337,917.15	$1,131,971.37	$807,554.34	$550,730.20	$2,828,173.06
Overhead on Labor Cost	30%			$242,266.30		$242,266.30
G & A on Labor Cost	10%			$80,755.43		$80,755.43
G & A on Material Cost	10%		$113,197.14			$113,197.14
G & A on Subcontract Cost	10%	$33,791.71				$33,791.71
FOGMA on Equipment Cost	7%				$38,551.11	$38,551.11
SUBTOTAL DIRECT COST		$371,708.86	$1,245,168.51	$1,130,576.07	$589,281.31	$3,336,734.76

INDIRECT COSTS

Indirect Cost Based on Total Direct Cost	30%	$111,512.66	$373,550.55	$339,172.82	$176,784.39	$1,001,020.43
Profit Margin on Total Direct Cost	10%	$37,170.89	$124,516.85	$113,057.61	$58,928.13	$333,673.48
SUBTOTAL INDIRECT COST		$148,683.55	$498,067.40	$452,230.43	$235,712.52	$1,334,693.90
TOTAL DIRECT AND INDIRECT COST		$520,392.41	$1,743,235.91	$1,582,806.50	$824,993.84	$4,671,428.66

CONTINGENCY AND ADMINISTRATIVE COSTS

Project Contingency on Project Cost	20%					$934,285.73
Contract Administration on Total Project Cost	5%					$233,571.43
Engineering on Total Project Cost	5%					$233,571.43
Health and Safety on Total Project Cost	2%					$93,428.57

TOTAL PROJECT CAPITAL COST	**$6,166,285.83**
TOTAL OPERATION AND MAINTENANCE COST - PRESENT WORTH	**$346,845.15**
TOTAL COST FOR ALTERNATIVE 2a	**$6,513,130.98**

Table B-3
Capital Costs
Alternative 2b - Excavation and Consolidation of All Sediment and Containment of Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Item	Quantity	Unit	Unit Cost				Extended Cost				Total
			Subcontract	Materials	Labor	Equipment	Subcontract	Materials	Labor	Equipment	Cost
1 SITE PREPARATION											
1.1 Pre-construction/Construction/As-Built Survey	1	LS	$40,000.00				$40,000.00				$40,000.00
1.2 Site Facilities (Trailers, etc.)	12	MONTH	$800.00				$9,600.00				$9,600.00
1.3 Equipment Mobilization/Demobilization	1	LS	$5,000.00				$5,000.00				$5,000.00
1.4 Site Utilities	12	MONTH	$2,000.00				$24,000.00				$24,000.00
1.5 Abandonment of Existing Monitoring Wells	11	EACH	$2,500.00				$27,500.00				$27,500.00
1.6 Clearing and Grubbing	7	ACRE	$4,000.00				$28,000.00				$28,000.00
1.7 Site Access	1	LS		$2,500.00	$2,500.00	$1,000.00		$2,500.00	$2,500.00	$1,000.00	$6,000.00
1.8 Temporary Cofferdams and Dewatering	1585	LF	$39.00	$12.00	$20.00	$15.00	$61,815.00	$19,020.00	$31,700.00	$23,775.00	$136,310.00
1.9 Decontamination Pad	1	LS		$4,000.00	$2,000.00	$2,000.00		$4,000.00	$2,000.00	$2,000.00	$8,000.00
1.10 Erosion and Sediment Controls	1	LS		$21,000.00	$18,000.00	$10,000.00		$21,000.00	$18,000.00	$10,000.00	$49,000.00
2 SEDIMENT EXCAVATION											
2.1 Delineation of Impacted Area	25	EACH	$400.00		$10.00	$15.00	$10,000.00		$250.00	$375.00	$10,625.00
2.2 Excavation of Impacted Sediment - Area I	1466	CY		$8.00	$2.00	$2.00		$11,727.70	$2,931.93	$2,931.93	$17,591.56
2.3 Excavation of Impacted Sediment - Area II	3046	CY		$8.00	$2.00	$2.00		$24,367.41	$6,091.85	$6,091.85	$36,551.11
2.4 Excavation of Impacted Sediment - Area III	1584	CY		$8.00	$2.00	$2.00		$12,674.07	$3,168.52	$3,168.52	$19,011.11
2.5 Verification Sampling and Analysis	10	EACH	$800.00		$10.00	$15.00	$8,000.00		$100.00	$150.00	$8,250.00
2.6 Transport of Sediment to Landfill	7315	CY		$5.85	$0.90	$0.90		$42,794.96	$6,583.84	$6,583.84	$55,962.64
3 SEDIMENT/WASTE EXCAVATION											
3.1 Excavation of Impacted Sediment/Waste	8937	CY		$8.00	$2.00	$2.00		$71,499.26	$17,874.81	$17,874.81	$107,248.89
3.2 Verification Sampling and Analysis	10	EACH	$800.00		$2.00	$2.00	$8,000.00		$20.00	$20.00	$8,040.00
3.3 Transport of Sediment/Waste to Landfill	10725	CY		$5.85	$0.90	$0.90		$62,740.60	$9,652.40	$9,652.40	$82,045.40
4 CAP SYSTEM											
4.1 Consolidation of Sediment and Waste	18040	CY			$3.00	$15.00			$54,120.80	$270,604.00	$324,724.80
4.2 Grade Existing Landfill Material	5801	CY			$3.00	$2.00			$17,404.06	$11,602.70	$29,006.76
4.3 Import and Place General Fill for Subgrade	5801	CY		$8.00	$2.00	$2.00		$46,410.81	$11,602.70	$11,602.70	$69,616.22
4.4 Import and Place Intermediate Cover/Gas Layer	11603	CY		$8.00	$2.00	$2.00		$92,821.63	$23,205.41	$23,205.41	$139,232.44
4.5 Placement of Geosynthetic Clay Liner	34808	SY		$5.85	$0.90	$0.90		$203,627.45	$31,327.30	$31,327.30	$266,282.05
4.6 Placement of Geomembrane Liner	34808	SY		$3.60	$4.50	$2.25		$125,309.20	$156,636.50	$78,318.25	$360,263.95
4.7 Placement of Geocomposite Drainage Layer	34808	SY		$4.50	$1.80	$0.90		$156,636.50	$62,654.60	$31,327.30	$250,618.40
4.8 Import and Place Cover Soil	17404	CY		$8.00	$2.00	$2.00		$139,232.44	$34,808.11	$34,808.11	$208,848.67
4.9 Import and Place Vegetative Layer	5801	CY		$20.00	$4.00	$4.00		$116,027.04	$23,205.41	$23,205.41	$162,437.85
4.10 Toe Stabilization/Protection	3695	CY		$24.00	$6.00	$4.00		$88,675.56	$22,168.89	$14,779.26	$125,623.70
5 SITE RESTORATION											
5.1 Installation of New Monitoring Wells	12	EACH	$3,200.00				$38,400.00				$38,400.00
5.2 Restore Areas I, II, and III, Sand	6096	CY		$10.50	$2.00	$1.00		$64,009.56	$12,192.30	$6,096.15	$82,298.00
5.3 Restore Areas I, II, and III, Vegetation	3.8	AC	$25,000.00				$94,465.11				$94,465.11
5.4 Vegetative Establishment - Cap	1	LS	$45,000.00				$45,000.00				$45,000.00
5.5 Land Use Controls	1	LS	$12,000.00				$12,000.00				$12,000.00
6 OVERSIGHT											
6.1 Field Personnel	12	MONTH			$26,000.00				$312,000.00		$312,000.00
6.2 Third-Party Field Oversight	12	MONTH			$3,900.00				$46,800.00		$46,800.00
SUBTOTAL DIRECT COST							$411,780.11	$1,305,074.19	$908,999.42	$620,499.94	$3,246,353.66

12/13/01

Table B-3a
Operation and Maintenance Costs
Alternative 2b - Excavation and Consolidation of All Sediment and Containment of Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Item	Quantity	Unit	Unit Cost				Extended Cost				Total Cost
			Subcontract	Materials	Labor	Equipment	Subcontract	Materials	Labor	Equipment	
1 CAP MAINTENANCE (Years 1 to 30)											
1.1 General Cap Repairs - Soil Erosion	1	LS	$4,000.00				$4,000.00				$4,000.00
1.2 Vegetation Replacement	1	LS	$1,000.00				$1,000.00				$1,000.00
										ANNUAL COST	**$5,000.00**
2 MONITORING (Year 1)											
2.1 Site Inspection and Sample Collection	4	EACH		$300.00	$2,400.00	$300.00		$1,200.00	$9,600.00	$1,200.00	$12,000.00
2.2 Groundwater Laboratory Analysis	48	EACH	$900.00				$43,200.00				$43,200.00
2.3 Monitoring Report	4	EACH		$100.00	$2,240.00			$400.00	$8,960.00		$9,360.00
										ANNUAL COST	**$64,560.00**
3 MONITORING (Years 2 to 30)											
3.1 Site Inspection and Sample Collection	1	EACH		$300.00	$2,400.00	$300.00		$300.00	$2,400.00	$300.00	$3,000.00
3.2 Groundwater Laboratory Analysis	12	EACH	$900.00				$10,800.00				$10,800.00
3.3 Monitoring Report	1	EACH		$100.00	$2,240.00			$100.00	$2,240.00		$2,340.00
										ANNUAL COST	**$16,140.00**
4 FIVE-YEAR REVIEW (Years 5, 10, 15, 20, 25, and 30)											
4.1 Report for Review of Data and Evaluation	1	EACH		$500.00	$6,400.00			$500.00	$6,400.00		$6,900.00
										ANNUAL COST	**$6,900.00**

Table B-3b
Present Worth Calculation
Alternative 2b - Excavation and Consolidation of All Sediment and Containment of Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Year	Maintenance Cost	Monitoring Cost		Subtotal of Annual O & M Cost	Annual Discount Rate	Annual Present Worth Cost
	(Years 1 - 30)	(Year 1)	(Years 2 - 30)		7.00%	
1	$5,000.00	$64,560.00		$69,560.00	0.935	$65,009
2	$5,000.00		$16,140.00	$21,140.00	0.873	$18,464
3	$5,000.00		$16,140.00	$21,140.00	0.816	$17,257
4	$5,000.00		$16,140.00	$21,140.00	0.763	$16,128
5	$5,000.00		$23,040.00	$28,040.00	0.713	$19,992
6	$5,000.00		$16,140.00	$21,140.00	0.666	$14,086
7	$5,000.00		$16,140.00	$21,140.00	0.623	$13,165
8	$5,000.00		$16,140.00	$21,140.00	0.582	$12,304
9	$5,000.00		$16,140.00	$21,140.00	0.544	$11,499
10	$5,000.00		$23,040.00	$28,040.00	0.508	$14,254
11	$5,000.00		$16,140.00	$21,140.00	0.475	$10,043
12	$5,000.00		$16,140.00	$21,140.00	0.444	$9,386
13	$5,000.00		$16,140.00	$21,140.00	0.415	$8,772
14	$5,000.00		$16,140.00	$21,140.00	0.388	$8,198
15	$5,000.00		$23,040.00	$28,040.00	0.362	$10,163
16	$5,000.00		$16,140.00	$21,140.00	0.339	$7,161
17	$5,000.00		$16,140.00	$21,140.00	0.317	$6,692
18	$5,000.00		$16,140.00	$21,140.00	0.296	$6,255
19	$5,000.00		$16,140.00	$21,140.00	0.277	$5,845
20	$5,000.00		$23,040.00	$28,040.00	0.258	$7,246
21	$5,000.00		$16,140.00	$21,140.00	0.242	$5,106
22	$5,000.00		$16,140.00	$21,140.00	0.226	$4,772
23	$5,000.00		$16,140.00	$21,140.00	0.211	$4,459
24	$5,000.00		$16,140.00	$21,140.00	0.197	$4,168
25	$5,000.00		$23,040.00	$28,040.00	0.184	$5,166
26	$5,000.00		$16,140.00	$21,140.00	0.172	$3,640
27	$5,000.00		$16,140.00	$21,140.00	0.161	$3,402
28	$5,000.00		$16,140.00	$21,140.00	0.150	$3,180
29	$5,000.00		$16,140.00	$21,140.00	0.141	$2,971
30	$5,000.00		$23,040.00	$28,040.00	0.131	$3,684

TOTAL OPERATION AND MAINTENANCE COST - PRESENT WORTH **$322,468.40**

Table B-4
Cost Summary
Alternative 2b - Excavation and Consolidation of All Sediment and Containment of Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Cost Buildup Items	Percentage	Extended Cost				Total Cost
		Subcontract	Materials	Labor	Equipment	
SUBTOTAL DIRECT COST		$411,780.11	$1,305,074.19	$908,999.42	$620,499.94	$3,246,353.66
Overhead on Labor Cost	30%			$272,699.83		$272,699.83
G & A on Labor Cost	10%			$90,899.94		$90,899.94
G & A on Material Cost	10%		$130,507.42			$130,507.42
G & A on Subcontract Cost	10%	$41,178.01				$41,178.01
FOGMA on Equipment Cost	7%				$43,435.00	$43,435.00
SUBTOTAL DIRECT COST		$452,958.12	$1,435,581.61	$1,272,599.19	$663,934.94	$3,825,073.85

INDIRECT COSTS

Indirect Cost Based on Total Direct Cost	30%	$135,887.43	$430,674.48	$381,779.76	$199,180.48	$1,147,522.16
Profit Margin on Total Direct Cost	10%	$45,295.81	$143,558.16	$127,259.92	$66,393.49	$382,507.39
SUBTOTAL INDIRECT COST		$181,183.25	$574,232.64	$509,039.68	$265,573.98	$1,530,029.54
TOTAL DIRECT AND INDIRECT COST		$634,141.36	$2,009,814.25	$1,781,638.87	$929,508.91	$5,355,103.40

CONTINGENCY AND ADMINISTRATIVE COSTS

Project Contingency on Project Cost	20%					$1,071,020.68
Contract Administration on Total Project Cost	5%					$267,755.17
Engineering on Total Project Cost	5%					$267,755.17
Health and Safety on Total Project Cost	2%					$107,102.07

TOTAL PROJECT CAPITAL COST	**$7,068,736.48**
TOTAL OPERATION AND MAINTENANCE COST - PRESENT WORTH	**$322,468.40**
TOTAL COST FOR ALTERNATIVE 2b	**$7,391,204.89**

12/13/01

Table B-5
Capital Costs
Alternative 3a - Excavation and Off-Site Disposal of Waste and Sediment, 10% Hazardous Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Item	Quantity	Unit	Unit Cost				Extended Cost				Total
			Subcontract	Materials	Labor	Equipment	Subcontract	Materials	Labor	Equipment	Cost
1 SITE PREPARATION											
1.1 Pre-construction/Construction/As-Built Survey	1	LS	$40,000.00				$40,000.00				$40,000.00
1.2 Site Facilities (Trailers, etc.)	11	MONTH	$800.00				$8,800.00				$8,800.00
1.3 Equipment Mobilization/Demobilization	1	LS	$5,000.00				$5,000.00				$5,000.00
1.4 Site Utilities	11	MONTH	$2,000.00				$22,000.00				$22,000.00
1.5 Abandonment of Existing Monitoring Wells	11	EACH	$2,500.00				$27,500.00				$27,500.00
1.6 Clearing and Grubbing	7	ACRE	$4,000.00				$27,200.00				$27,200.00
1.7 Site Access	1	LS		$2,500.00	$2,500.00	$1,000.00		$2,500.00	$2,500.00	$1,000.00	$6,000.00
1.8 Temporary Cofferdams and Dewatering	1260	LF	$39.00	$12.00	$20.00	$15.00	$49,140.00	$15,120.00	$25,200.00	$18,900.00	$108,360.00
1.9 Decontamination Pad / Loadout Area	1	LS		$12,000.00	$10,000.00	$6,000.00		$12,000.00	$10,000.00	$6,000.00	$28,000.00
1.10 Erosion and Sediment Controls	1	LS		$21,000.00	$18,000.00	$10,000.00		$21,000.00	$18,000.00	$10,000.00	$49,000.00
2 SEDIMENT EXCAVATION											
2.1 Delineation of Impacted Area	25	EACH	$400.00		$10.00	$15.00	$10,000.00		$250.00	$375.00	$10,625.00
2.2 Excavation of Impacted Sediment - Area I	1466	CY		$8.00	$2.00	$2.00		$11,727.70	$2,931.93	$2,931.93	$17,591.56
2.3 Excavation of Impacted Sediment - Area II	3046	CY		$8.00	$2.00	$2.00		$24,367.41	$6,091.85	$6,091.85	$36,551.11
2.4 Excavation of Impacted Sediment - Area III	1584	CY		$8.00	$2.00	$2.00		$12,674.07	$3,168.52	$3,168.52	$19,011.11
2.5 Verification Sampling and Analysis	10	EACH	$800.00		$10.00	$15.00	$8,000.00		$100.00	$150.00	$8,250.00
2.6 Transport of Excavated Sediment to Loadout Area	7315	CY		$5.85	$0.90	$0.90		$42,794.96	$6,583.84	$6,583.84	$55,962.64
3 EXCAVATION OF LANDFILL WASTE											
3.1 Excavation of Landfill Material	61665	CY			$6.00	$4.00			$369,992.22	$246,661.48	$616,653.70
3.2 Verification Sampling and Analysis	20	EACH	$800.00		$60.00	$25.00	$16,000.00		$1,200.00	$500.00	$17,700.00
3.3 Transport of Excavated Waste to Loadout Area	73998	CY		$5.85	$0.90	$0.90		$432,890.90	$66,598.60	$66,598.60	$566,088.10
4 TRANSPORTATION AND DISPOSAL											
4.1 Waste Characterization	30	EACH	$1,500.00				$45,000.00				$45,000.00
4.2 Non-Hazardous Transportation and Disposal	118556	TON	$40.00				$4,742,222.11				$4,742,222.11
4.3 Hazardous Transportation and Disposal	13173	TON	$120.00				$1,580,740.70				$1,580,740.70
5 SITE RESTORATION											
5.1 Import and Place Backfill - Bank Area	11757	CY		$8.00	$1.00	$2.00		$94,056.30	$11,757.04	$23,514.07	$129,327.41
5.2 Import and Place Topsoil - Bank Area	735	CY		$24.00	$1.00	$2.00		$17,635.56	$734.81	$1,469.63	$19,840.00
5.3 Restore Areas I, II, III, and Excavated Landfill Area	16960	CY		$10.50	$2.00	$1.00		$178,080.00	$33,920.00	$16,960.00	$228,960.00
5.4 Vegetative Establishment	11.4	ACRE	$25,000.00				$285,000.00				$285,000.00
6 OVERSIGHT											
6.1 Field Personnel	11	MONTH			$26,000.00				$286,000.00		$286,000.00
6.2 Third-Party Field Oversight	11	MONTH			$3,900.00				$42,900.00		$42,900.00
SUBTOTAL DIRECT COST							$6,866,602.82	$864,846.90	$887,928.81	$410,904.92	$9,030,283.44

Table B-6
Cost Summary
Alternative 3a - Excavation and Off-Site Disposal of Waste and Sediment, 10% Hazardous Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Cost Buildup Items	Percentage	Extended Cost				Total Cost
		Subcontract	Materials	Labor	Equipment	
SUBTOTAL DIRECT COST		$6,866,602.82	$864,846.90	$887,928.81	$410,904.92	$9,030,283.44
Overhead on Labor Cost	30%			$266,378.64		$266,378.64
G & A on Labor Cost	10%			$88,792.88		$88,792.88
G & A on Material Cost	10%		$86,484.69			$86,484.69
G & A on Subcontract Cost[1]	10%	$54,364.00				$54,364.00
FOGMA on Equipment Cost	7%				$28,763.34	$28,763.34
SUBTOTAL DIRECT COST		$6,920,966.82	$951,331.59	$1,243,100.33	$439,668.27	$9,555,067.00

INDIRECT COSTS

Indirect Cost Based on Total Direct Cost[1]	30%	$179,401.20	$285,399.48	$372,930.10	$131,900.48	$969,631.26
Profit Margin on Total Direct Cost[1]	10%	$59,800.40	$95,133.16	$124,310.03	$43,966.83	$323,210.42
SUBTOTAL INDIRECT COST		$239,201.60	$380,532.63	$497,240.13	$175,867.31	$1,292,841.67
Markup for Disposal Cost[2]	5%	$316,148.14				$316,148.14
TOTAL DIRECT AND INDIRECT COST		$7,476,316.56	$1,331,864.22	$1,740,340.47	$615,535.57	$11,164,056.82

CONTINGENCY AND ADMINISTRATIVE COSTS

Project Contingency on Project Cost	20%					$2,232,811.36
Contract Administration on Total Project Cost	5%					$558,202.84
Engineering on Total Project Cost	5%					$558,202.84
Health and Safety on Total Project Cost	2%					$223,281.14

TOTAL PROJECT CAPITAL COST	**$14,736,555.00**
TOTAL OPERATION AND MAINTENANCE COST	**$0.00**
TOTAL COST FOR ALTERNATIVE	**$14,736,555.00**

[1] Does not include the cost for waste transportation and disposal subcontract
[2] Includes the subcontracted cost for transportation and disposal of waste materials

12/13/01

Table B-7
Capital Costs
Alternative 3b - Excavation and Off-Site Disposal of Waste and Sediment, 1% Hazardous Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Item	Quantity	Unit	Unit Cost				Extended Cost				Total Cost
			Subcontract	Materials	Labor	Equipment	Subcontract	Materials	Labor	Equipment	
1 SITE PREPARATION											
1.1 Pre-construction/Construction/As-Built Survey	1	LS	$40,000.00				$40,000.00				$40,000.00
1.2 Site Facilities (Trailers, etc.)	11	MONTH	$800.00				$8,800.00				$8,800.00
1.3 Equipment Mobilization/Demobilization	1	LS	$5,000.00				$5,000.00				$5,000.00
1.4 Site Utilities	11	MONTH	$2,000.00				$22,000.00				$22,000.00
1.5 Abandonment of Existing Monitoring Wells	11	EACH	$2,500.00				$27,500.00				$27,500.00
1.6 Clearing and Grubbing	7	ACRE	$4,000.00				$27,200.00				$27,200.00
1.7 Site Access	1	LS		$2,500.00	$2,500.00	$1,000.00		$2,500.00	$2,500.00	$1,000.00	$6,000.00
1.8 Temporary Cofferdams and Dewatering	1260	LF	$39.00	$12.00	$20.00	$15.00	$49,140.00	$15,120.00	$25,200.00	$18,900.00	$108,360.00
1.9 Decontamination Pad / Loadout Area	1	LS		$12,000.00	$10,000.00	$6,000.00		$12,000.00	$10,000.00	$6,000.00	$28,000.00
1.10 Erosion and Sediment Controls	1	LS		$21,000.00	$18,000.00	$10,000.00		$21,000.00	$18,000.00	$10,000.00	$49,000.00
2 SEDIMENT EXCAVATION											
2.1 Delineation of Impacted Area	25	EACH	$400.00		$10.00	$15.00	$10,000.00		$250.00	$375.00	$10,625.00
2.2 Excavation of Impacted Sediment - Area I	1466	CY		$8.00	$2.00	$2.00		$11,727.70	$2,931.93	$2,931.93	$17,591.56
2.3 Excavation of Impacted Sediment - Area II	3046	CY		$8.00	$2.00	$2.00		$24,367.41	$6,091.85	$6,091.85	$36,551.11
2.4 Excavation of Impacted Sediment - Area III	1584	CY		$8.00	$2.00	$2.00		$12,674.07	$3,168.52	$3,168.52	$19,011.11
2.5 Verification Sampling and Analysis	10	EACH	$800.00		$10.00	$15.00	$8,000.00		$100.00	$150.00	$8,250.00
2.6 Transport of Excavated Sediment to Loadout Area	7315	CY		$5.85	$0.90	$0.90		$42,794.96	$6,583.84	$6,583.84	$55,962.64
3 EXCAVATION OF LANDFILL WASTE											
3.1 Excavation of Landfill Material	61665	CY			$6.00	$4.00			$369,992.22	$246,661.48	$616,653.70
3.2 Verification Sampling and Analysis	20	EACH	$800.00		$60.00	$25.00	$16,000.00		$1,200.00	$500.00	$17,700.00
3.3 Transport of Excavated Waste to Loadout Area	73998	CY		$5.85	$0.90	$0.90		$432,890.90	$66,598.60	$66,598.60	$566,088.10
4 TRANSPORTATION AND DISPOSAL											
4.1 Waste Characterization	30	EACH	$1,500.00				$45,000.00				$45,000.00
4.2 Non-Hazardous Transportation and Disposal	130411	TON	$40.00				$5,216,444.32				$5,216,444.32
4.3 Hazardous Transportation and Disposal	1317	TON	$120.00				$158,074.07				$158,074.07
5 SITE RESTORATION											
5.1 Import and Place Backfill - Bank Area	11757	CY		$8.00	$1.00	$2.00		$94,056.30	$11,757.04	$23,514.07	$129,327.41
5.2 Import and Place Topsoil - Bank Area	735	CY		$24.00	$1.00	$2.00		$17,635.56	$734.81	$1,469.63	$19,840.00
5.3 Restore Areas I, II, III, and Excavated Landfill Area	16960	CY		$10.50	$2.00	$1.00		$178,080.00	$33,920.00	$16,960.00	$228,960.00
5.4 Vegetative Establishment	11.4	ACRE	$25,000.00				$285,000.00				$285,000.00
6 OVERSIGHT											
6.1 Field Personnel	11	MONTH			$26,000.00				$286,000.00		$286,000.00
6.2 Third-Party Field Oversight	11	MONTH			$3,900.00				$42,900.00		$42,900.00
SUBTOTAL DIRECT COST							$5,918,158.39	$864,846.90	$887,928.81	$410,904.92	$8,081,839.02

Table B-8
Cost Summary
Alternative 3b - Excavation and Off-Site Disposal of Waste and Sediment, 1% Hazardous Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Cost Buildup Items	Percentage	Extended Cost				Total Cost
		Subcontract	Materials	Labor	Equipment	
SUBTOTAL DIRECT COST		$5,918,158.39	$864,846.90	$887,928.81	$410,904.92	$8,081,839.02
Overhead on Labor Cost	30%			$266,378.64		$266,378.64
G & A on Labor Cost	10%			$88,792.88		$88,792.88
G & A on Material Cost	10%		$86,484.69			$86,484.69
G & A on Subcontract Cost[1]	10%	$54,364.00				$54,364.00
FOGMA on Equipment Cost	7%				$28,763.34	$28,763.34
SUBTOTAL DIRECT COST		$5,972,522.39	$951,331.59	$1,243,100.33	$439,668.27	$8,606,622.58
INDIRECT COSTS						
Indirect Cost Based on Total Direct Cost[1]	30%	$179,401.20	$285,399.48	$372,930.10	$131,900.48	$969,631.26
Profit Margin on Total Direct Cost[1]	10%	$59,800.40	$95,133.16	$124,310.03	$43,966.83	$323,210.42
SUBTOTAL INDIRECT COST		$239,201.60	$380,532.63	$497,240.13	$175,867.31	$1,292,841.67
Markup for Disposal Cost[2]	5%	$268,725.92				$268,725.92
TOTAL DIRECT AND INDIRECT COST		$6,480,449.91	$1,331,864.22	$1,740,340.47	$615,535.57	$10,168,190.18
CONTINGENCY AND ADMINISTRATIVE COSTS						
Project Contingency on Project Cost	20%					$2,033,638.04
Contract Administration on Total Project Cost	5%					$508,409.51
Engineering on Total Project Cost	5%					$508,409.51
Health and Safety on Total Project Cost	2%					$203,363.80

TOTAL PROJECT CAPITAL COST	**$13,422,011.03**
TOTAL OPERATION AND MAINTENANCE COST	**$0.00**
TOTAL COST FOR ALTERNATIVE	**$13,422,011.03**

[1] Does not include the cost for waste transportation and disposal subcontract
[2] Includes the subcontracted cost for transportation and disposal of waste materials

Capital Costs
Modified Alternative 2a - Excavation and Consolidation of Pesticide and Inorganic Contaminated Sediment in Excess of Ecological RGOs and Containment of Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Item	Quantity	Unit	Unit Cost				Extended Cost				Total
			Subcontract	Materials	Labor	Equipment	Subcontract	Materials	Labor	Equipment	Cost
1 SITE PREPARATION											
1.1 Pre-construction/Construction/As-Built Survey	1	LS	$40,000.00				$40,000.00				$40,000.00
1.2 Site Facilities (Trailers, etc.)	12	MONTH	$800.00				$9,600.00				$9,600.00
1.3 Equipment Mobilization/Demobilization	1	LS	$5,000.00				$5,000.00				$5,000.00
1.4 Site Utilities	12	MONTH	$2,000.00				$24,000.00				$24,000.00
1.5 Abandonment of Existing Monitoring Wells	11	EACH	$2,500.00				$27,500.00				$27,500.00
1.6 Clearing and Grubbing	7	ACRE	$4,000.00				$28,000.00				$28,000.00
1.7 Site Access	1	LS		$2,500.00	$2,500.00	$1,000.00		$2,500.00	$2,500.00	$1,000.00	$6,000.00
1.8 Temporary Cofferdams and Dewatering	1160	LF	$39.00	$12.00	$20.00	$15.00	$45,240.00	$13,920.00	$23,200.00	$17,400.00	$99,760.00
1.9 Decontamination Pad	1	LS		$4,000.00	$2,000.00	$2,000.00		$4,000.00	$2,000.00	$2,000.00	$8,000.00
1.10 Erosion and Sediment Controls	1	LS		$21,000.00	$18,000.00	$10,000.00		$21,000.00	$18,000.00	$10,000.00	$49,000.00
2 SEDIMENT EXCAVATION											
2.1 Delineation of Impacted Area	25	EACH	$400.00		$10.00	$15.00	$10,000.00		$250.00	$375.00	$10,625.00
2.2 Excavation of Impacted Sediment - Area I	1466	CY		$8.00	$2.00	$2.00		$11,727.70	$2,931.93	$2,931.93	$17,591.56
2.3 Excavation of Impacted Sediment - Area III	1584	CY		$8.00	$2.00	$2.00		$12,674.07	$3,168.52	$3,168.52	$19,011.11
2.4 Verification Sampling and Analysis	10	EACH	$1,500.00		$10.00	$15.00	$15,000.00		$100.00	$150.00	$15,250.00
2.5 Transport of Sediment to Landfill	3660	CY		$5.85	$0.90	$0.90		$21,412.56	$3,294.24	$3,294.24	$28,001.04
3 SEDIMENT/WASTE EXCAVATION											
3.1 Excavation of Impacted Sediment/Waste	10970	CY		$8.00	$2.00	$2.00		$87,762.96	$21,940.74	$21,940.74	$131,644.44
3.2 Verification Sampling and Analysis	10	EACH	$1,500.00		$2.00	$2.00	$15,000.00		$20.00	$20.00	$15,040.00
3.3 Transport of Sediment/Waste to Landfill	13164	CY		$5.85	$0.90	$0.90		$77,012.00	$11,848.00	$11,848.00	$100,708.00
4 CAP SYSTEM											
4.1 Consolidation of Sediment and Waste	16825	CY			$3.00	$15.00			$50,474.13	$252,370.67	$302,844.80
4.2 Grade Existing Landfill Material	5278	CY			$3.00	$2.00			$15,833.33	$10,555.56	$26,388.89
4.3 Import and Place General Fill for Subgrade	5278	CY		$8.00	$2.00	$2.00		$42,222.22	$10,555.56	$10,555.56	$63,333.33
4.4 Import and Place Intermediate Cover/Gas Layer	10556	CY		$8.00	$2.00	$2.00		$84,444.44	$21,111.11	$21,111.11	$126,666.67
4.5 Placement of Geosynthetic Clay Liner	31667	SY		$5.85	$0.90	$0.90		$185,250.00	$28,500.00	$28,500.00	$242,250.00
4.6 Placement of Geomembrane Liner	31667	SY		$3.60	$4.50	$2.25		$114,000.00	$142,500.00	$71,250.00	$327,750.00
4.7 Placement of Geocomposite Drainage Layer	31667	SY		$4.50	$1.80	$0.90		$142,500.00	$57,000.00	$28,500.00	$228,000.00
4.8 Import and Place Cover Soil	15833	CY		$8.00	$2.00	$2.00		$126,666.67	$31,666.67	$31,666.67	$190,000.00
4.9 Import and Place Vegetative Layer	5278	CY		$20.00	$4.00	$4.00		$105,555.56	$21,111.11	$21,111.11	$147,777.78
4.10 Toe Stabilization/Protection	3656	CY		$24.00	$6.00	$4.00		$87,747.56	$21,936.89	$14,624.59	$124,309.04
5 SITE RESTORATION											
5.1 Installation of New Monitoring Wells	12	EACH	$3,200.00				$38,400.00				$38,400.00
5.2 Restore Areas I and III, Sand	3050	CY		$10.50	$2.00	$1.00		$32,027.33	$6,100.44	$3,050.22	$41,178.00
5.3 Restore Areas I and III, Vegetation	1.9	AC	$25,000.00				$47,265.84				$47,265.84
5.4 Vegetative Establishment - Cap	1	LS	$45,000.00				$45,000.00				$45,000.00
5.5 Land Use Controls	1	LS	$12,000.00				$12,000.00				$12,000.00
6 OVERSIGHT											
6.1 Field Personnel	12	MONTH			$26,000.00				$312,000.00		$312,000.00
6.2 Third-Party Field Oversight	12	MONTH			$3,900.00				$46,800.00		$46,800.00
SUBTOTAL DIRECT COST							$362,005.84	$1,172,423.08	$854,842.67	$567,423.91	$2,956,695.50

12/31/01

Operation and Maintenance Costs
Modified Alternative 2a - Excavation and Consolidation of Pesticide and Inorganic Contaminated Sediment in Excess of Ecological RGOs and Containment of Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Item	Quantity	Unit	Unit Cost				Extended Cost				Total Cost
			Subcontract	Materials	Labor	Equipment	Subcontract	Materials	Labor	Equipment	
1 CAP MAINTENANCE (Years 1 to 30)											
1.1 General Cap Repairs - Soil Erosion	1	LS	$4,000.00				$4,000.00				$4,000.00
1.2 Vegetation Replacement	1	LS	$1,000.00				$1,000.00				$1,000.00
										ANNUAL COST	**$5,000.00**
2 MONITORING (Year 1)											
2.1 Site Inspection and Sample Collection	4	EACH		$300.00	$2,400.00	$300.00		$1,200.00	$9,600.00	$1,200.00	$12,000.00
2.2 Groundwater Laboratory Analysis	48	EACH	$900.00				$43,200.00				$43,200.00
2.3 Monitoring and Natural Attenuation Report	4	EACH		$100.00	$2,240.00			$400.00	$8,960.00		$9,360.00
										ANNUAL COST	**$64,560.00**
3 MONITORING (Years 2 to 30)											
3.1 Site Inspection and Sample Collection	1	EACH		$300.00	$2,400.00	$300.00		$300.00	$2,400.00	$300.00	$3,000.00
3.2 Groundwater Laboratory Analysis	12	EACH	$900.00				$10,800.00				$10,800.00
3.3 Monitoring and Natural Attenuation Report	1	EACH		$100.00	$2,240.00			$100.00	$2,240.00		$2,340.00
										ANNUAL COST	**$16,140.00**
4 FIVE-YEAR REVIEW (Years 5, 10, 15, 20, 25, and 30)											
4.1 Report for Review of Data and Evaluation	1	EACH		$500.00	$6,400.00			$500.00	$6,400.00		$6,900.00
										ANNUAL COST	**$6,900.00**

Present Worth Calculation
Modified Alternative 2a - Excavation and Consolidation of Pesticide and Inorganic Contaminated Sediment in Excess of Ecological RGOs and Containment of Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Year	Maintenance Cost	Monitoring Cost		Subtotal of Annual O & M Cost	Annual Discount Rate	Annual Present Worth Cost
	(Years 1 - 30)	(Year 1)	(Years 2 - 30)		7.00%	
1	$5,000.00	$64,560.00		$69,560.00	0.935	$65,009
2	$5,000.00		$16,140.00	$21,140.00	0.873	$18,464
3	$5,000.00		$16,140.00	$21,140.00	0.816	$17,257
4	$5,000.00		$16,140.00	$21,140.00	0.763	$16,128
5	$5,000.00		$23,040.00	$28,040.00	0.713	$19,992
6	$5,000.00		$16,140.00	$21,140.00	0.666	$14,086
7	$5,000.00		$16,140.00	$21,140.00	0.623	$13,165
8	$5,000.00		$16,140.00	$21,140.00	0.582	$12,304
9	$5,000.00		$16,140.00	$21,140.00	0.544	$11,499
10	$5,000.00		$23,040.00	$28,040.00	0.508	$14,254
11	$5,000.00		$16,140.00	$21,140.00	0.475	$10,043
12	$5,000.00		$16,140.00	$21,140.00	0.444	$9,386
13	$5,000.00		$16,140.00	$21,140.00	0.415	$8,772
14	$5,000.00		$16,140.00	$21,140.00	0.388	$8,198
15	$5,000.00		$23,040.00	$28,040.00	0.362	$10,163
16	$5,000.00		$16,140.00	$21,140.00	0.339	$7,161
17	$5,000.00		$16,140.00	$21,140.00	0.317	$6,692
18	$5,000.00		$16,140.00	$21,140.00	0.296	$6,255
19	$5,000.00		$16,140.00	$21,140.00	0.277	$5,845
20	$5,000.00		$23,040.00	$28,040.00	0.258	$7,246
21	$5,000.00		$16,140.00	$21,140.00	0.242	$5,106
22	$5,000.00		$16,140.00	$21,140.00	0.226	$4,772
23	$5,000.00		$16,140.00	$21,140.00	0.211	$4,459
24	$5,000.00		$16,140.00	$21,140.00	0.197	$4,168
25	$5,000.00		$23,040.00	$28,040.00	0.184	$5,166
26	$5,000.00		$16,140.00	$21,140.00	0.172	$3,640
27	$5,000.00		$16,140.00	$21,140.00	0.161	$3,402
28	$5,000.00		$16,140.00	$21,140.00	0.150	$3,180
29	$5,000.00		$16,140.00	$21,140.00	0.141	$2,971
30	$5,000.00		$23,040.00	$28,040.00	0.131	$3,684

TOTAL OPERATION AND MAINTENANCE COST - PRESENT WORTH **$322,468.40**

Cost Summary
Modified Alternative 2a - Excavation and Consolidation of Pesticide and Inorganic Contaminated Sediment in Excess of Ecological RGOs and Containment of Waste

Marine Corps Recruit Depot
Parris Island, South Carolina

Cost Buildup Items	Percentage	Extended Cost				Total Cost
		Subcontract	Materials	Labor	Equipment	
SUBTOTAL DIRECT COST		$362,005.84	$1,172,423.08	$854,842.67	$567,423.91	$2,956,695.50
Overhead on Labor Cost	30%			$256,452.80		$256,452.80
G & A on Labor Cost	10%			$85,484.27		$85,484.27
G & A on Material Cost	10%		$117,242.31			$117,242.31
G & A on Subcontract Cost	10%	$36,200.58				$36,200.58
FOGMA on Equipment Cost	7%				$39,719.67	$39,719.67
SUBTOTAL DIRECT COST		$398,206.42	$1,289,665.39	$1,196,779.74	$607,143.58	$3,491,795.13

INDIRECT COSTS

Indirect Cost Based on Total Direct Cost	30%	$119,461.93	$386,899.62	$359,033.92	$182,143.07	$1,047,538.54
Profit Margin on Total Direct Cost	10%	$39,820.64	$128,966.54	$119,677.97	$60,714.36	$349,179.51
SUBTOTAL INDIRECT COST		$159,282.57	$515,866.15	$478,711.89	$242,857.43	$1,396,718.05
TOTAL DIRECT AND INDIRECT COST		$557,488.99	$1,805,531.54	$1,675,491.63	$850,001.01	$4,888,513.18

CONTINGENCY AND ADMINISTRATIVE COSTS

Project Contingency on Project Cost	20%					$977,702.64
Contract Administration on Total Project Cost	5%					$244,425.66
Engineering on Total Project Cost	5%					$244,425.66
Health and Safety on Total Project Cost	2%					$97,770.26

TOTAL PROJECT CAPITAL COST	**$6,452,837.40**
TOTAL OPERATION AND MAINTENANCE COST - PRESENT WORTH	**$322,468.40**
TOTAL COST FOR ALTERNATIVE 2a	**$6,775,305.80**

APPENDIX C

APRIL 2001 SEDIMENT SAMPLING

WORK PLAN ADDENDUM 3
RCRA FACILITY INVESTIGATION/
REMEDIAL INVESTIGATION WORK PLAN
FOR SITE/SWMU 1 – INCINERATOR LANDFILL
MCRD PARRIS ISLAND, SOUTH CAROLINA

OBJECTIVE: The objective of this addendum is to identify field work needed to better delineate the extent of chemicals of potential concern in sediments at Site/SWMU 1 (Site 1).

BACKGROUND: The original sampling event in 1998 and a supplemental sampling event in 1999 were intended to determine whether Site chemicals have adversely impacted adjacent sediments. Based on an evaluation of this sediment data, metals consistent with landfilling operations were detected at concentrations exceeding potential human health and ecological screening levels in the adjacent sediments.

In addition, pesticides and polynuclear aromatic hydrocarbons (PAHs) were detected in the sediments at concentrations that exceed human health and/or ecological screening values. These chemicals may be associated with Site 1 waste disposal activities. However, based on the prevalence of these chemicals throughout the area, some may also be associated with commercial application of the chemicals for beneficial use at the facility or may not be site related.

The Remedial Investigation/RCRA Facility Investigation for the site is complete. The Feasibility Study/Corrective Measures Study for the Site is currently in progress. Based on an initial evaluation of the sediment analytical data relative to potential remediation goals, the extent of sediment to be excavated varies from approximately 4,600 cubic yards to 21,000 cubic yards. The proposed sampling will be conducted to refine the estimate of sediment to be excavated and/or otherwise addressed. The number of samples and location-specific analysis were agreed to during the February 2001 MCRD Parris Island Partnering Team meeting.

SAMPLING PLAN: To address the objectives described above, nine sediment samples will be collected in April 2001. A summary of the proposed testing rationale and analytes are presented in Tables C-1, C-2, and C-3. The proposed sample locations are presented in Figure C-1. Location-specific discussion is presented below.

On the western edge of the site, two sediment samples (PAI-01-SD-001 and -009) collected in 1998 were found to contain copper, lead, mercury, PAHs, and pesticides at concentrations greater than background/typical facility concentrations and ecological and/or human health screening values. These

values represent potential preliminary remediation goals for this Site. The two sediment samples were collected from approximately 5 to 10 feet away from exposed ash that is representative of the Site waste. In 1999, two additional sediment samples (PAI-01-SD-013 and -014) were collected approximately 300 feet west of the Site and the 1998 sample locations. Chemicals found in these remote samples did not exceed the potential preliminary remediation goals for the site. A small tidal stream running northeast/southwest is located approximately 30 to 100 feet from the edge of the exposed ash and contaminated sediment sample locations and represents a potential barrier to contaminant migration to the west.

To evaluate this western area, three sediment samples will be collected to the west of the landfill (PAI-01-SD-018, -019, and -020). The samples will be analyzed for copper, lead, mercury, PAHs, pesticides, and total organic carbon (TOC). To test the hypothesis that the small tidal stream represents a potential barrier to contaminant migration, one proposed sediment sample location will be east of this small tidal stream (PAI-01-SD-018) and two of the proposed sediment samples will be located west of this small tidal stream (PAI-01-SD-019 and -020), see Figure C-1. Based on these results, sediment excavation to the west of the Site will likely be limited to either the small tidal stream or to the PAI-01-SD-013/014 locations.

Approximately 100 to 200 feet the north of the Site, arsenic was detected in two sediment samples at concentrations of 12.6 and 15.6 milligrams per kilogram (mg/kg) (PAI-01-SD-010 and -015). These detected values are similar to the facility background concentration of 12 mg/kg and represent only minor exceedances of the human health and ecological screening values. Elevated arsenic concentrations were not detected in sediment samples closer to the Site or in other sediment samples located around the Site. In addition, these two sediment locations did not exhibit exceedances of other Site-related metals and potentially Site-related pesticides and PAHs. Because of the minor exceedances, the remote area, and the lack of Site-related contaminants, this area will likely be targeted for land use controls. However, to support this position, two additional sediment samples (PAI-01-SD-021 and -022) will be collected in the area to better define the magnitude and extent of the arsenic detections, see Figure C-1. These samples will be analyzed for arsenic.

On the eastern edge of the site, three sediment samples (PAI-01-SD-003, -011, and -017) were found to contain PAHs and metals at concentrations greater than background and ecological and/or human health screening values. Two of the sediment samples (PAI-01-SD-003 and -011) were collected approximately 5 to 10 feet away from exposed ash that is representative of the Site waste. In 1999, one sediment sample (PAI-01-SD-017) was collected at a distance of approximately 300 feet from the Site and the near Site sample locations. PAHs found in the distant sample (PAI-01-SD-017) were at higher concentrations than found in the samples adjacent to this site. A relatively large tidal stream located east of sediment sample PAI-01-SD-017 represents a south and eastern boundary to the extent of sediment contamination.

In 1998, 1999, and early 2000, debris was observed near sediment sample PAI-01-SD-017. The debris appeared to be creosote-type treated poles and lumber that would be a likely source of the PAH contamination detected in Site sediments. In February 2001, debris area in this area was not present, but additional similar debris was observed on the edge of the Site. Based on visual evidence, it is likely that most of the debris previously observed in the marsh had washed onto the edge of the Site. Regardless of the location of the debris, this area still represents a potential area of concern for PAHs. As agreed to during the partnering team meeting, four sediment samples (PAI-01-SD-023, -024, -025, and -026) will be collected in this area to better define the extent and magnitude of PAH contamination. The samples will be analyzed for PAHs, copper, lead, mercury, and TOC.

Specific addenda to tables in the Work Plan are attached and include the following:

Table C-1 - Investigation Rationale, Addendum 3
Table C-2 - Investigation Summary, Addendum 3
Table C-3 - Summary of Environmental Sampling, Addendum 3

All other aspects of the Work Plan will be followed. QA/QC samples will not be collected as part of this field work.

TABLE C-1

INVESTIGATION RATIONALE, ADDENDUM 3
SITE/SWMU 1 – INCINERATOR LANDFILL
MCRD PARRIS ISLAND

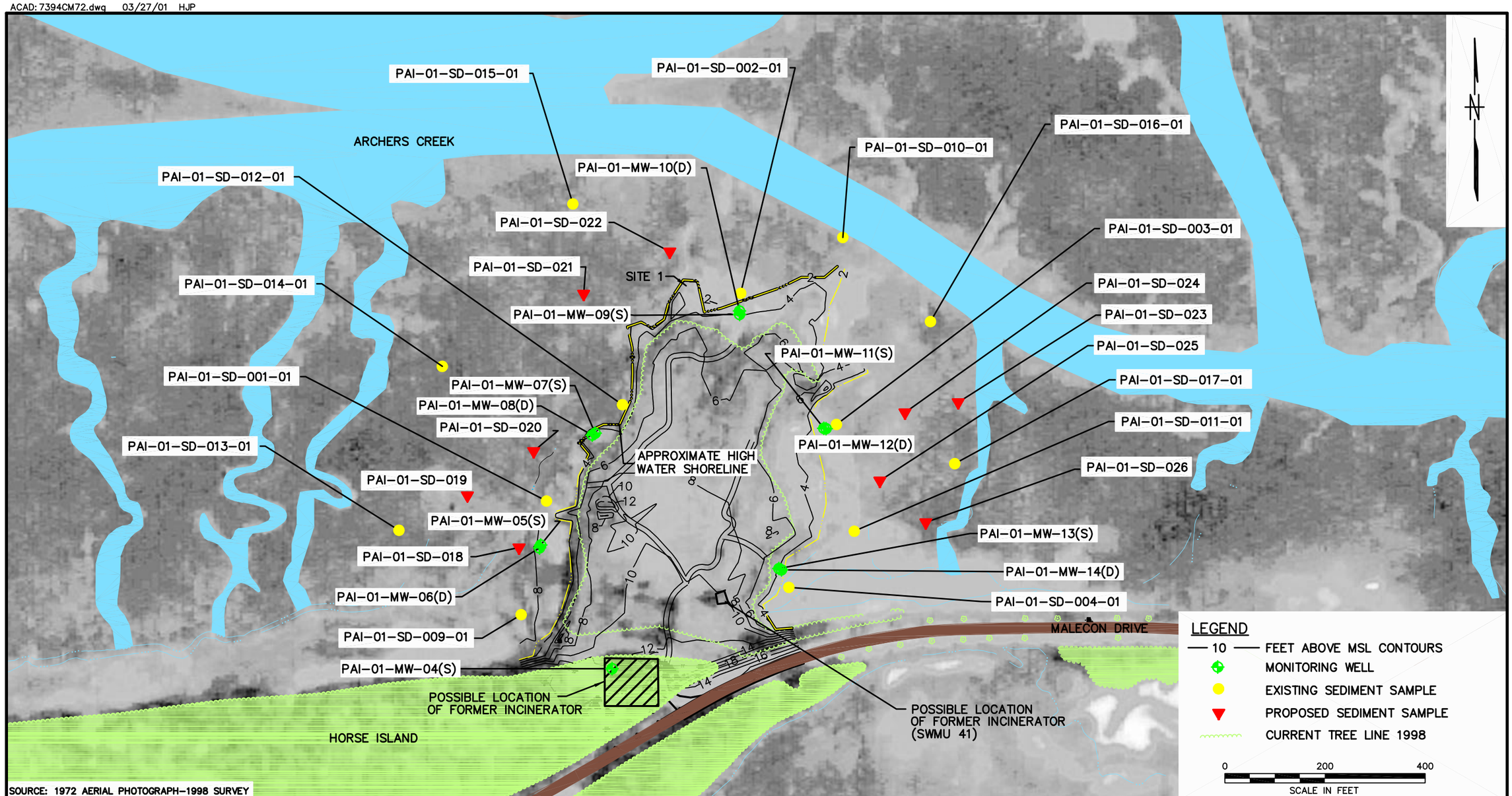
Media	Identified/Suspected Contaminants	Preliminary Assessment	Data Gaps/Needs	Resolution of Data Gaps/Needs
Sediment	PAHs, pesticides, copper, lead, and mercury	Data indicate that these compounds may have migrated from the fill into the adjacent sediment.	• Further define the western extent of potential sediment contamination.	• PAHs, pesticides copper, lead, mercury, and TOC
Sediment	Arsenic	Data indicate that two minor elevated detections for arsenic were found and may be Site related.	• Further define the northern extent and magnitude of potential sediment contamination.	• Arsenic
Sediment	PAHs, copper, lead, and mercury	Data indicate that these compounds may have migrated from the fill or local debris into the adjacent sediment.	• Further define the eastern extent of potential sediment contamination.	• PAHs, copper, lead, mercury, and TOC

TABLE C-2

INVESTIGATION SUMMARY, ADDENDUM 3
SITE/SWMU 1 – INCINERATOR LANDFILL
MCRD PARRIS ISLAND

Media	Data Gaps/Needs	Investigation Activity	Number of Locations	Samples per Location	Analysis
Sediment	• Pesticides, PAHs, copper, lead, and mercury	Collect sediment samples.	3	1	Pesticides, PAHs, Copper, lead, mercury, TOC
Sediment	• Arsenic	Collect sediment samples.	2	1	Arsenic
Sediment	• PAHs, copper, lead, and mercury	Collect sediment samples.	4	1	PAHs, Copper, lead, mercury, TOC

ACAD: 7394CM72.dwg 03/27/01 HJP



SOURCE: 1972 AERIAL PHOTOGRAPH-1998 SURVEY

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 3/26/01
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

PROPOSED SUPPLEMENTAL SEDIMENT SAMPLE LOCATIONS
SITE 1-INCINERATOR LANDFILL AND SWMU 41-FORMER INCINERATOR
MCRD PARRIS ISLAND, SOUTH CAROLINA

CONTRACT NO. 7394
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE C-1
REV. 0

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

WR1395

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER 042701 | PAGE 1 OF 1

PROJECT NO: 7803a 7394

SITE NAME: Jericho Island a Site 1

PROJECT MANAGER AND PHONE NUMBER: Dave Brayack 412-921-8375

LABORATORY NAME AND CONTACT: Katahdin, Andrea Colby 207-874-2400

SAMPLERS (SIGNATURE)

FIELD OPERATIONS LEADER AND PHONE NUMBER: Jason Brown 412-921-8401

ADDRESS: 340 County Road No. 5

CARRIER/WAYBILL NUMBER: FEDEX 8216-5043-9127

CITY, STATE: Westbrook, ME 04098

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR 2001	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	TCL PAHs (8270 8310)	TCL Pesticides	Copper, Lead, Mercury	Arsenic	TOC	Pentachlorophenol			COMMENTS
CONTAINER TYPE PLASTIC (P) or GLASS (G)						G	G	G	G	G	G			
PRESERVATIVE USED						—	—	—	—	—	—			
4/26	1230	PA1-10-SS-12-02	~~Solid~~ Soil	G	1	X					X			
4/26	1150	PA1-10-SS-08-02	~~Solid~~ Soil	G	1	X								
4/26	1550	PA1-01-SD-26-01	Soil	G	3	X		X		X				
4/26	1605	PA1-01-SD-23-01	Soil	G	3	X		X		X				
4/26	1625	PA1-01-SD-25-01		G	3	X		X		X				
4/26	1615	PA1-01-SD-24-01		G	3	X		X		X				
4/26	1735	PA1-01-SD-22-01		G	1				X					
4/26	1739	PA1-01-SD-21-01		G	1				X					
4/26	1754	PA1-01-SD-20-01		G	4	X	X	X		X				
4/26	1805	PA1-01-SD-19-01		G	4	X	X	X		X				
4/26	1815	PA1-01-SD-18-01		G	4	X	X	X		X				

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY	4/27	1300	1. RECEIVED BY Shelly Hill	04-28-01	1030
2. RELINQUISHED BY			2. RECEIVED BY		
3. RELINQUISHED BY			3. RECEIVED BY		

COMMENTS: Call Dave Brayack with Questions

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

3/99
FORM NO. TtNUS-001

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: Parris Island - Site 1
Project No.: 7394

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: PAI-01-SD-018-01
Sample Location: PAI-01-SD-18
Sampled By: JJB + DDB
C.O.C. No.: 042701

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date: 4/26/01 Time: 1815 Method: Monitor Reading (ppm):	0-6"	Black/ Grey	Muck

COMPOSITE SAMPLE DATA:

Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

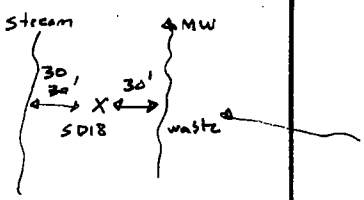
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
PAHs (TCL)	8 oz jar	✓	
TCL Pesticides	4 oz jar	✓	
Copper, lead, mercury	2 oz jar	✓	
TOC	2 oz jar w/septum	✓	

OBSERVATIONS / NOTES:

Reference:
MW13 N32°21.617
W80°42.327

SD-018: N32°21.616
W80°42.432



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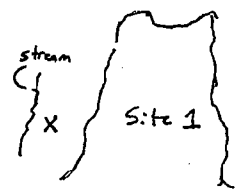


Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s): JJB DDB

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: Parris Island - Site 1
Project No.: 7394

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: PA1-01-SD-019-01
Sample Location: PA1-01-SD-19
Sampled By: JJB + DOB
C.O.C. No.: 042701

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date: 4/26/01 Time: 1805 Method: Monitor Reading (ppm):	0-6"	Black/Gray	Silty Clay /Muck

COMPOSITE SAMPLE DATA:

Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

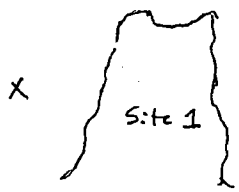
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
PAHs (TCL)	8oz jar	✓	
TCL Pesticides	4oz jar	✓	
Copper, lead, mercury	2oz jar	✓	
TOC	2oz jar w/septum	✓	

OBSERVATIONS / NOTES:

SD19 N32°21.638
W80 42.449

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s): DOB

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: Parris Island - Site 1
Project No.: 7394

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: PA1-01-SD-020-01
Sample Location: PA1-01-SD-20
Sampled By: JJB & DDB
C.O.C. No.: 042701

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date: 04/26/01 Time: 1754 Method: Monitor Reading (ppm):	0-6"	Black/ Gray	Silty Clay / Muck

COMPOSITE SAMPLE DATA:

Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

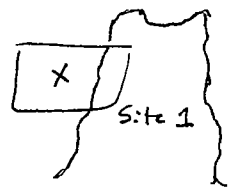
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
PAHs (TCL)	8 oz jar	✓	
TCL Pesticides	4 oz jar	✓	
Copper, lead, mercury	2 oz jar	✓	
TOC	2 oz jar/w septum	✓	

OBSERVATIONS / NOTES:

SD 20 N32°21.654 W80°42.419

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s): JJB DDB

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: Parris Island - Site 1
Project No.: 7394

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: PA1-01-SD-021-01
Sample Location: PA1-01-SD-21
Sampled By: JJB + DDB
C.O.C. No.: 042701

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date: 04/26/01 Time: 1739 Method: Monitor Reading (ppm):	0-6"	Black/Grey	Silty clay / Muck

COMPOSITE SAMPLE DATA:

Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

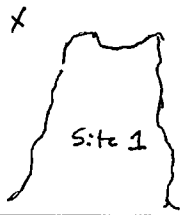
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
Arsenic	2 oz jar	✓	

OBSERVATIONS / NOTES:

SD21 N32°21.702
W80°42.395

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s): JJB DDB

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: Parris Island - Site 1
Project No.: 7394

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: PA1-01-SD-022-01
Sample Location: PA1-01-SD-22
Sampled By: JJB + DDB
C.O.C. No.: 042701

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date: 4/26/01 Time: 1735 Method: Monitor Reading (ppm):	0-6"	Grey to Black	Silty-Clay / Muck

COMPOSITE SAMPLE DATA:

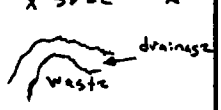
Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
Arsenic	2 oz Jar	✓	

OBSERVATIONS / NOTES:

Reference: MW05-S; N32°21.625, W80°42.418
Thick Vegetation
Very wet
Location N32°21.721
W 80°42.366



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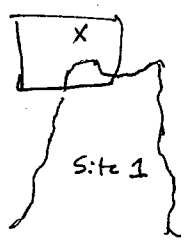


Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s): JJB DDB

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: Parris Island - Site 1
Project No.: 7394

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: PAI-01-SD-023-01
Sample Location: PAI-01-SD-23
Sampled By: JJB & DDB
C.O.C. No.: 042701

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date: 4/26/01 Time: 1605 Method: Monitor Reading (ppm):	0-6"	Gray to Black	Silty Clay

COMPOSITE SAMPLE DATA:

Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:

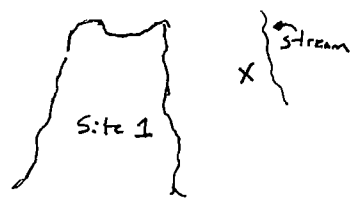
Analysis	Container Requirements	Collected	Other
TCL PAHs	8 oz jar	✓	
Copper, lead, mercury	2 oz jar	✓	
TOC	2 oz jar	✓	

OBSERVATIONS / NOTES:

Collected in Area vegetated with marsh grass

location N32°21.670
W80°42.257

MAP:



Circle If Applicable:

MS/MSD	Duplicate ID No.:

Signature(s): JJB DDB

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: Parris Island - Site 1
Project No.: 7394

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: PA1-01-SD-024-01
Sample Location: PA1-01-SD-24
Sampled By: JJB + DDD
C.O.C. No.: 042701

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date: 04/26/01 Time: 1615 Method: Monitor Reading (ppm):	0-6"	Gray to Black	Silty Clay with sand / muck Dry

COMPOSITE SAMPLE DATA:

	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date:				
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:

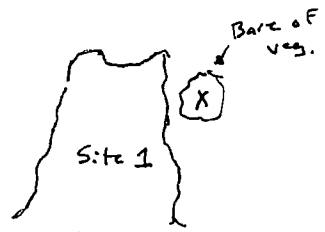
Analysis	Container Requirements	Collected	Other
TCL PAHs	8 oz jar	✓	
Copper, lead, mercury	2 oz jar	✓	
TOC	2 oz jar	✓	

OBSERVATIONS / NOTES:

Ground slightly Elevated. Area around sample bare of vegetation

location N 32°21.664
W 80°42.278

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s): JJB DDB

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: Parris Island - Site 1
Project No.: 7394

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: PA1-01-SD-025-01
Sample Location: PA1-01-SD-25
Sampled By: JJB & DDB
C.O.C. No.: 042701

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date: 4/26/01 Time: 1625 Method: Monitor Reading (ppm):	0-6"	black to gray	silty clay

COMPOSITE SAMPLE DATA:

Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

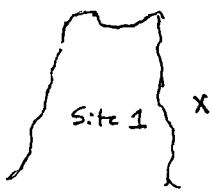
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL PAHs	8 oz jar	✓	
Copper, lead, mercury	2 oz jar	✓	
TOC	2 oz jar	✓	

OBSERVATIONS / NOTES:

Collected in Area vegetated with swamp/ grass marsh
location: N32°21.642
W 80°42.286

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s): JJB DDB

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: Parris Island - Site 1
Project No.: 7394

[] Surface Soil
[] Subsurface Soil
[X] Sediment
[] Other:
[] QA Sample Type:

Sample ID No.: PAI-01-SD-0026-01
Sample Location: PAI-01-SD-26
Sampled By: JJB + DDB
C.O.C. No.: 042701

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Date: 4/26/01 Time: 1550 Method: Monitor Reading (ppm):	0"-6"	Gray/Brown/Black	Muck

COMPOSITE SAMPLE DATA:

Date:	Time	Depth Interval	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:

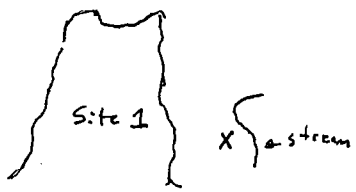
Analysis	Container Requirements	Collected	Other
TCL PAHs	8 oz jar	✓	
Copper, lead, mercury	2 oz jar	✓	
TOC	2 oz jar	✓	

OBSERVATIONS / NOTES:

Collected in area vegetated with marsh grass

Location: N 32°21.629
W 80°42.267

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:

Signature(s): JJB DDB