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DRAFT ZONE A SOLID WASTE MANAGEMENT UNIT 42/ AREA OF CONCERN 505 CORRECTIVE MEASURES STUDY REPORT CNC CHARLESTON SC

5/18/1999

ENSAFE

DRAFT ZONE A, SWMU 42/AOC 505
CORRECTIVE MEASURES STUDY REPORT
CHARLESTON NAVAL COMPLEX
CHARLESTON, SOUTH CAROLINA

CTO-029

Contract Number: N62467-89-D-0318

Prepared for:

Department of the Navy
Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina

Prepared by:

EnSafe Inc.
5724 Summer Trees Drive
Memphis, Tennessee 38134
(901) 372-7962

May 18, 1999

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The Contractor, EnSafe Inc., hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-89-D-0318 is complete, accurate, and complies with all requirements of the contract.

Date:	May 18, 1999
Signature:	
Name:	Lawson Anderson
Title:	Task Order Manager

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Dodds, David P

From: Dodds, David P
Sent: Friday, June 25, 1999 4:55 PM
To: Larry (E-mail); Thaverkost (E-mail)
Cc: Hunt, M A (Tony)
Subject: SWMU 42/505 CMS Report Navy comments

General Comments:
1) In the future I expect that a more detailed QA review of the document will take place before it is sent to me for signature.
2) Based on the RFI Conditional approval letter from DHEC, this report or an RFI Addendum letter/report needs to resolve the fate and transport question for BEQ, antimony, arsenic and thallium and provide results for well sampling for PCBs. DHEC's letter also refers to "GRID-BASED SAMPLES" with ARs and BEQ as issues. Since these need to be covered by some Zone A CMS report to reach closure I recommend including them here. The COCs appear identical. Is this practical?

3) Also, The last round of comments I have on the CMS Workplan states that we will include groundwater flow maps. This would be relevant for showing that the current extent of the plume from SWMU 39 is not in the area of SWMU 42/505.
4) Why is Hazard Quotient not a contributor to the CMS?

Specific Comments:

1) Page 1-1. The second paragraph refers to the Zone H RFI instead of Zone H. The same goes for Page 1-2, Section 3 bullet
2) Page 2-3. Beryllium and Lead should be included as COCs in this discussion since it refers to the RFI and were COCs until the next paragraph for Lead and section 3. for Beryllium.
3) Section 2.3.1 Where any of these soil samples post-RFI? If so, the data sheets, validation reports, and all supporting data normally presented in the RFI needs to be included in this document. This will be the regulators first view at this data and we can expect the requirements of data presentation to be identical to that of the RFI. This goes the same for Groundwater data. Section 2.3 should acknowledge this additional data and refer readers to the appendices.
4) Section 2.3.1 Please add a paragraph at the end of this section to wrap up the resulting residential and industrial SR and HQ and the compounds identified as COCs. With respect to that I recommend writing off Beryllium here versus waiting until Section 3.
5) Section 2.3.2 should include text identifying sampling events post RFI and identify which wells were added post RFI. Assuming multiple rounds were taken, these should be presented. Also, it is not clear in this report whether any of the sample points were removed by the DET action and therefore should not be considered in the remainder of the report. Please clarify which samples if any fall in this category and eliminate them from the remainder of the report.
6) Table 2.1 Notes should be a capital A if referring to BEQ background.
7) Page 2-10, Section 2.3.2 Groundwater. Please add a discussion acknowledging that adjacent site SWMU 39 does have groundwater contamination issues which are still under investigation and will be presented in the upcoming CMS Report for SWMU 39.
8) Section 2.3.3 and 2.3.4 We need to be clearer here that these media were found not to be a concern during the RFI and that the Ecological Risk Assessment for this area of the base concluded that no further action was necessary for the sites with regard to ecological risk.
9) I request that you add a section 2.3.5 Risk Summary, which wraps up the media to be considered in the CMS Report. Similar to "Based on the RFI and additional sampling presented in this report the following media are addressed by the CMS report:
Soil - Site Risk (5X 10-5), Hazard Quotient=3.1, COC = Ars, BEQ
etc.

10) Page 3-1, Section 3.2. I do not see where Table 2.2 shows that COCs were not detected in two rounds of sampling. It appears to show only one round with not reference to past rounds. I suggest revising the table to show all rounds of sampling with results as a better demonstration. Again, any data taken POST RFI must be fully presented with the detail of RFI data and supporting lab documentation, custody forms, etc.
11) Page 3-3, top of page, Section 3.3.1. We need to refer to where the reader can find the method for risk calculation used to get these numbers, a specific RFI reference. Otherwise, how will the reader know the method defaults we used? We should also, state that the background risk levels were done using the same method.
12) Section 3.3.1 Also, this section is our first opportunity to begin to discuss the concept of risk above background.

This is relevant because we have heard that DHEC will question all sites with risk greater than 1x10-6. We may have to discuss this as an overall issue with Todd. I order to get buyin on cleaning up to these risk levels we are going to have to have buyin on the background numbers and the risk calculations. I am assuming these have been bought off in a previous document. We should make a clear reference to that for the new DHEC (and myself). Also, there is a typo in the last paragraph of section 3.3.1 - 5th line down should be 3.2E-05 vs. -06.

13) Table 3.1 I suggest inserting the Combined background and inorganic background in the rows to show which points could be removed to meet those goals based on worst-first.

14) Table 3.2 is the first real presentation of Hazard resulting from the Arsenic on the site. The rest of the document covers risk but does not cover hazard. We need to include both in our discussions since the Arsenic results create an unacceptable Hazard. Also, discussion of industrial risk seems to be dropped here. It should at least be covered in sections referring to ICs.

15) Section 4. Please lighten the shading of Table 4.1, it is hard to read. Also, Please add as a last page to section 4, a wrap up which summarizes which alternatives were kept for further consideration. One paragraph or bullets will do.

16) Section 5. While capping apparently survived Section 4, it was not evaluated in Section 5, what happened?

17) Section 5 general comment. All of Section 5 appears to neglect the fact that there is a hazard quotient over 1 at the site based on Table 3.2. How is that possible?

18) Section 5.2.1. Since HQ>1 the site has risk above acceptable levels so this section should be revised to reflect this.

19) Section 5.2.2 This also needs to be revised for HQ>1. Also, a discussion is needed to compare industrial/commercial risk which are more appropriate when ICs are involved.

20) What happened to the capping alternative?

21) The tables should be in the following order. Tables 5.2, 5.3, and 5.4 should be before Figure 5.1, since they are mentioned in the text first.

22) Page 5-23, Section 5.2.4.1. Please revise this paragraph to reflect that only soil contaminated with risk above the inorganic background levels would be removed and that soil would remain above the background organic range. Risk would be above background organic COCs.

23) General: Does this report include sampling results from the Zone L RFI Report. They should and this should be clearly shown/discussed.

24) Figure 5.2 shows excavation in the marsh. What is this based on? Have Ecological concerns been adequately addressed in the RFI? Does this CMS include remediation for Eco concerns?

25) I question all of the alternative evaluation sections conclusions on acceptable risk because it looks as though hazard was not considered. Please clarify?

26) Table 5.9 Because there is a HQ>1 at the site the NFA alternative should have a score of 0 for Protection of HH/E and Attainment of cleanup stds. Also, the comment section of the table should reflect the HQ exceedence. The acceptable risk range is not relevant under these conditions. Same for other tables.

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LETTER OF TRANSMITTAL

DATE 5-21-99 | JOB NO. 2901-001-14000 / 2908-001-14000

ATTENTION

RE

TO David Dodds
NAVFACENGCOM
Charleston SC

WE ARE SENDING YOU ☐ Attached ☐ Under separate cover via ________ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications

☐ Copy of letter ☐ Change order ☐ ________

COPIES	DATE	NO.	DESCRIPTION
1	5/21/99		DRAFT Zone A, SWMU 42/AOC 505 CMS Report
1	5/21/99		Zone H Combined 14 CMS Report

THESE ARE TRANSMITTED as checked below:

☐ For approval ☐ Approved as submitted ☐ Resubmit ____ copies for approval

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☐ FOR BIDS DUE ________ 19____ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS Please prepare distribution letter and have the Signature page signed.

Thank you

Carol L Henson

COPY TO ________

SIGNED: Diane M Maddux

1.0 INTRODUCTION

Purpose and Organization of Report

This Corrective Measures Study (CMS) identifies, screens, develops, evaluates, and compares remedial action alternatives to mitigate hazards and threats to human health and the environment from soil and groundwater contamination at Solid Waste Management Unit (SWMU) 42 and Area of Concern (AOC) 505 at the Charleston Naval Complex (CNC), Charleston, South Carolina.

The CMS is being performed under the Resource Conservation and Recovery Act of 1976 (RCRA), based on findings reported in the *Zone H RCRA Facility Investigation Report, NAVBASE Charleston, North Charleston, South Carolina* (EnSafe, 1998). As required by RCRA, the CNC Restoration Advisory Board (RAB) provides a focus for community input to the remedial decision making process. The RAB, which regularly holds open public meetings, consists of community members, regulators, Navy Southern Division (SOUTHDIV) representatives, and other CNC project team representatives.

When the CMS is complete, a Statement of Basis (SOB) that documents the CMS process and presents the preferred site alternatives will be made available for public comment to ensure that decision makers are aware of public concerns. The selection of the final remedy for the site could be affected by public input. The primary CNC decision makers include SOUTHDIV, the South Carolina Department of Health and Environmental Control (SCDHEC), and the United States Environmental Protection Agency (USEPA).

This CMS report has been organized according to the format in the Office of Solid Waste and Emergency Response (OSWER) Directive 9902.3-2A, *RCRA Corrective Action Plan* (Final, May 1994):

- **Section 1, Introduction:** This section presents the report's purpose and summarizes the project.

- **Section 2, Site Description:** This section presents SWMU 42/AOC 505 history and background and the results of previous investigations, including the RCRA Facility Investigation (RFI), baseline risk assessment (BRA), interim stabilization measures (ISM) performed by the Navy Environmental Detachment (DET), and supplemental CMS sampling.

- **Section 3, Remedial Objectives:** To improve the CMS's focus, this section summarizes the contaminants of concern (COCs) to be directly addressed by this CMS and their remedial objectives. In some cases, this section justifies the inclusion or removal COCs identified in the RFI based on the compound's contribution or lack thereof to significant risks, hazards, or other regulatory standards applicable to this site. In other cases, remedial objectives have been modified in response to calculated Zone H background risk and hazard.

- **Section 4, Identification and Screening of Technologies:** This section outlines response actions and identifies and screens remedial technologies that may be used to achieve remedial action objectives.

- **Section 5, Development and Evaluation of Alternatives:** This section evaluates potential remedial alternatives according to the nine evaluation criteria identified in OSWER Directive 9902.3-2A, *RCRA Corrective Action Plan* (Final, May 1994), presenting strengths and weaknesses to prioritize or rank them relative to the nine evaluation criteria.

- **Section 6, Recommendations:** This section assesses the relative performance of the alternatives and presents recommendations.

- **Section 7, Public Involvement Plan:** This section summarizes the public involvement plan as it relates to the CMS.

- **Section 8, References:** This section lists applicable references used to prepare the CMS.

- **Section 9, Signatory Requirement:** This section provides the applicable signatory requirements for the CMS.

2.0 SITE DESCRIPTION

2.1 General

SWMU 42 and AOC 505 are overlapping sites in the southwest portion of Zone A of the CNC. A wetland area is west of the sites, Noisette Creek is south, and a former railroad storage yard surrounding former Building 1614 is to the north. The east side of the sites is along an inactive railroad spur, which divides an open area to the Noisette Creek bridge on Avenue D. Figure 2.1, Site Map, shows site features and RFI monitoring well locations.

SWMU 42 is the site of a former asphalt plant and associated tanks. The plant operated from 1947 until 1962 and has been demolished. AOC 505 is the former golf course maintenance shop (Building 1803) and an area used to store creosote cross-ties and railroad ballasts during the 1960s and 1970s. Operations in this area were discontinued in the 1970s.

Current and Future Use

The site is not currently in use. According to the Charleston Naval Complex Redevelopment Authority, this area could be redeveloped for residential or industrial purposes.

2.2 Interim Stabilization Measures

The Navy DET completed the removal of approximately 5.4 cubic yards of lead-impacted soil near RFI soil borings 505SB005 and 042SB009. Confirmation sample results presented in the DET's *Completion Report Interim Measure for SWMU 42 Asphalt Plant Tanks* (July 17, 1997), did not indicate lead concentrations exceeding the 400 milligrams per kilogram (mg/kg) residential cleanup goal. The excavated area was backfilled with clean soil.

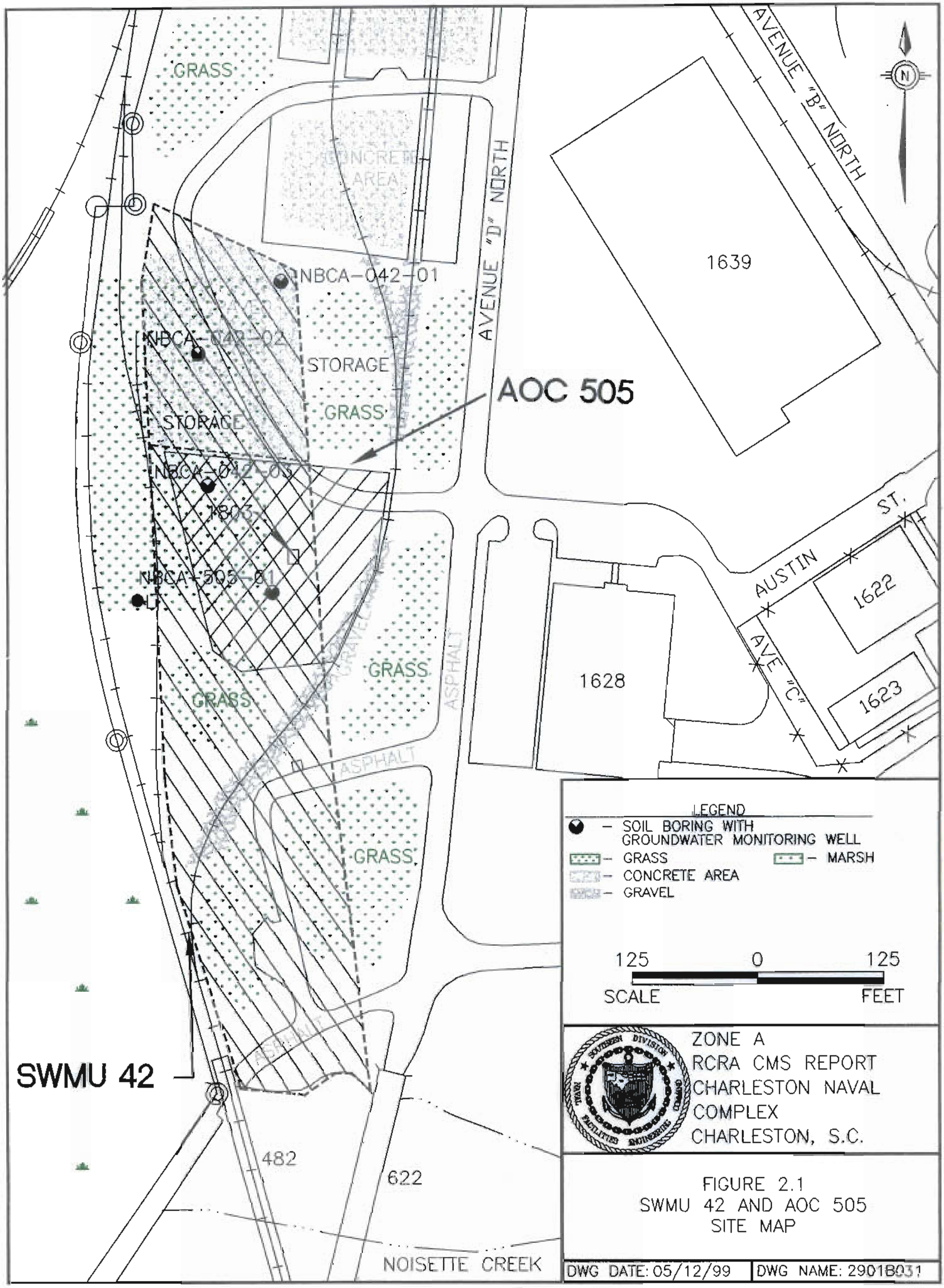


FIGURE 2.1
SWMU 42 AND AOC 505
SITE MAP

2.3 RFI/CMS Sampling Results

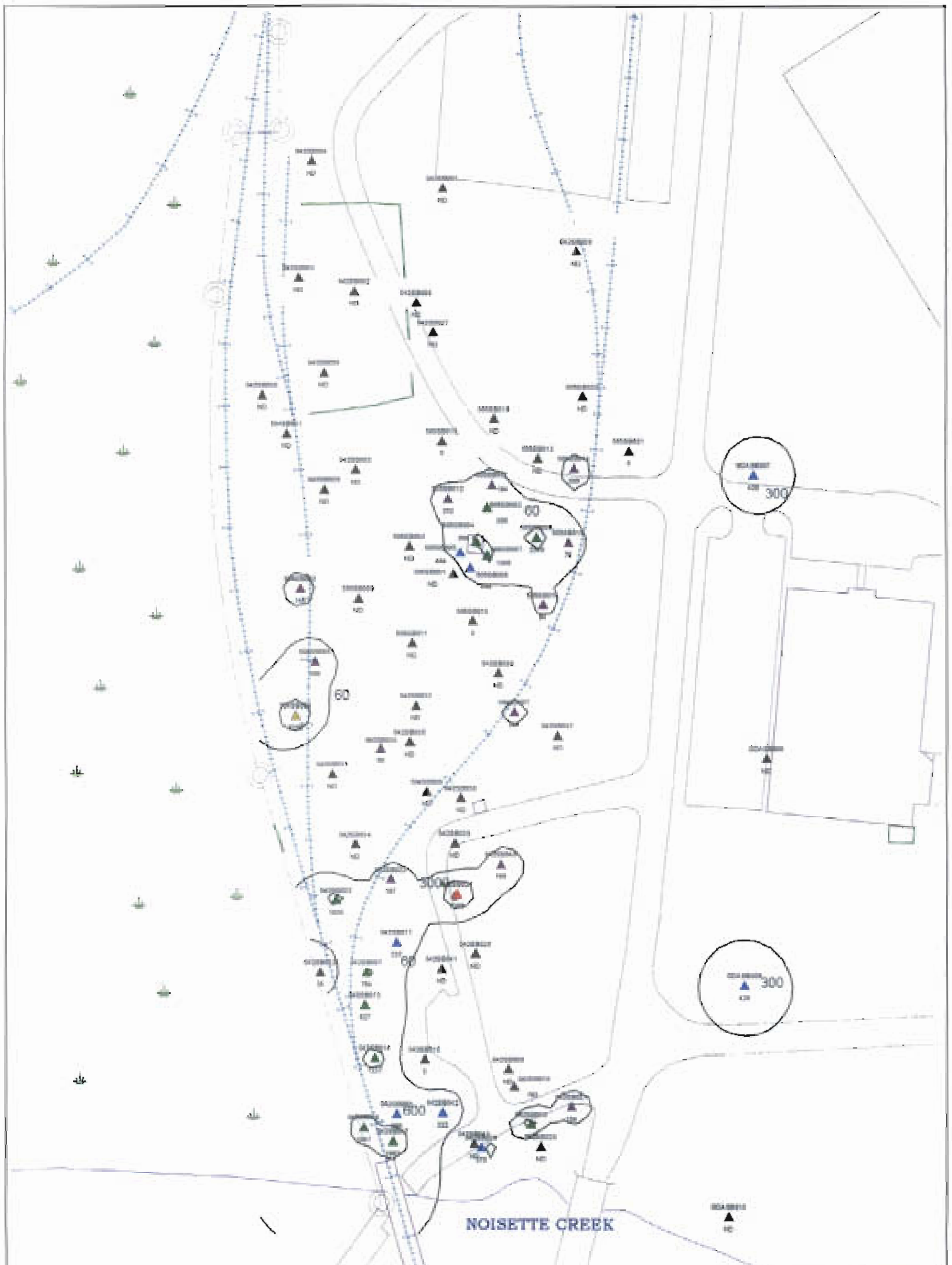
2.3.1 Soil

SWMU 42/AOC 505 soil was sampled in three rounds during the RFI. The first round included 21 surface soil samples and 17 subsurface samples. Subsurface samples were not collected from four locations where groundwater was encountered. First round samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, cyanide, pesticides, herbicides, and polychlorinated biphenyls (PCBs). Seventeen additional borings were sampled during the second round. SWMU 42 surface and subsurface soil was sampled in 11 locations for benzo(a)pyrene equivalents (BEQs) and metals. AOC 505 soil was sampled in six locations for SVOCs, pesticides, and PCBs. Three surface soil samples were also collected during the second round from the geoprobe interval and analyzed in the on-site laboratory for VOCs. The third sampling round included the collection of eight surface and two subsurface samples for SVOC analysis. Analytical results for BEQs and arsenic are presented in Table 2.1 and Figures 2.2 and 2.3. These contaminants exceeded screening values and were identified as chemicals of concern (COCs) based on the RFI results.

When the ISM for lead-impacted soil was completed (1997), the DET collected confirmation surface soil samples from the excavated areas' bottom and walls. The lead concentrations for the 10 confirmation samples were less than 400 mg/kg, the EPA residential reuse threshold for lead. These results are presented in Table 2.1.

2.3.2 Groundwater

Four shallow monitoring wells installed in SWMU 42/AOC 505 were sampled for VOCs, SVOCs, metals, cyanide, herbicides, and PCBs. Based on the presence of chlorinated compounds in the first-round samples, a Geoprobe investigation was conducted to further delineate the presence of VOCs in groundwater. It is thought that this VOC contamination is from nearby SWMU 39 and not the result of SWMU 42/AOC 505 site operations. Five shallow and two deep Geoprobe



LEGEND

BUILDING
BOUNDARY
FENCE
ROAD
RR
WATER

ENSAFE

N

50 0 50 Feet

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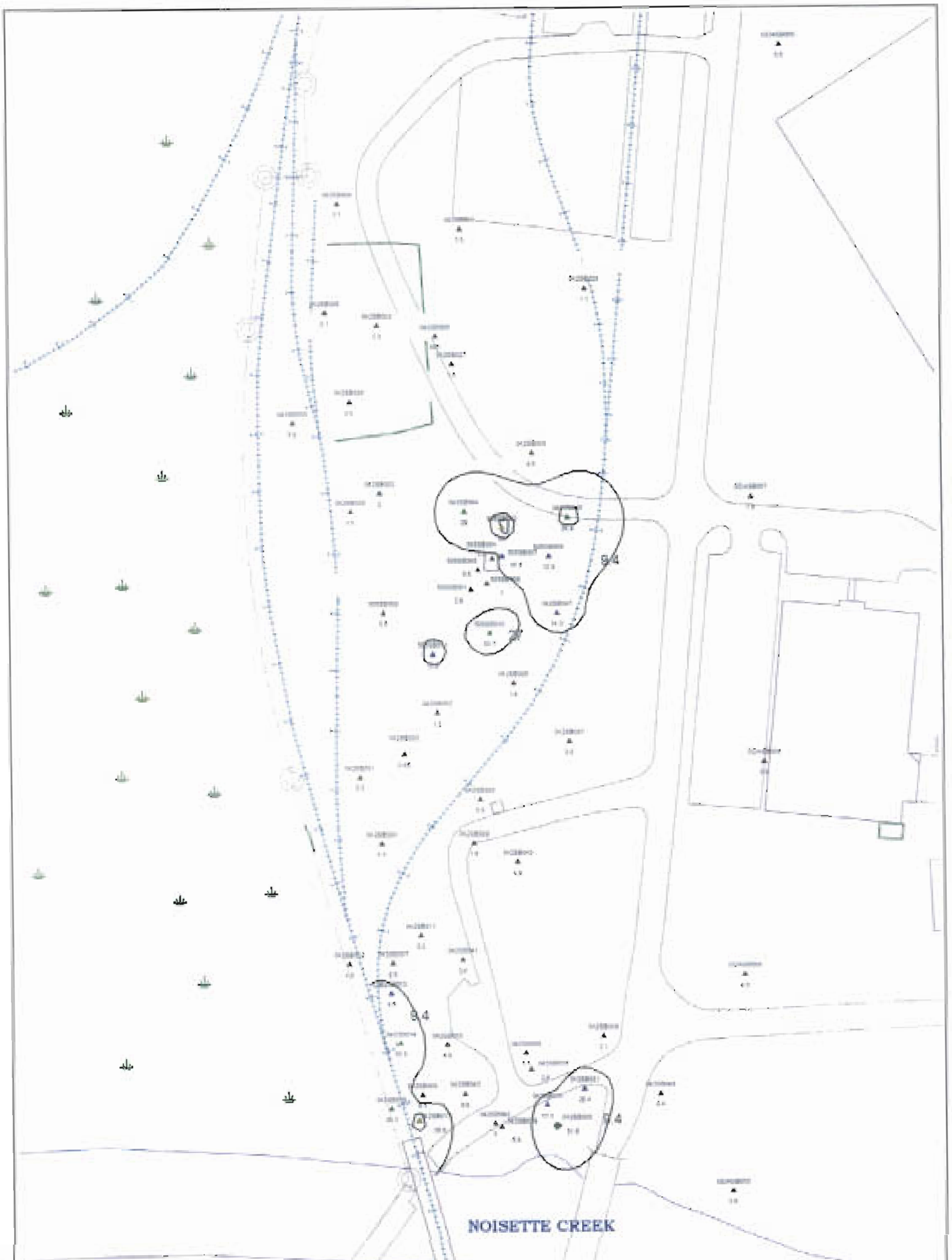
Figure 2.2
BEQs in Upper Interval Surface Soils

g:/projects/charlstn/zone a/big_beq_a

May 3, 1999



LEGEND

ARSENIC (mg/kg)

- 0 - 9.4 (Below Background)
- 9.41 - 27 (> 1E-05 Industrial Risk)
- 27.01 - 38 (< 1E-04 Residential Risk)
- 38.01 - 270 (< 1E-04 Industrial Risk, > 1E-04 Residential Risk)
- 270.01 - 100000 (> 1E-04 Industrial Risk)

BUILDING
BOUNDARY
FENCE
ROAD
RR
WATER

N

SWMU 42/ AOC 505
CMS REPORT
CHARLESTON NAVAL COMPLEX
Charleston, SC

60 0 60 Feet

Figure 2.3
Arsenic in Upper Interval Surface Soil

ENSAFE | g:/projects/charlstn/zone a/big_as_a | May 3, 1999

Table 2.1
Surface Soil Data For COCs at SWMU 42/AOC 505

Sample Number	Arsenic (mg/kg)	Benzo (A) Pyrene Equivalents (μg/kg)	Beryllium (mg/kg)	Lead (mg/kg)
RBC or Remedial Goal	**0.43**		**160**[F]	**400**
Background	**9.44**	**590**[A]	**NA**	**140**
042-S-B001	1.5 J	ND	ND	14.4
042-S-B002	2.3	ND	0.27 J	4.2
042-S-B003	2 J	ND	0.37 J	9.4
042-S-B004	1.8 J	ND	ND	11.3 J
042-C-B004	2.4	ND	ND	17
042-S-B005	2.1 J	ND	ND	30.7
042-S-B006	ND	ND	ND	23
042-S-B007	5.5	753.51	ND	96
042-S-B008	1.1 J	ND	ND	7.1
042-S-B009	This sample location was removed during the DET's ISM.			
042-S-B010	12.3	1887.4	0.38 J	339
042-S-B011	3.2	537.2	0.19 J	162
042-S-B012	4.8	15.086	0.28	7.2
042-S-B013	9.5	626.81	0.19 J	167
042-S-B014	30.3	1227.2	0.27	173
042-S-B015	4.9	4.5	0.18 J	28.1
042-C-B015	4.2	ND	0.14 J	
042-S-B016	28.2	1067.08	0.17 J	39.2
042-S-B017	38.6	1882.95	0.23 J	86.5
042-S-B018	2.6	ND	0.13 J	44
042-S-B019	6.3	374.74	0.17 J	128
042-S-B020	31.6	ND	0.09 J	153
042-S-B021	25.4	124.051	0.13 J	34.4

Table 2.1
Surface Soil Data For COCs at SWMU 42/AOC 505

Sample Number	Arsenic (mg/kg)	Benzo (A) Pyrene Equivalents (μg/kg)	Beryllium (mg/kg)	Lead (mg/kg)
RBC or Remedial Goal	**0.43**		**160[B]**	**400**
Background	**9.44**	**590[A]**	**NA**	**140**
042-S-B022	NS	1019.84	NS	NS
042-S-B023	NS	360.645	NS	NS
042-S-B024	NS	7389.1	NS	NS
042-S-B025	NS	ND	NS	NS
042-S-B026	0.9J	ND	0.1 J	NS
042-S-B027	1.4	ND	0.11 J	NS
042-S-B028	1.1	ND	0.08 J	NS
042-S-B029	3.5	ND	0.17 J	NS
042-S-B030	3.8	ND	0.12 J	NS
042-S-B031	5.3	ND	0.25 J	NS
042-S-B032	0.62 J	ND	0.14 J	NS
042-C-B032	1.9	ND	0.35 J	NS
042-S-B033	0.65 J	88	0.14 J	NS
042-S-B034	4.4	ND	0.24 J	NS
042-S-B035	2.8	ND	0.22 J	NS
042-S-B036	1.4	ND	0.21 J	NS
042-S-B037	3.3	ND	0.12 J	NS
042-S-B038	2.9	ND	0.27 J	NS
042-S-B039	1.8	ND	0.25 J	NS
042-S-B040	4.8 J	199	0.57	NS
042-S-B041	2.4	ND	0.16 J	NS
042-S-B042	8.6	322	0.2 J	NS
042-S-B043	3	ND	0.17 J	NS

Table 2.1
Surface Soil Data For COCs at SWMU 42/AOC 505

Sample Number	Arsenic (mg/kg)	Benzo (A) Pyrene Equivalents (μg/kg)	Beryllium (mg/kg)	Lead (mg/kg)
RBC or Remedial Goal	0.43		160[B]	400
Background	9.44	590[A]	NA	140
042-S-B044	28	NS	NS	NS
042-S-B045	4.5	NS	NS	NS
042-S-B046	36.9	NS	NS	NS
042-S-B047	14.3	NS	NS	NS
042-S-B048	2.1	NS	NS	NS
042-S-B049	4.6	NS	NS	NS
042-S-BC01	NS	NS	NS	61.5
042-S-BC02	NS	NS	NS	48.7
042-S-BC03	NS	NS	NS	323
042-S-BC04	NS	NS	NS	163
505-S-B001	2.9	ND	ND	5.9
505-S-B002	62	698.42	ND	73.5
505-S-B003	3.3	ND	ND	43.6
505-S-B004	6.6	995.87	ND	125
505-S-B005*	This sample location was removed during the DET's ISM.			
505-S-B006	7	448.35	ND	26
505-S-B007	18.2	1365.9	ND	94.9
505-S-B008	12.9	2348.8	ND	195
505-S-B009	3.6	ND	ND	15.4
505-S-B010	33.1	0.15	ND	26.5
505-S-B011	10.3	ND	ND	6.1
505-S-B012	NS	251.81	NS	NS
505-S-B013	NS	ND	NS	NS

Table 2.1
Surface Soil Data For COCs at SWMU 42/AOC 505

Sample Number	Arsenic (mg/kg)	Benzo (A) Pyrene Equivalents (μg/kg)	Beryllium (mg/kg)	Lead (mg/kg)
RBC or Remedial Goal	**0.43**		**160[a]**	**400**
Background	**9.44**	**590[A]**	**NA**	**140**
505-S-B014	NS	267.97	NS	NS
505-S-B015	NS	74.635	NS	NS
505-S-B016	NS	84.096	NS	NS
505-S-B017	NS	184.35	NS	NS
505-S-B018	NS	0.12	NS	NS
505-S-B019	NS	ND	NS	NS
505-S-B020	NS	ND	NS	NS
505-S-B021	NS	0.12	NS	NS
DET 01	NS	NS	NS	89.3
DET 02	NS	NS	NS	22
DET 03	NS	NS	NS	63.1
DET 04	NS	NS	NS	76
DET05	NS	NS	NS	125
DET06	NS	NS	NS	160
DET07	NS	NS	NS	121
DET08	NS	NS	NS	66.7
DET09	NS	NS	NS	98.1
DET010	NS	NS	NS	145

Notes:
NA — Not Applicable
ND — Not Detected
NS — Sample Not Analyzed
D — Diluted Result
J — Estimated Value
DJ — Diluted Result/Estimated Value
a — Risk-based remedial goal developed during the ISM
b — RBC

groundwater samples were collected. Results were nondetect for VOCs in these samples except for one duplicate which contained 2.6 micrograms per kilogram (μg/kg) toluene. Although VOCs were not detected in fourth-round samples, an additional round of sampling was conducted at the four monitoring wells. These samples were also nondetect for VOCs. An additional sample from well 505GW001was also nondetect for pesticides and PCBs, except for methoxychlor (0.15 μg/L) which was well below its maximum contaminant level (MCL) of 40 micrograms per liter (μg/L). The results of groundwater monitoring at SWMU 42/AOC 505 are presented in Table 2.2.

2.3.3 Sediment

Sediment has not been sampled at SWMU 42/AOC 505.

2.3.4 Surface Water

Surface water has not been sampled at SWMU 42/AOC 505.

Table 2.2
Groundwater Data For COCs at SWMU 42/AOC 505

Sample Number	Aluminum (μg/l)	Arsenic (μg/l)	Chromium (μg/l)	Silver (μg/l)	Vanadium (μg/l)	PCE (μg/l)	1,1,2,2,-TCA (μg/l)	1,1,-DCE (μg/l)	Manganese (μg/l)
MCL or RBC	**37,000[b]**	**50[a]**	**100[a]**	**180[b]**	**260[b]**	**5.0[a]**	**0.053[b]**	**7.0[a]**	**730[b]**
Background	**3,210**	**7.4**	**8.7**	**ND**	**5.4**	**NA**	**NA**	**NA**	**577**
042-G-W001-01	649	ND	ND	ND	ND	5.9	ND	ND	353
042-G-W001-02	1,230	ND	ND	ND	ND	1.5 J	ND	ND	306
042-G-W001-03	477	ND	ND	ND	ND	1.4 J	ND	ND	313
042-G-W001-04	364	ND	ND	ND	ND	ND	ND	ND	218
042-G-W001-C1	ND	ND	ND	ND	ND	ND	ND	ND	318 J
042-G-W002-01	2,020	ND	4.9 J	ND	ND	ND	ND	ND	827
042-G-W002-02	ND	ND	ND	ND	ND	ND	ND	ND	690
042-G-W002-03	77 J	ND	ND	ND	ND	ND	ND	ND	656
042-G-W002-04	ND	2.9 J	ND	ND	ND	ND	ND	ND	533
042-G-W002-C1	209	ND	ND	ND	ND	ND	ND	ND	402 J
042-G-W003-01	229	ND	ND	ND	ND	ND	ND	ND	365
042-G-W003-02	27,200 J	ND	45.9	ND	61	ND	ND	ND	692
042-G-W003-03	6,760	ND	9.7 J	ND	9.0 J	ND	ND	ND	549

Table 2.2
Groundwater Data For COCs at SWMU 42/AOC 505

Sample Number	Aluminum (μg/l)	Arsenic (μg/l)	Chromium (μg/l)	Silver (μg/l)	Vanadium (μg/l)	PCE (μg/l)	1,1,2,2,-TCA (μg/l)	1,1,-DCE (μg/l)	Manganese (μg/l)
MCL or RBC	**37,000[b]**	**50[a]**	**100[a]**	**180[b]**	**260[b]**	**5.0[a]**	**0.053[b]**	**7.0[a]**	**730[b]**
Background	**3,210**	**7.4**	**8.7**	**ND**	**5.4**	**NA**	**NA**	**NA**	**577**
042-G-W003-04	ND	ND	ND	111	ND	ND	ND	ND	18.6
042-G-W003-C1	457	ND	ND	ND	ND	ND	ND	ND	20.6 J
505-G-W001-01	675	ND	ND	ND	ND	ND	1.5 J	1.0 J	232
505-G-W001-02	1,930 J	ND	6.4 J	ND	ND	ND	ND	ND	281
505-G-W001-03	272	9.0 J	ND	ND	ND	ND	ND	ND	287
505-G-W001-04	ND	6.4 J	ND	ND	1.5 J	ND	ND	ND	323 J
505-G-W001-C1	ND	4.0 J	5.8 J	ND	ND	ND	ND	ND	319 J

Notes:
NA — Not Applicable
ND — Not Detected
J — Estimated Value
a — MCL
b — RBC

3.0 REMEDIAL OBJECTIVES

To improve the focus of this CMS, this section summarizes the COCs to be directly addressed and their remedial objectives. In some cases, this section justifies the inclusion or removal of COCs identified in the RFI based on the compound's contribution, or lack of contribution, to significant risks, hazards, or other regulatory standards applicable to this site. In other cases, remedial objectives have been based on calculated Zone A background risk and hazard.

3.1 Soil Chemicals of Concern

BEQs, arsenic, and beryllium were identified as COCs during the SWMU 42/AOC 505 RFI. These constituents were identified as COCs because they exceeded at least one RFI screening criterion, including regulatory, risk-based, or background values. Remedial goal options (RGOs) were established during the RFI for BEQs, arsenic, and beryllium based on risk calculations for each constituent. In addition to the RGOs, the remedial objectives also include reducing contaminant concentrations to background levels.

Beryllium was identified as a COC before EPA released the revised risk-based concentration (RBC) of 160 mg/kg. This revised RBC was not exceeded; therefore, beryllium will not be further addressed in the CMS.

3.2 Groundwater Chemicals of Concern

During the RFI, identification of COCs was based on detections exceeding screening values. The South Carolina Department of Health and Environmental Control (SCDHEC) Bureau of Solid Waste Management Assessment and Remediation Criteria has identified groundwater MCLs as the triggers for corrective measures. In the absence of MCLs, RBCs are the corrective measure triggers. As shown in Table 2.2, COCs were either not detected in the final two sample sets or did not exceed either MCLs or RBCs. Therefore, groundwater remedial objectives are not warranted and will not be developed during the CMS.

Arsenic and chromium were identified as COCs during the RFI, however, detections did not exceed groundwater MCLs. Therefore, these constituents will not be further addressed in the CMS. **Aluminum, silver, vanadium, and manganese** detections were also identified as COCs during the RFI, but they did not exceed tap-water RBCs. Therefore, these constituents will not be further addressed in the CMS.

PCE, 1,1,2,2-TCA, and 1,1-DCE were identified as COCs during the RFI but were not detected in the last two sampling rounds. Therefore, they will not be further addressed in the CMS.

3.3 Remedial Goal Options

3.3.1 SWMU 42/AOC 505 Soil

RFI remedial goal options (RGOs) are based on a 95% UTL site concentration driving a certain level of risk or hazard in surface soil. It is important to note that RFI RGOs are not maximum allowable residual concentrations. Rather, these RGOs represent the 95% UTL of the mean residual concentration.

why not UCL?

In addition to these RFI RGOs, alternate RGOs can be calculated by evaluating the incremental reduction in site risk as areas of greatest contamination are removed or otherwise remediated. Such calculations can be used to estimate the area and volume of soil requiring remediation in order to achieve some risk- or hazard-specific goal such as background risk and hazard. RGOs under risk reduction-based clean-up scenarios are generally equal to Zone A background concentrations. However, risk-reduction based RGOs can be set above background in cases where residual site-risk above background is acceptable and desirable based on site-specific characteristics.

Zone A background risk was calculated by applying the zone-specific background concentration of arsenic and BEQs to the risk and hazard formulas. Background arsenic concentrations

Show the formulas or reference the page/section of RFI of [illegible]

(9.4 mg/kg) generate a Zone A background inorganic residential risk of 2.5E-05. Background BEQ concentrations (0.59 mg/kg) generate a Zone A combined background inorganic and organic risk of 3.2E-05.

Table 3.1 ranks the sample point risks in terms of their relative contribution to overall site risk. Figure 3.1 shows the reduction in site risk as each point is removed or otherwise remediated. The graph shows which points and the corresponding areas of the site which must be remediated in order to achieve a residual site risk equal to or less than Zone A background risk.

Compound-specific surface soil RGOs developed during the RFI and the alternate site risk-based RGOs are summarized in Table 3.2 These values present the range from which the final remedial objectives will be selected by the project team based on the alternative evaluations discussed in Section 5.0. Based on future use plans, the remedial objectives selected from the RGO tables will be used as cleanup goals during the CMS.

Because residual site risk goals can be selected from a range of 10^{-6} to 10^{-4}, selecting an appropriate RGO can be based on a residual site risk within this range. For example, to achieve a residential site risk of 2.5E-05 (Zone A inorganic background), an area over 24,105 ft^2 will require removal and/or treatment. Alternatively, to achieve Zone A combined background inorganic and organic risk (3.2E-06), only 15,580 ft^2 of soil would require removal/disposal. While such exercises in comparative risk vs. volume should not be the sole decision tool in selecting a residual risk goal, they do directly influence the cost effectiveness of any alternative selected.

3.3.2 SWMU 42/AOC 505 Groundwater

Because groundwater remedial action is not required at this site, no groundwater RGOs were developed for SWMU 42/AOC 505.

Figure 3.1 SWMU 42/AOC 505
Residential Risk Reduction Graph

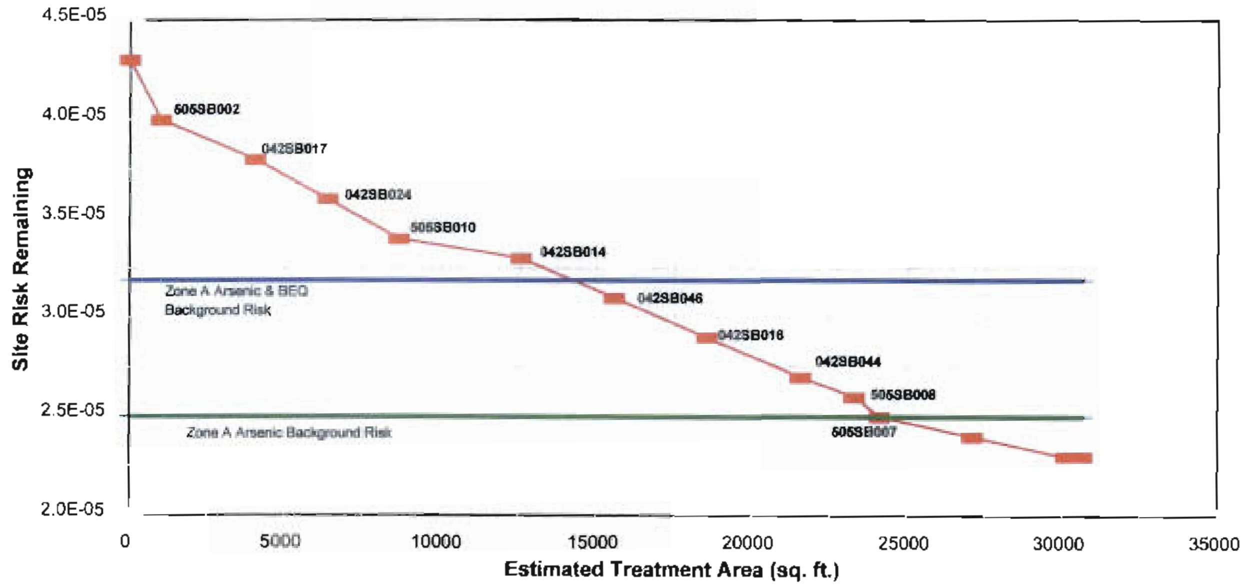


Table 3.1
SWMU 42/AOC 505
Residential Re-use Scenario Risk Reduction Summary
(Points grouped by geographic proximity)

Point to be Removed	Estimated Area	Cumulative Area	Point Risk	Site Risk Remaining After Point Removal
None	0	0	NA	4.3E-05
505SB002	1027	1027	1.7E-04	4.0E-05
042SB017	3000	4027	1.3E-04	3.8E-05
042SB024	2356	6383	1.2E-04	3.6E-05
505SB010	2297	8680	1.0E-04	3.4E-05
042SB014	3899	12580	9.9E-05	3.3E-05 3.2
042SB046	3000	15580	9.6E-05	3.1E-05
042SB016	3000	18580	9.1E-05	2.9E-05
042SB044	3000	21580	7.3E-05	2.7E-05
505SB008	1730	23310	7.3E-05	2.6E-05
505SB007	795	24105	7.0E-05	2.5E-05
504SB006	3000	27105	5.3E-05	2.4E-05
042SB047	3000	30105	3.7E-05	2.3E-05
505SB004	554	30659	3.4E-05	2.3E-05
504SB005	671	31330		

Add arow or some how on this table show the background risk values for effect.

Table 3.2
Surface Soil Remedial Goal Options (mg/kg)

Residential Reuse Scenario									
	Point Hazard-Based RGOs				**Point Risk-Based RGOs**				
Compound	**0.1**	**1**	**3**	**Alt.**	**1E-06**	**1E-05**	**1E-04**	**Alt.**	**Background Concentration**
Arsenic	2.2	21.9	65.6	9.44	0.38	3.8	38	9.44	9.44
BEQs[1]	NA[2]	NA[2]	NA[2]	NA[2]	0.06	0.6	6.0	0.59	0.59
Industrial Reuse Scenario									
	Point Hazard-Based RGOs				**Point Risk-Based RGOs**				
Compound	**0.1**	**1**	**3**	**Alt.**	**1E-06**	**1E-05**	**1E-04**	**Alt.**	**Background Concentration**
Arsenic	43.5	435	1,305	15.4	2.7	27.1	270.6	15.4	15.4
BEQs[1]	NA[2]	NA[2]	NA[2]	NA[2]	0.30	3.0	29.7	0.59	0.59

Notes:
1 — BEQs are calculated by multiplying the cPAHs by their respective TEFs and assuming that *non-detect* values are estimated according to the memo from Barry Doll, EnSafe, Inc. to Johnny Tapia, SCDHEC, *CNC Background Calculations for Carcinogenic PAHs in Terms of BEQs*, dated February 5, 1999.
2 — Compound does not contribute to hazard.
NA — not applicable

4.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section describes the initial steps toward remedy selection: identification and screening of applicable technologies. After technologies are identified, they are reviewed based on site-specific conditions and waste constraints. Screening occurs when technologies are either eliminated from further consideration or retained for it. From the technologies retained, alternatives for remedial action at SWMU 42/AOC 505 will be developed and further evaluated in Section 5.

4.1 Potential Response Actions

Remedial action technologies can be broadly categorized into general response actions for consideration in the CMS. From these generalized categories, potentially applicable technologies will be selected. The general categories of response actions are summarized below.

- **Institutional controls:** Institutional controls often supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous substances, pollutants, or contaminants. Institutional controls should not supplant active response measures as the sole remedy, unless active measures are determined to be impractical. Institutional controls typically include:

  - Site access controls
  - Public awareness, education
  - Groundwater use restrictions
  - Long-term monitoring
  - Deed restrictions
  - Warning against excavation, soil use

Text & table coverage repetitive. Also the shading in table make hard to read. use lighter shade.

- **Monitored Natural Attenuation:** This term refers to dilution, dispersion, advection, and biotic degradation of contaminants in the environment. Monitoring must be conducted throughout the process to confirm that degradation is proceeding at rates consistent with remediation objectives and to ensure that receptors are not threatened.

- **Treatment:** Treatment can be used to reduce the toxicity, mobility, or volume of the principal threats posed by a site, where practical.

- **Containment:** This engineering control would protect human health and the environment by preventing or controlling exposure to site contaminants for waste that poses a relatively low long-term threat, or where treatment is impractical.

- **Combination:** Appropriate methods can be combined to protect human health and the environment.

4.2 Technology Screening

Applicable technology descriptions, site constraints, and waste constraints are summarized in Table 4-1 at the end of Section 4. Site and waste constraints were used to screen or retain the applicable technologies.

4.2.1 Technology Screening Results for Soil Remediation

SWMU 42/AOC 505 soil contamination is primarily confined to the uppermost 0 to 3 feet below ground surface, which is generally comprised of hard, tight, silty, clayey fill down to the water table. It has relatively low permeability and porosity and a variable organic content. The water table ranges from approximately 4 to 6 feet in this area based on location, tidal influence, and time of year (e.g., seasonal precipitation differences).

Evaluation of potential remedial technologies was based on these general site characteristics and the contaminants discussed in Sections 2 and 3. The following technologies were all screened from further consideration.

Institutional Controls

- None

Containment

- None

Soil In Situ Biological Treatment Technologies

- **Bioventing** was screened from further consideration because it does not effectively treat inorganics and BEQs. In addition, the shallow water table limits its effectiveness because it is difficult to control gases and vapor in the subsurface. The vadose zone should extend at least 10 feet below the ground surface to provide enough soil for bioventing to be an effective way to treat soil contaminants. Furthermore, soil-vapor transport can be severely limited in a soil with a high bulk density, low porosity, and low permeability.

- **Electrokinetically enhanced bioremediation** was screened from further consideration, also because it does not effectively treat inorganics and BEQs. Metals can also be immobilized by undesirable chemical reactions with naturally occurring and co-dispersed chemicals. In addition, the vadose zone should extend at least 10 feet below the ground surface to provide enough soil for this technology to effectively treat soil contaminants in it. Furthermore, a heterogenous subsurface (nearly all fill at this site) can reduce removal efficiencies.

Soil In Situ Physical/Chemical Treatment Technologies

- **In situ chemical oxidation** was screened from further consideration because it treats VOCs and SVOCs more effectively than it treats inorganics and BEQs. Moreover, chemical oxidation is typically used to treat soil containing contaminants too concentrated or too toxic for bioremediation to be effective. For in situ oxidation, soil must be sufficiently permeable for the oxidant solution to reach the contamination and for reaction products to move away from the area. Furthermore, background metals concentrations would likely interfere with the process by competing for the chemical oxidants.

- **Electrokinetic separation** was screened from further consideration because it treats consolidated soil contamination more effectively than it treats compounds dispersed over a large site such as SWMU 42/AOC 505

- **Fracturing** was screened from further consideration because it does not apply to current site conditions.

- **Pressure dewatering** was screened from further consideration because vadose zone technologies are not being considered for this site. Soil-vapor transport can be severely limited in a soil with a high bulk density, low porosity, and low permeability.

- **Soil flushing** was screened from further consideration because groundwater contamination is independent of soil contamination. Soil flushing might cross-contaminate the groundwater.

- **In situ soil-vapor extraction (SVE)** was screened from further consideration because vadose zone technologies are not being considered for this site. The shallow water table limits the technology's effectiveness because it is difficult to control gases and vapor in the subsurface. The vadose zone should extend at least 10 feet below the ground surface to provide enough soil for SVE to effectively treat soil contaminants. Furthermore, soil-vapor transport can be severely limited in a soil with a high bulk density, low porosity, and low permeability.

- **In situ solidification/stabilization** was screened from further consideration because it may interfere with future site use.

Soil In Situ Thermal Treatment Technologies

- **In situ aquathermolysis** was screened from further consideration because it does not effectively treat inorganics and BEQs. The shallow water table limits the technology's effectiveness because it is difficult to move the heated water through the subsurface without impacting the aquifer. The vadose zone should extend at least 10 feet below the ground surface to provide enough soil for aquathermolysis to effectively treat soil contaminants. Furthermore, effective transport of the heated water can be severely limited in a soil with a high bulk density, low porosity, and low permeability.

- **Thermally enhanced SVE** was screened from further consideration because vadose zone technologies are not being considered for this site. The shallow water table limits the technology's effectiveness because it is difficult to control gases and vapor in the subsurface. The vadose zone should extend at least 10 feet below the ground surface to provide enough soil for SVE to effectively treat soil contaminants. Furthermore, soil-vapor transport can be severely limited in a soil with a high bulk density, low porosity, and low permeability.

- **In situ vitrification** was screened from further consideration because it may impact future use of the site.

Soil Ex Situ Biological Treatment Technologies

- **Biopiles (or composting)** was screened from further consideration because it treats VOCs and fuel hydrocarbons more effectively than it does inorganics and BEQs. Composting is generally limited to wastes containing smaller hydrocarbon molecules. The presence of salts or metals may inhibit microbial activity.

- **Biosorption** was screened from further consideration because it treats dissolved species more effectively than it does soil-sorbed constituents.

- **Fungal biodegradation** was screened from further consideration because it does not effectively treat inorganics and BEQs. Fungal biodegradation is generally limited to organopollutants.

- **Ex situ landfarming** was screened from further consideration because a significant amount of land area is required for treatment. In addition, ex situ landfarming requires a more sophisticated (i.e., costly) engineering system than in situ landfarming or bioremediation.

- **Slurry-phase biological treatment** was screened from further consideration because it is primarily used to treat nonhalogentated VOCs and SVOCs — it does not effectively treat inorganics and BEQs.

Soil Ex Situ Physical/Chemical Treatment Process

- **Dehalogenation** was screened from further consideration because it does not effectively treat inorganics and BEQs. Dehalogenation is limited to halogenated contaminants.

- **Ex situ SVE** was screened from further consideration because it effectively treats VOCs and SVOCs, but not inorganics and BEQs.

- **Solar detoxification** was screened from further consideration because it primarily targets VOCs, SVOCs, and solvents rather than inorganics and BEQs.

- **Supercritical carbon dioxide extraction (SCDE)** was screened from further consideration because it does not effectively treat inorganics and BEQs.

Soil Ex Situ Thermal Treatment Technologies

- **Distillation** was screened from further consideration because it is limited to the removal of organic contamination.

- **High-pressure oxidation** was screened from further consideration because it does not effectively treat inorganics and BEQs.

- **Hot gas decontamination** was screened from further consideration because it is primarily used to manage explosives.

- **Incineration and pyrolysis** were screened from further consideration because they do not effectively treat inorganics and BEQs.

- **Thermal desorption** was screened from further consideration because it does not effectively treat inorganic compounds. BEQs may be treated with thermal desorption; however, SWMU 42/AOC 505 BEQs concentrations are too low to supply sufficient British thermal units (Btus) to warrant this thermal technology — it would likely be cost prohibitive.

- **Vitrification** was screened from further consideration because it is primarily used to treat radioactive contaminants.

- **Open burn and detonation** were screened from further consideration because they are used primarily to treat munitions rather than inorganics and BEQs.

The following technologies are effective for *only one* of the two principal waste streams (inorganics and BEQs) and were therefore screened from further consideration:

Institutional Controls

- None

Containment

- None

Soil In Situ Biological Treatment Technologies

- **In situ bioremediation** was screened from further consideration because it does not effectively treat inorganic compounds. BEQs may be treated with this technology, although less effectively than lighter hydrocarbons.

- **Monitored natural attenuation (MNA)** was screened from further consideration because it does not effectively treat inorganics which are often immobilized but not destroyed during the process. Immobilization may involve adsorption, coprecipitation, precipitation, and diffusion into the soil matrix, and may either be reversible or slowly reversible. MNA may treat BEQs and other polynuclear aromatic hydrocarbons (PAHs) effectively, but institutional controls may be required to limit access to the site during remediation.

Soil In Situ Physical/Chemical Treatment Technologies

- None

Soil In Situ Thermal Treatment Technologies

- None

Soil Ex Situ Biological Treatment Technologies

- None

Soil Ex Situ Physical/Chemical Treatment Process

- **Chemical extraction** was screened from further consideration because it does not effectively treat BEQs due to its molecular weight (252). Chemical extraction effectively treats soil contaminated with inorganics and organics, but is generally less effective on high molecular weight organics and hydrophilic substances.

- **Physical separation** was screened from further consideration because:
  - Physical separation may not yield cost-effective quantities of recoverable metals due to dispersed and relatively low concentrations of inorganic contamination at SWMU 42/AOC 505.
  - It does not effectively treat BEQs.

- **Soil washing** was screened from further consideration because of *potential* site constraints. Soil washing does treat inorganics and BEQs; however, its effectiveness decreases when a soil's clay and silt content of the soil increases. Because the soil at SWMU 42/AOC 505 is primarily clay, this technology may be impractical since the primary treatment mechanism is separation of the fine and coarse soil materials, coupled with the assumption that the contaminants adhere to the fine stream. If the fine stream is a substantial portion of the soil matrix, then volume is reduced.

- **Ex situ stabilization/solidification** effectively treats inorganics and BEQs; however, it was screened from further consideration because it may not be practical for the soil concentrations at SWMU 42/AOC 505. There is no current threat to the groundwater via migration from soil. As a result, binding the contaminants to the soil matrix would not provide a substantial benefit. Furthermore, there would still be a dermal and gastrointestinal contact risk if the material remained onsite.

Soil Ex Situ Thermal Treatment Technologies

- None

Soil technologies retained for further consideration are listed below.

Institutional Controls

- Institutional controls that restrict access to contaminated soil

Containment

- None

Soil In Situ Biological Treatment Technologies

- Phytoremediation

Soil In Situ Physical/Chemical Treatment Technologies

- None

Soil In Situ Thermal Treatment Technologies

- None

Soil Ex Situ Biological Treatment Technologies

- None

Soil Ex Situ Physical/Chemical Treatment Process

- None

Soil Ex Situ Thermal Treatment Technologies

- None

Other Treatment Technologies

- Excavation with offsite disposal

4.2.2 Technology Screening Results for Groundwater Remediation

Groundwater remedial technology identification and screening were not required during the CMS. Based on the results of additional groundwater sampling performed during the CMS, SWMU 42/AOC 505 shallow groundwater complies with MCLs or tap-water RBCs and does not require remedial action.

Table 4.1
Soil Technology Screening for SWMU 42/AOC 505

Technology	Description	Site Constraints	Waste Constraints	Retained
INSTITUTIONAL CONTROLS				
Institutional Controls	Leaves contaminated soil in place. Site access would be controlled by site access controls, public awareness, education, deed restrictions, etc.	Does not remove the source — plans for future site use may be impacted.	None.	Yes.
CONTAINMENT				
Surface Cap	Capping is a containment technology that will limit human contact with soil and reduce infiltration of rainwater through contaminated soil. Capping materials include soil, asphalt, and concrete.	Plans for future site use may be impacted by capping technology.	None.	Yes.
SOIL IN SITU BIOLOGICAL TREATMENT TECHNOLOGIES				
Bioremediation	Naturally occurring microbes are stimulated by circulating water-based solutions through contaminated soil to enhance biodegradation. Nutrients, oxygen, hydrogen peroxide, and other amendments may enhance biodegradation and contaminant desorption from subsurface materials. Bioremediation may occur in aerobic and anaerobic conditions.	Preferential flow paths may severely decrease contact between injected fluids and contaminants throughout the contaminated zones.	In situ bioremediation most readily treats non-halogenated volatile, semivolatile, and fuel hydrocarbons. High concentrations of heavy metals, highly chlorinated organics, long-chain hydrocarbons, or inorganic salts are likely to be toxic to microorganisms.	No, waste constraint for inorganics and BEQs.

Table 4.1
Soil Technology Screening for SWMU 42/AOC 505

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL IN SITU BIOLOGICAL TREATMENT TECHNOLOGIES				
Bioventing	Air is either extracted from or injected into the unsaturated soil to increase oxygen concentration and stimulate biological activity. Flow rates are much lower than for soil-vapor extraction, minimizing volatilization and release of contaminants to the atmosphere.	Bioventing is applicable to contaminants in the vadose zone.	Bioventing is applicable for any contaminant that more readily degrades aerobically than anaerobically.	No, waste constraint for inorganics and BEQs.
Electrokinetically Enhanced Bioremediation	An electric field is applied to electrokinetically transport nutrients and biodegrade bacteria to areas of contamination.	The effectiveness of an electric field can be reduced by the presence of buried metallic conductors, and pH and reduction-oxidation changes induced by the process electrode reactions. Permeability, degree of water saturation, and/or high water table can also impact the process effectiveness.	This technology is appropriate for treating soil contaminated with petroleum hydrocarbons and other compounds easily biodegraded under anaerobic conditions.	No, waste constraint for inorganics and BEQs and site constraint for shallow water table.
Landfarming	Contaminated soil is cultivated to enhance contaminant biodegradation.	In situ landfarming should only be performed in low-risk areas where contaminant leaching is not a concern.	In situ landfarming cannot support anaerobic conditions, which are required to cultivate the proper microorganisms for biodegradation of some contaminants.	No, site constraint for space.
Monitored Natural Attenuation (MNA)	MNA is a long-term management philosophy. Natural subsurface processes such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials are allowed to reduce contaminants to acceptable concentrations.	MNA may not be a good remediation choice for locations where site conditions make it difficult to predict contaminant movement.	Some inorganics can be immobilized through MNA, but they will not be degraded.	No, waste constraint for inorganics.

Table 4.1
Soil Technology Screening for SWMU 42/AOC 505

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL IN SITU BIOLOGICAL TREATMENT TECHNOLOGIES				
Phytoremediation	Phytoremediation is the use of plants to remove, contain, and/or degrade contaminants. Examples include; enhanced rhizosphere biodegradation, phytoaccumulation, phytodegradation, and phytostabilization.	Climatic or hydrologic conditions may restrict the remediation plants' rate of growth, and treatment is generally limited to within 3 feet of the soil surface. Due to time required for remediation, plans for future site use may be impacted by phytoremediation.	High concentrations of hazardous materials can be toxic to plants.	Yes.
SOIL IN SITU PHYSICAL/CHEMICAL TREATMENT TECHNOLOGIES				
Chemical Oxidation	Chemical oxidation is a process in which the oxidation state of a contaminant is increased while the oxidation state of the reactant is decreased. The reactant can be another element, including the oxygen molecule, or it may be a chemical species containing oxygen, such as hydrogen peroxide or chlorine dioxide.	Iron and manganese in the soil will compete with contaminants for oxygen.	This technology is effective in treating media contaminated with low concentrations of halogenated and non-halogenated volatiles and semivolatiles,PCBs, pesticides, cyanides, and volatile and nonvolatile metals.	No, waste constraint for inorganics and BEQs.
Electrokinetic Separation	Low intensity direct electrical current is applied across electrode pairs that have been implanted in the ground on either side of the contaminated zone. Contaminants desorbed from the soil surface are transported toward cathodes or anodes, depending on their charge.	The effectiveness of electrokinetic remediation can be reduced by the presence of buried metallic conductors, immobilization of metal ions by undesirable chemical reactions with naturally occurring and co-disposed chemicals, and pH and reduction-oxidation changes induced by the process electrode reactions. Permeability and degree of water saturation can also impact the process effectiveness.	This technology can be used to treat soil contaminated with heavy metals, radionuclides, and organic contaminants.	No, waste constraint for wide distribution.

Table 4.1
Soil Technology Screening for SWMU 42/AOC 505

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL IN SITU PHYSICAL/CHEMICAL TREATMENT TECHNOLOGIES				
Fracturing	Cracks are developed by fracturing beneath the surface in low permeability and over-consolidated sediments to open new passageways that increase the effectiveness of many in situ processes and enhance extraction efficiencies. Fracturing must be used with a treatment technology such as soil vapor extraction, bioremediation, vitrification, electrokinetics or pump-and-treat systems. Technologies used in fracturing include blast-enhanced fracturing, pneumatic fracturing, hydraulic fracturing, and Lasagna process.	Cemented sediment limits fracturing effectiveness and fractures will close in non-clayey soil. The technology should not be used in areas of high seismic activity. Fracturing can potentially interfere with utilities and site activities.	The potential exists for opening new pathways, which could spread contaminants such as dense nonaqueous phase liquids (DNAPLs).	No, site constraints for impact to current site conditions.
Pressure Dewatering	Air is injected into the soil at a rate that increases groundwater pressure, resulting in groundwater flow away from the air injection site. This technique increases the amount of soil that can be biodegraded through bioventing.	Pressure dewatering applies for remediating contaminants in the vadose zone.	Pressure dewatering applies for any contaminant that is more readily degraded aerobically than anaerobically.	No, site constraints for low permeability vadose zone.
Soil Flushing	Soil flushing uses water or a solvent to leach contaminants from the soil. Groundwater extraction must be included to prevent spreading contamination in groundwater.	Low-permeability soil is difficult to treat with soil flushing. Soil flushing should only be used where flushed contaminants and flushing fluid can be contained and recaptured.	Mobilization of NAPLs in response to cosolvent flooding can worsen the extent of site contamination.	No, site constraint for shallow water table.

Table 4.1
Soil Technology Screening for SWMU 42/AOC 505

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL IN SITU PHYSICAL/CHEMICAL TREATMENT TECHNOLOGIES				
Soil-Vapor Extraction	SVE uses extraction wells and vacuum pumps to create a pressure gradient to volatilize contaminants from the soil. The offgases from the extraction wells may require treatment prior to release into the atmosphere.	This technology can be used at sites where areas of contamination are large and deep and/or underneath a structure. Soil should be fairly homogeneous and have high permeability, porosity, and uniform particle size distribution.	SVE applies to soil contaminated with VOCs and some SVOCs. The presence of NAPL in subsurface soil may affect the efficiency of SVE on organic compounds.	No, site constraints for shallow water table.
Solidification/ Stabilization	In situ solidification/stabilization immobilizes contaminants by mixing site soil with portland cement, lime, or a chemical reagent to reduce the mobility of the contaminant. Large augering equipment is used to mix soil in place with the reagent.	This technology will likely leave a solid mass, similar to concrete, which may impact future use of the site.	This technology works well for inorganics, including radionuclides. Although organic contaminated soil may be treated with solidification/stabilization, some organics can delay or inhibit reactions necessary for solidification.	No, site constraints for future use.

Table 4.1
Soil Technology Screening for SWMU 42/AOC 505

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL IN SITU THERMAL TREATMENT TECHNOLOGIES				
Aquathermolysis	Water is heated to 200° to 450°C under pressure and injected into a contaminated area. At these temperatures water acts as a catalyst, reactant, and solvent.	Shallow groundwater will limit the effectiveness this technology. Aquathermolysis can impact utilities and water/sewer transport systems.	Aquathermolysis may be effective in aiding the remediation of waste oils, chromium, and volatile organic compounds.	No, waste constraints for inorganics and BEQs.
Thermally Enhanced Soil Vapor Extraction	Site soil is electrically heated to 370°C or higher to degrade and volatilize contaminants. A vacuum system covering the entire treatment area collects all offgases and vaporizes them with heating elements. Residual gases are passed through activated carbon. Different heating systems that are used for this technology include electrical heating blankets, radio frequency/electromagnetic heating, and hot air injection.	This technology typically requires at least 5 feet between groundwater and the bottom of the treatment zone. Heating the soil to high temperatures can impact utilities and water/sewer transport systems.	This technology has been proven to remove some VOCs, SVOCs, pesticides, herbicides, and PCBs from soil. It can remove some volatile forms of metals from soil, although elemental forms will not be removed.	No, site constraints for shallow water table.
Vitrification	Electrical heating is used to melt contaminated soil, producing a glass-like matrix with very low leaching characteristics.	Shallow groundwater tends to interfere with this process. The technology will create a vitreous mass that may impact future use of the site.	Some organic and inorganic contaminants may volatilize in the process.	No, site constraints for future use.

Table 4.1
Soil Technology Screening for SWMU 42/AOC 505

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL EX SITU BIOLOGICAL TREATMENT TECHNOLOGIES				
Biopiles	Excavated soil is mixed with amendments, nutrients, and fillers and placed in aboveground enclosures. In an aerated static pile, excavated soil is formed into piles and aerated with blowers or vacuum pumps. Compost piles and static piles are examples of biopiles.	Existing structures and utilities may impede or restrict excavation. A large amount of space is required for biopiles.	Biopile treatment has been used to treat nonhalogenated VOCs and fuel hydrocarbons. Halogenated VOCs, SVOCs, and pesticides also can be treated, but the effectiveness varies; treatment may apply only to some compounds within these contaminant groups. Heavy metals cannot be degraded by biopiles and can be toxic to the microorganisms.	No, waste constraints for inorganics and BEQs.
Biosorption	Biosorption is the sorptive removal of toxic metals from solution by a specially prepared biomass.	Existing structures and utilities may impede or restrict excavation. This technology may not be effective for clayey soil.	Biosorption removes toxic metals from solution. Not proven effective at concentrations above 30 ppm.	No, waste constraints for soil-sorbed constituents.
Fungal Biodegradation	Fungal biodegradation refers to the degradation of a wide variety of organopollutants by using the lignin-degrading or wood-rotting enzyme system of white rot fungus.	Existing structures and utilities may impede or restrict excavation.	White rot fungus can degrade and mineralize a number of organopollutants, including the predominant conventional explosives TNT, RDX, and HMX. In addition, white rot fungus has the potential to degrade and mineralize other recalcitrant materials such as DDT, PAHs, and PCBs.	No, waste constraints for inorganics and BEQs.
Landfarming	Contaminated soil is excavated, applied into lined beds, and periodically turned over or tilled to aerate and enhance contaminant biodegradation.	Existing structures and utilities may impede or restrict excavation. A large amount of space is required for landfarming.	Inorganic contaminants will not be biodegraded and volatile contaminants must be pretreated to prevent polluting the air.	No, site constraints for space availability.

Table 4.1
Soil Technology Screening for SWMU 42/AOC 505

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL EX SITU BIOLOGICAL TREATMENT TECHNOLOGIES				
Slurry Phase Biological Treatment	An aqueous slurry is created by combining soil with water and other additives. The slurry is mixed continuously to keep solids suspended and microorganisms in contact with the soil contaminants. Upon completion of the process, the slurry is dewatered and the treated soil is disposed of.	Existing structures and utilities may impede or restrict excavation. Nonhomogeneous soil and clayey soil can create material handling problems.	Slurry-phase bioreactors are used primarily to treat nonhalogenated SVOCs and VOCs in excavated soil or dredged sediment. Slurry-phase bioreactors containing co-metabolites and specially adapted microorganisms can be used to treat halogenated VOCs and SVOCs, pesticides, and PCBs.	No, waste constraints for inorganics and BEQs.
SOIL EX SITU PHYSICAL/CHEMICAL TREATMENT TECHNOLOGIES				
Chemical Extraction	Excavated soil is washed with aqueous-based solutions to separate contaminants sorbed onto fine particles from the rest of the soil matrix. The fractions of soil to be treated are processed in a slurry with specific leachant mixtures to ionize target metals. The treated mixture is further treated to develop an enriched leaching solution, which is then treated to remove the target metals.	Existing structures and utilities may impede or restrict excavation. Soil with higher clay content may reduce extraction efficiency and require longer contact times.	Acid extraction is suitable for treating soil contaminated by heavy metals. Solvent extraction has been shown to be effective in treating soil containing primarily organic contaminants, but is generally least effective on very high molecular weight organics and very hydrophilic substances.	No, waste constraints for BEQs.
Chemical Oxidation	Chemical oxidation is a process in which the oxidation state of a contaminant is increased while the oxidation state of the reactant is decreased. The reactant can be another element, including the oxygen molecule, or it may be a chemical species containing oxygen, such as hydrogen peroxide or chlorine dioxide.	Existing structures and utilities may impede or restrict excavation. Iron and manganese in the soil will compete with contaminants for oxygen.	This technology is effective in treating media contaminated with low concentrations of halogenated and non-halogenated volatiles and semivolatiles, PCBs, pesticides, cyanides, and volatile and nonvolatile metals.	No, waste constraints for inorganics and BEQs.

Table 4.1
Soil Technology Screening for SWMU 42/AOC 505

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL EX SITU PHYSICAL/CHEMICAL TREATMENT TECHNOLOGIES				
Dehalogenation	Reagents are added to soil contaminated with halogenated organics. The dehalogenation process is achieved by either replacing the halogen molecules or decomposing and partially volatilizing the contaminants. Examples of dehalogenation include base-catalyzed decomposition and glycolate/alkaline polyethylene glycol (A/PEG).	Existing structures and utilities may impede or restrict excavation. High clay and moisture content will increase treatment costs. Capture and treatment of residuals from the process will be especially difficult for soil containing high levels of fines and moisture.	The target contaminant groups for dehalogenation treatment are halogenated SVOCs and pesticides. The technology can be used, but may be less effective against selected halogenated VOCs.	No, waste constraints for inorganics and BEQs.
Physical Separation	Separation techniques concentrate contaminated solids through physical means. These processes seek to detach contaminants from their medium (e.g., soil, sand, or other binding material). Gravity separation, magnetic separation, and sieving/physical separation are examples of this technology.	Existing structures and utilities may impede or restrict excavation. Specific gravity of particles will affect settling rates and process efficiency.	The target contaminant groups are SVOCs, fuels, and inorganics (including radionuclides). The technologies can be used on selected VOCs and pesticides. Magnetic separation is specifically used on heavy metals, radionuclides, and magnetic radioactive particles, such as uranium and plutonium compounds.	No, waste constraints for low contaminant concentration.
Soil Washing	Excavated soil is washed with aqueous-based solutions to separate contaminants sorbed onto fine particles from the rest of the soil matrix. This technology only separates the contaminants and does not destroy them. Further treatment or disposal of the process water is required.	Existing structures and utilities may impede or restrict excavation. High humic content in soil may require pretreatment. It may be difficult to remove organics adsorbed to clay-size particles.	This technology is effective at removing SVOCs and inorganics. It is less effective at treating VOCs.	No, site constraint for soil composition.

Table 4.1
Soil Technology Screening for SWMU 42/AOC 505

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL EX SITU PHYSICAL/CHEMICAL TREATMENT TECHNOLOGIES				
Soil-Vapor Extraction	A vacuum is applied to a network of aboveground piping to encourage volatilization of organics from the excavated soil. The process includes a system for handling offgases.	Existing structures and utilities may impede or restrict excavation. A large amount of space is required for this technology. High moisture content, high humic content, or compact soil will inhibit volatilization.	SVE applies to soil contaminated with VOCs and some SVOCs.	No, waste constraints for inorganics and BEQs.
Solar Detoxification	Solar detoxification is a process that destroys contaminants by photochemical and thermal reactions using the ultraviolet energy in sunlight.	Existing structures and utilities may impede or restrict excavation. Site must have adequate sunlight.	The target contaminant groups for solar detoxification are VOCs, SVOCs, solvents, pesticides, and dyes. The process may also remove some heavy metals from water.	No, waste constraints for inorganics and BEQs.
Solidification/ Stabilization	Contaminants are physically bound or encased within a stabilized mass, or chemical reactions are induced with stabilizing agents. The contaminants are not removed or destroyed, but their mobility is reduced. Examples of S/S technologies include bitumminization, emulsified asphalt, modified sulfur cement, polyethylene extrusion, Pozzolan/portland cement, radioactive waste solidification, sludge stabilization, and soluble phosphates.	Existing structures and utilities may impede or restrict excavation.	This technology works well for inorganics, including radionuclides. Although organic contaminated soil may be treated with solidification/stabilization, some organics can delay or inhibit reactions necessary for solidification.	No, waste constraints for low concentration.
Supercritical Carbon Dioxide Extraction	This process employs supercritical carbon dioxide as a solvent to remove normally insoluble organic compounds. It does not destroy target contaminants.	Existing structures and utilities may impede or restrict excavation. Elevated water content can have a negative impact on SCDE performance.	This technology can remove normally insoluble organics from soil.	No, waste constraints for inorganics and BEQs.

Table 4.1
Soil Technology Screening for SWMU 42/AOC 505

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL EX SITU THERMAL TREATMENT TECHNOLOGIES				
Aquathermolysis	Water is heated to 200° to 450°C under pressure and injected into a contaminated area. At these temperatures, water acts as a catalyst, reactant and solvent.	Existing structures and utilities may impede or restrict excavation.	Aquathermolysis may be effective in aiding the remediation of waste oils, chromium, and volatile organic compounds.	No, waste constraints for inorganics and BEQs.
Distillation	Hydrocarbons and water are volatilized from contaminated media using either heat or vacuum.	Existing structures and utilities may impede or restrict excavation.	This technology is limited to the removal of organic contaminants from wastes.	No, waste constraints for inorganics and BEQs.
High-Pressure Oxidation	Wet air oxidation and supercritical water oxidation belong to this technology category. Both processes use high pressure and temperature to treat organic contaminants.	Existing structures and utilities may impede or restrict excavation.	Wet air oxidation can treat hydrocarbons and other organic compounds. Supercritical water oxidation applies to PCBs and other stable compounds.	No, waste constraints for inorganics and BEQs.
Hot Gas Decontamination	This process involves raising the temperature of the contaminated material for a specified period of time. The gas effluent from the material is treated in an afterburner system to destroy all volatilized contaminants.	Existing structures and utilities may impede or restrict excavation.	This process applies to demilitarizing explosive items, such as mines and shells (after removal of explosives), or scrap material contaminated with explosives.	No, waste constraints for inorganics and BEQs.

Table 4.1
Soil Technology Screening for SWMU 42/AOC 505

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL EX SITU THERMAL TREATMENT TECHNOLOGIES				
Incineration/Pyrolysis	Incineration burns contaminated sediment at high temperatures (1,600° - 2,200°F) to volatilize and combust organic contaminants. A combustion gas treatment system must be included with the incinerator. The circulating bed combustor, fluidized bed reactor, infrared combustor, and rotary kiln are examples of incinerators. Pyrolysis chemically changes contaminated sediment by heating it in the absence of air. Pyrolysis can be achieved by limiting oxygen to rotary kilns and fluidized bed reactors. Molten salt destruction is another example of pyrolysis.	Existing structures and utilities may impede or restrict excavation. Highly abrasive feed can damage the processor unit. The technology requires drying the soil to achieve less than 1% moisture content.	Incineration may be effective in treating organic contaminated soil, but not soil with metals as the primary contaminants. The target contaminant groups for pyrolysis are SVOCs and pesticides. Pyrolysis is not effective in either destroying or physically separating inorganics from the contaminated medium. Volatile metals may be removed by the higher temperatures, but are not destroyed.	No, waste constraints for inorganics and BEQs.
Open Burn/Open Detonation	In open burn operations, explosives or munitions are destroyed by self-sustained combustion, which is ignited by an external source, such as flame, heat, or a detonatable wave. Open detonation destroys detonatable explosives and munitions by detonating with an energetic charge.	Existing structures and utilities may impede or restrict excavation. For safety purposes, substantial space is required for open processes. Open burn/open detonation requires a RCRA Subpart X permit.	Open burn/open detonation can be used to destroy excess, obsolete, or unserviceable munitions, components, and energetic materials, as well as media contaminated with energetics.	No, waste constraints for inorganics and BEQs.

Table 4.1
Soil Technology Screening for SWMU 42/AOC 505

Technology	Description	Site Constraints	Waste Constraints	Retained
SOIL EX SITU THERMAL TREATMENT TECHNOLOGIES				
Thermal Desorption	Soil is generally heated between 200° and 1,000°F to separate VOCs, water, and some SVOCs from the solids into a gas stream. The organics in the gas stream must be treated or captured. Thermal desorption may be used at high or low temperatures, depending on the volatility of the contaminants.	Existing structures and utilities may impede or restrict excavation. Highly abrasive feed can damage the processor unit. Clay and silty soil and soil with high humic content increase reaction time due to contaminant binding.	Inorganic contaminants or metals that are not particularly volatile will not be effectively removed by thermal desorption.	No, waste constraints for inorganics.
Vitrification	Electrical heating is used to melt contaminated soil, producing a glass-like matrix with very low leaching characteristics.	Existing structures and utilities may impede or restrict excavation.	This technology is primarily used for radioactive contaminants.	No, waste constraints for inorganics and BEQs.
OTHER SOIL TREATMENT TECHNOLOGIES				
Excavation and Offsite Disposal	Contaminated soil is excavated and disposed of offsite at a licensed waste disposal facility.	Existing structures and utilities may impede or restrict excavation. Transportation of the soil through populated areas may affect community acceptance.	TCLP results may impact disposal options.	Yes.

Include: Summary of alt. to consider further

5.0 DEVELOPMENT AND EVALUATION OF ALTERNATIVES

The purpose of the detailed analysis of alternatives is to provide decision makers with adequate information to select an appropriate site remedy. During the detailed analysis, each alternative is assessed against the evaluation criteria described in the OSWER Directive Number 9902.3-2A. Assessment results are then arrayed to compare the alternatives and identify key tradeoffs among them.

5.1 Evaluation Process

The evaluation process is designed to provide decision makers with sufficient information to adequately compare the alternatives, select an appropriate remedy for a site, and satisfy RCRA requirements for selecting the remedial action.

Primary Criteria

Four evaluation criteria have been developed to address the RCRA requirements and considerations and their additional technical and policy considerations. The evaluation criteria with the associated statutory considerations that must be met are:

- Primary Criteria 1 — Protection of human health and the environment
- Primary Criteria 2 — Attainment of cleanup standards
- Primary Criteria 3 — Source control
- Primary Criteria 4 — Compliance with applicable waste management standards

Secondary Criteria

The alternatives are scored on their abilities to meet the four primary criteria as well as five secondary criteria. These secondary criteria can help rank remedial alternatives that have met all four of the primary criteria described above.

- Secondary Criteria 1 — Long-term reliability and effectiveness
- Secondary Criteria 2 — Reduction in waste toxicity, mobility, or volume
- Secondary Criteria 3 — Short-term effectiveness
- Secondary Criteria 4 — Implementability
- Secondary Criteria 5 — Cost

Each remedial alternative is evaluated with respect to the above criteria, as described in the following sections.

5.1.1 Protection of Human Health and the Environment

Corrective action remedies must be protective of human health and the environment. Each alternative must satisfy this criteron to be eligible for selection. Evaluation of this criteron should provide a final measure to assess whether each alternative adequately protects human health and the environment. The overall assessment of protection draws on the assessments conducted under other evaluation criterion, especially long-term reliability and effectiveness, short-term effectiveness, and compliance with applicable waste management standards.

Evaluation of the overall protectiveness of a remedial alternative should gauge whether an alternative achieves adequate protection by eliminating, reducing, or controlling the risks each pathway poses through treatment, engineering, or institutional controls. This evaluation considers whether an alternative poses any unacceptable short-term or cross-media impacts.

5.1.2 Attainment of Cleanup Standards

Remedies will be required to attain media cleanup standards set by the implementing agency, which may be derived from existing state or federal regulations (e.g., groundwater standards) or other standards. The media cleanup standards for a remedy will often play a large role in determining the extent of and technical approaches to it. In some cases, certain technical aspects of the remedy, such as the practical capabilities of remedial technologies, may influence to some degree the media cleanup standards that are established.

In addition, this CMS will evaluate whether the potential remedial technologies will achieve the preliminary remediation objective identified by the implementing agency, as well as other alternative remediation objectives proposed in the CMS. The estimated time for each alternative to meet these standards will also be discussed.

5.1.3 Source Control

A critical objective of any remedy must be to stop further environmental degradation by controlling or eliminating further releases that may threaten human health and the environment. Unless source control measures are taken, efforts to clean up releases may be ineffective or, at best, will essentially involve a perpetual cleanup. Therefore, an effective source control program is essential to ensure the long-term effectiveness and protectiveness of the corrective action program.

The source control standard is not intended to mandate a specific remedy or class of remedies. Instead, the CMS will examine a wide range of options. This standard should not be interpreted to preclude the equal consideration of using other protective remedies to control the source, such as partial waste removal, capping, slurry walls, in situ treatment/stabilization, and consolidation.

This CMS report will also evaluate whether source control measures are necessary, and if so, the type of actions that would be appropriate. For any proposed source control measure, estimated effectiveness will be discussed based on site conditions and the history of the specific technology.

5.1.4 Compliance with Applicable Waste Management Standards

Corrective action remedies must comply with applicable waste management standards. To be eligible for selection, each alternative must satisfy this criterion which is used to evaluate whether the alternative will meet federal and state waste management standards identified in previous stages of the remedial process.

5.1.5 Long-Term Reliability and Effectiveness

The evaluation of alternatives under this secondary criterion addresses the results of a remedial action in terms of the risk remaining at the site after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes. The following should be addressed for each alternative:

- **Magnitude of Residual Risk:** This factor assesses the residual risk from untreated waste or treatment residuals at the conclusion of remedial activities. This risk may be measured by numerical standards such as cancer risk levels or the volume or concentration of constituents in waste, media, or treatment residuals remaining onsite.

- **Adequacy and Reliability of Controls:** This factor assesses the adequacy and suitability of any controls used to manage treatment residuals or untreated wastes remaining onsite. It may include an assessment of containment systems and institutional controls to determine if they are sufficient to ensure that any exposure to human and environmental receptors is within protective levels.

5.1.6 Reduction in Waste Toxicity, Mobility, or Volume

This criterion addresses the preference for remedial actions employing treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances. The evaluation should consider the following specific factors:

- The treatment processes, the remedies they will employ, and the materials they will treat.
- The amount of hazardous materials that will be destroyed or treated, including how principal threat(s) will be addressed.
- The degree of expected reduction in toxicity, mobility, or volume, measured as a percentage of reduction (or order of magnitude), when possible.
- The degree to which the treatment will be irreversible.
- The type and quantity of treatment residuals that will remain following treatment.

5.1.7 Short-Term Effectiveness

The short-term effectiveness of a remedial alternative is evaluated relative to its effect on human health and the environment during implementation. Short-term effectiveness is based on four key factors:

- Risks to the community during implementation.
- Risks to workers during implementation.
- Potential for adverse environmental impact as a result of implementation.
- Time until remedial response objectives are achieved.

5.1.8 Implementability

This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. It involves analysis of the following factors:

Technical Feasibility

- Technical difficulties and unknowns associated with construction and operation.
- Potential technical problems during implementation that may lead to schedule delays.
- Ease of remedial action and potential future activities based on technology performance.
- Ability and ease of monitoring the remedy's effectiveness, including an evaluation of the risks of exposure if monitoring is insufficient to detect a system failure.

Administrative Feasibility

Activities needed to coordinate with other offices and agencies.

Availability of Services and Materials

- Availability of adequate offsite treatment, storage capacity, and disposal services.
- Availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources.
- Availability of services and materials, plus the potential to obtain competitive bids, which may be particularly important for innovative technologies.
- Availability of prospective technologies.

5.1.9 Cost

Detailed cost estimates for each remedial alternative are based on engineering analyses, suppliers' estimates of necessary technology and costs for similar actions (such as excavation) at other RCRA sites. The cost estimate for a remedial alternative typically consists of four principal elements: capital cost, annual operation and maintenance (O&M) costs, costs for evaluation reports, and present-worth analysis. Costs are expressed in 1999 dollars.

Capital Costs

- *Direct costs* for equipment, labor, and materials used to develop, construct, and implement a remedial action.

- *Indirect costs* for engineering, financial, and other services that are not actually part of construction, but are required to implement a remedial alternative. The percentage applied to the direct cost varies with the degree of difficulty associated with construction and/or implementation of the alternative. In this CMS, the indirect costs include health and safety items, permitting and legal fees, bid and scope contingencies, engineering design and services, and miscellaneous supplies or costs.

Annual O&M Costs

O&M costs refer to post-construction costs necessary to ensure the continued effectiveness of a remedial action. They typically refer to long-term power and material costs (such as the operational cost of a water treatment facility), equipment replacement costs, and long-term monitoring costs.

Evaluation Reports

Those costs are associated with reports prepared to evaluate the results of the selected alternative.

Present-Worth Analysis

This analysis makes it possible to compare remedial alternatives on the basis of a single cost representing an amount that would be sufficient to cover all costs associated with the remedial action during its planned life, if invested in the base year and disbursed as needed. A performance period appropriate to each alternative is assumed for present-worth analyses. Discount rates of 6% are assumed for base calculations. An increase in the discount rate decreases the present worth of the alternative.

The cost elements for each remedial alternative are summarized in the cost analysis section. The study estimate costs provided for the alternatives are intended to reflect actual costs with an accuracy of minus 30% to plus 50%, in accordance with USEPA guidelines.

5.2 Development and Evaluation of Soil Remedial Alternatives

The alternatives include no further remedial action, institutional controls, in situ treatment, and excavation and disposal. Depending on remedial objectives and property reuse considerations, the treatment alternative may include institutional controls and monitoring. The following alternatives have been developed from the technologies retained from the screening described in Section 4:

- Alternative 1: No Further Remedial Action
- Alternative 2: Institutional Controls
- Alternative 3: Phytoremediation
- Alternative 4: Excavation to Zone A Residential Background Inorganic Site Risk with Offsite Disposal

- Alternative 5: Excavation of Areas Exceeding Zone A Background Concentrations with Offsite Disposal

5.2.1 Alternative 1: No Further Remedial Action

No remedial actions would be taken to contain, remove, or treat soil contamination that exceeds remedial objectives. Soil would remain in place. This alternative would leave residual site residential risk at its current level of 4.3E-05. Implementation of this alternative is viable because residual site residential risk is within the USEPA acceptable range (1E-06 to 1E-04).

5.2.1.1 No Further Remedial Action: Primary Criteria

Protection of Human Health and the Environment

No further remedial action provides no additional protection of human health and the environment. Under this scenario, arsenic- and BEQ-contaminated soil would remain onsite, but, is within the USEPA acceptable residential risk range of 1E-06 to 1E-04.

Attainment of Cleanup Standards

This alternative does not comply with the risk-based goals developed in Section 3. Contaminated soil would remain above remedial objectives, but residential site risk is within the USEPA acceptable range of 1E-06 to 1E-04.

Source Control

Although this alternative does not address source control, there are no known sources of contamination remaining in SWMU 42/AOC 505. Soil contaminated from previous site activities or previously existing sources would remain above remedial objectives, but residential site risk is within the USEPA acceptable range of 1E-06 to 1E-04. In addition, the removal of chemicals stored in the golf course maintenance building and related contaminant sources in AOC 505 and the interim response actions performed by the DET have eliminated sources of contamination.

Compliance with Applicable Waste Management Standards

No waste would be managed under this alternative. Therefore, waste management standards do not apply.

5.2.1.2 No Further Remedial Action: Secondary Criteria

Long-term Reliability and Effectiveness

Long-term reliability and effectiveness are minimal. Soil volumes and concentrations would remain unchanged. Although this alternative would not reduce the magnitude of current site risk, it is within the USEPA acceptable residential risk range of 1E-06 to 1E-04.

Reduction in Waste Toxicity, Mobility, or Volume

This alternative would not reduce the mobility, toxicity, or volume of soil contaminants. Contaminants would remain untreated and in place onsite, but residential site risk is within the USEPA acceptable residential risk range of 1E-06 to 1E-04.

Short-term Effectiveness

There are no short-term effects resulting from this alternative.

Implementability

This alternative is technically feasible and easily implemented. No construction, operation, or reliability issues are associated with this alternative. Administrative coordination, offsite services, materials, specialists, or innovative technologies would not be required. No implementation risks are associated with this alternative.

Cost

No costs are associated with this alternative.

5.2.2 Alternative 2: Institutional Controls

No remedial actions would be taken to contain, remove, or treat soil contamination that exceeds remedial objectives. Soil would remain in place. This alternative would allow the site-wide residential risk to remain at its current level (4.3E-05), which is within the USEPA acceptable residential risk range of 1E-06 to 1E-04. However, at four sample locations in four different areas of the site, point risk calculations exceed 1E-04.

The following institutional controls would be implemented in this alternative:

- Public awareness
- Long-term monitoring of general site conditions
- Land-use restrictions (i.e., development for reuse must address residual contamination)
- Excavation warnings and soil-use restrictions

5.2.2.1 Institutional Controls: Primary Criteria

Protection of Human Health and the Environment

Installation of institutional controls would protect human health and the environment additionally by reducing the potential for ingestion or dermal contact. Under the institutional controls scenario, soil arsenic and BEQ concentrations would remain, but risks would be reduced by elimination of dermal contact and ingestion pathways that exist without controls.

Attainment of Cleanup Standards

This alternative complies with the range of risk-based goals developed in Section 3. Contaminated soil would remain, but contamination is within the USEPA acceptable residential risk range of 1E-06 to 1E-04. Current residential site risk is 4.3E-05, or 1.1E-05 above the combined arsenic and BEQ background risk of 3.2E-05.

Source Control

This alternative does not address source control. However, appropriate institutional controls would reduce the likelihood of additional risks to future site workers by minimizing exposure pathways. In addition, the removal of chemicals stored in the golf course maintenance building and related contaminant sources in AOC 505 and the interim response actions performed by the DET have eliminated sources of contamination.

Compliance with Applicable Waste Management Standards

No waste would be managed under this alternative. Therefore, the waste management standards do not apply.

5.2.2.2 Institutional Controls: Secondary Criteria

Long-term Reliability and Effectiveness

Long-term reliability and effectiveness of institutional controls is limited to the ability to control and manage access to the contaminated soil. The volume and concentrations of contaminants in the soil would remain unchanged. This alternative lacks treatment actions that would provide reliability and effectiveness.

Reduction in Waste Toxicity, Mobility, or Volume

This alternative would not reduce the mobility, toxicity, or volume of soil contaminants. Contaminants would remain untreated and in place onsite.

Short-term Effectiveness

There are no short-term effects resulting from the institutional controls alternative.

Where is the capping alternative?

Implementability

The institutional controls alternative is technically feasible and easily implemented. No construction issues are associated with this alternative. Land-use restrictions and administrative coordination are required to implement institutional controls. Offsite services, materials, specialists, or innovative technologies would not be required. No implementation risks are associated with this alternative.

Cost

Costs associated with institutional controls are presented in Table 5.1. These costs include the cost for establishing the controls, and soil monitoring and report preparation every five years for 30 years. The total cost for this alternative is $74,400, including annual O&M costs of $10,000.

Table 5.1
Institutional Controls Costs

Action	Quantity	Cost per Unit	Total Cost
Capital Costs			
Institutional Controls	LS	$50,000	$50,000
Subtotal			**$50,000**
Operations and Maintenance Costs			
Soil sampling, site monitoring, and report preparation every 5 years	LS	$10,000	$10,000
Subtotal			**$10,000**
Present Value at 6% discount rate over 30 years			**$24,400**
Total			**$74,400**

Note:
LS — lump sum

5.2.3 Alternative 3: Phytoremediation

Phytoremediation is an emerging technology that uses specific plant species and their associated rhizospheric microorganisms to remove, degrade, or contain chemical contaminants in soil, sediments, groundwater, surface water, and even the atmosphere. Several types of phytoremediation systems would be applicable to SWMU 42/AOC 505:

- *Phytoextraction:* Metals, radionuclides, and certain organic compounds (i.e., petroleum hydrocarbons) are removed by direct uptake into the plant tissue. Implementation of a phytoextraction program involves planting at least one species that hyperaccumulates the COCs.

- *Hyperaccumulation:* This specific technology for the remediation of low-level, widespread heavy-metal and radionuclide contamination is defined as the ability of a plant to uptake and store more than 2.5% of its dry weight in heavy metals. To accomplish hyperaccumulation, plants are grown in contaminated soil or water and assimilate the contaminants through a process known as *translocation*. In this process, contaminants are absorbed by a plant's root system and moved to the aboveground parts — the stems and leaves — where they can be easily harvested and removed from the site.

- *Phytostabilization:* Certain plant species are used to absorb and precipitate contaminants, generally metals, reducing their bioavailability, and so reducing the potential for human exposure to these contaminants. Plants used in this process often produce a large root biomass that can immobilize the COCs through uptake, precipitation, or reduction.

- *Phytotransformation:* Certain plants are used to degrade contaminants through plant metabolism.

- *Phytostimulation:* Microbial biodegradation is stimulated in the root zone. The plants provide carbonaceous material and essential nutrients through liquids released from roots and root tissue decay. In addition, oxygen released from plants increases the oxygen content in the microbially rich rhizopheric zone.

Laboratory and field studies would be used to determine the appropriate plant species required to remediate the COCs. In addition, these studies would help determine the planting scheme design including plant spacing, fertilization frequency, soil amendments, and water requirements.

5.2.3.1 Phytoremediation: Primary Criteria

Protection of Human Health and the Environment

Phytoremediation protects human health and the environment by slowly removing, transforming, or immobilizing contaminants in the soil. This alternative, coupled with appropriate institutional controls, would eliminate risk to future site workers and the environment and drastically reduce the potential for continued contaminant migration.

Short-term risks from inhalation and dermal contact during implementation would be minimal and could be controlled using common engineering techniques and appropriate PPE. This alternative would comply with applicable waste management standards and remedial objectives.

Phytoremediation is still considered an innovative technology. As such, long-term reliability and effectiveness are relatively unknown. However, substantial research has been conducted to: (1) identify and develop plants that are more effective on target compounds, (2) understand the biological processes behind phytoremediation, and (3) increase the number of field-scale applications. Phytoremediation, which may be two to three times less expensive than chemical and physical remedial technologies, is a passive approach that is effective over a period of months and years rather than weeks.

Finally, public acceptance of phytoremediation can be very high, in part because of the park-like aesthetic benefit, which includes bird and wildlife habitats.

Attainment of Cleanup Standards

Phytoremediation would attain media cleanup standards as established by the project team. Phytoremediation is the least aggressive remedial technology and would likely require the most time to attain proposed cleanup standards.

Source Control

This alternative would provide effective source control by slowly removing, transforming, or immobilizing contaminants in the soil that contribute to site risk. Disposition of resulting affected plant material would eliminate the contaminants from the site. Furthermore, institutional controls would drastically reduce the likelihood of additional risks to future site workers by eliminating potential exposure pathways to residual contamination.

Compliance with Applicable Waste Management Standards

Phytoremediation meets the remedial objectives that are protective of future industrial site workers. Transportation of harvested materials offsite might trigger U.S. Department of Transportation regulations. Land-disposal restrictions would be triggered if the contaminated media were determined to be a hazardous waste. Although it is anticipated that the harvested plant materials would be nonhazardous, TCLP analyses would likely be performed for verification. No location-specific regulations would be triggered by this alternative.

5.2.3.2 Phytoremediation: Secondary Criteria

Long-term Reliability and Effectiveness

Phytoremediation is currently limited to research activities and limited field testing. While several recent and on-going applications have reportedly been successful in lowering contaminant concentrations, complete full-scale applications of these innovative technology projects are scarce. Reported results show fair potential for practical applications of these techniques to achieve remedial objectives and regulatory approval; however, at least two or three more years of field tests are necessary to validate the current and on-going small-scale field tests.

Reduction in Waste Toxicity, Mobility, or Volume

This alternative would effectively reduces toxicity, mobility, or volume by slowly removing, transforming, or immobilizing contaminants in the soil that contribute to site risk. Toxicity would be reduced by phytotransformation and phytostimulation, which use biological processes to degrade the contaminants to less toxic forms. However, this alternative may generate more toxic treatment residuals. Mobility would be reduced by phytoextraction and phytostabilization, which either immobilize the contaminants in the subsurface or in the plant leaves. Volume would be reduced by phytoextraction. Contaminants, particularly metals, are transferred from the soil to the plants, which can be harvested and disposed of in a landfill. Typically the volume of plant material requiring disposal is much less than the original quantity of contaminated soil. Moreover, with appropriate monitoring and maintenance, the toxicity, mobility, and volume reduction processes would be irreversible.

Short-term Effectiveness

The phytoremediation operation would be sufficiently removed from the public to reduce health and safety concerns associated with soil remediation. Workers would be exposed to increased particulate emissions during planting and grading activities and might also have more dermal contact with hazardous constituents. However, worker risks can be reduced by implementing dust control technologies and a site-specific health and safety plan that specifies PPE, respiratory protection, etc.

Implementability

Phytoremediation is technically and administratively feasible at SWMU 42/AOC 505. Areas to be remediated are readily accessible. Contaminants are generally in the top 1 to 3 feet of soil, which contributes to phytoremedial success. Overall, this alternative is easy to install, maintain, and monitor. Only landscaping equipment would be required to implement this technology. Confirmatory sampling would be required to monitor its performance of the process. No future remedial actions would be required after this alternative is completed. Institutional controls would be required to ensure that contaminant-extracting species remain in place.

Specific methods for application to contaminated sites have not been standardized, but general principles have been established. The general steps followed in the design and implementation of a phytoremediation project for any of the techniques include:

- Site characterization, including determination of soil and water chemistry/conditions, climate, and contaminant distributions.
- Treatability studies to determine rates of remediation and appropriate plant species, density of planting, location, etc. Agricultural analyses and principles are required to complete the treatability study.
- Preliminary field testing at the site to monitor results and refine design parameters.
- Full-scale remediation
- Disposal of resulting plant material.

Phytoremediation would probably take years to satisfy remedial objectives. Table 5.2 summarizes its advantages and limitations.

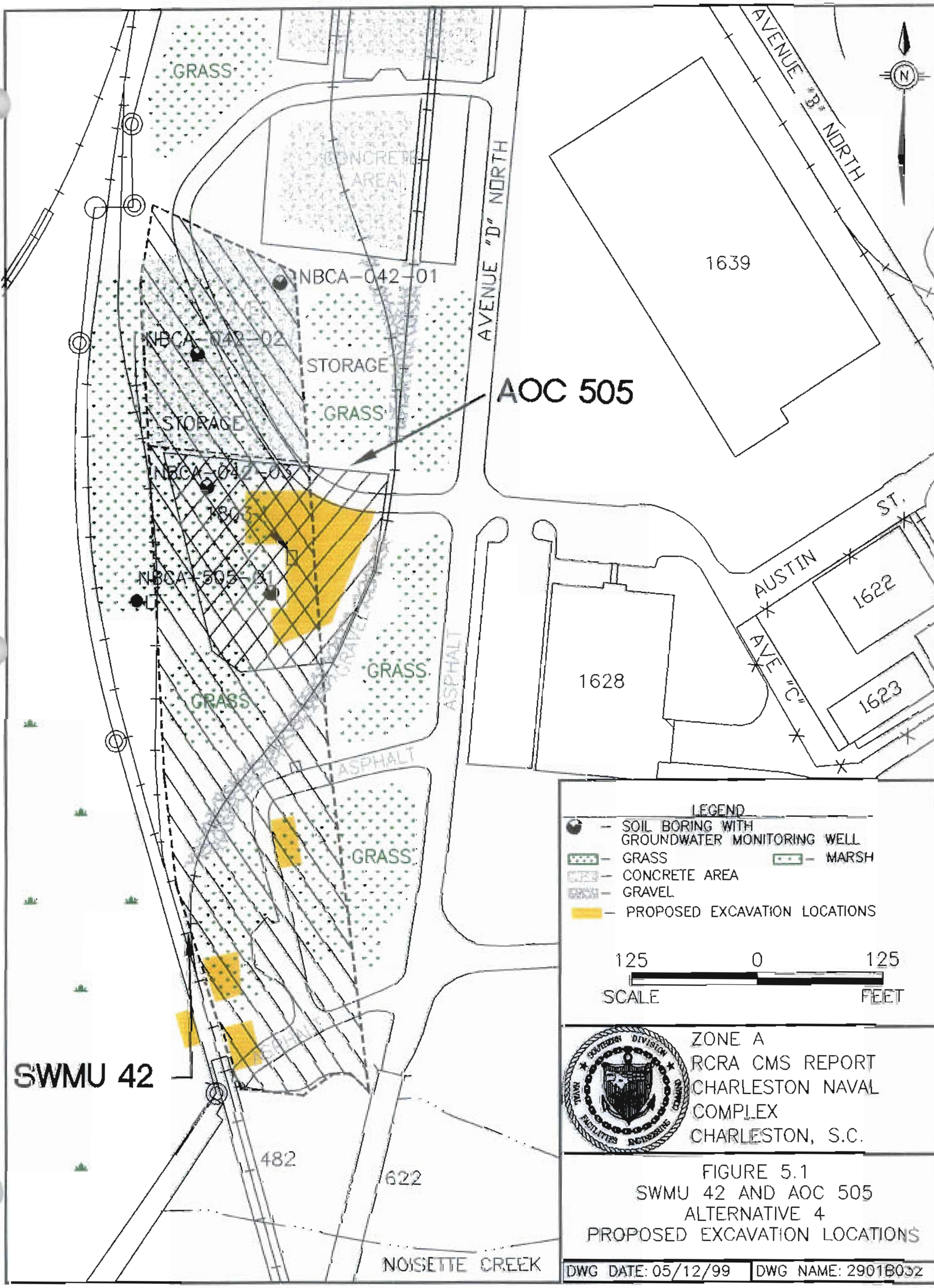
Cost

Costs associated with phytoremediation are presented in Table 5.3. Although current cost estimates for phytoremediation vary widely, the total cost for phytoremediation at SWMU42/AOC 505 is estimated to be $698,300, including annual O&M and monitoring costs of $31,220.

5.2.4 Alternative 4: Excavation to Zone A Residential Background Inorganic Site Risk with Offsite Disposal

SWMU 42/AOC 505 soil in which contaminants exceed calculated background reference concentrations would be excavated down to 1 foot below ground surface (bgs) and disposed of in an offsite landfill. To achieve calculated background conditions for SWMU 42/AOC 505 COCs, approximately 900 yd^3 of soil would require removal/disposal. Sample points and their associated areas requiring removal are listed in Table 5.4.

Excavated soil would be placed in discrete stockpiles for TCLP sampling and analysis. Based on the sampling results, the stockpiles would be designated as either hazardous or nonhazardous and disposed of accordingly. It is anticipated that all of the excavated soil would be nonhazardous. After the contaminated soil is removed, clean backfill would be placed in the excavated areas and graded. Excavation locations are shown on Figure 5.1.



ZONE A
RCRA CMS REPORT
CHARLESTON NAVAL COMPLEX
CHARLESTON, S.C.

FIGURE 5.1
SWMU 42 AND AOC 505
ALTERNATIVE 4
PROPOSED EXCAVATION LOCATIONS

DWG DATE: 05/12/99 | DWG NAME: 2901B052

Table 5.2
Phytoremediation Advantages and Limitations
(Miller, 1996 and Chappell, 1997)

Advantages	Limitations
In situ technology	Limited to shallow soils, streams, and groundwater — generally restricted to groundwater within 10 feet of the ground surface
Passive treatment with minimal associated O&M	High concentration of hazardous materials can be toxic to plants.
Solar powered	Regulator unfamiliarity
Organic pollutants may be degraded to carbon dioxide and water, removing, as opposed to transferring, environmental toxicity.	Climatic and agricultural conditions may influence growth rate and indirectly influence treatment system effectiveness
Cost-effective for large volumes of soil having low concentrations.	Slower than mechanical treatment systems
Overall costs can be 10% to 20% of traditional ex situ systems.	Only effective for moderately hydrophobic contaminants
Transfer is faster than with monitored natural attenuation.	Toxicity and bioavailability of degradation products are unknown
Significant public acceptance	Contaminants may be mobilized into the groundwater (for soil applications).
Air emissions are minimal.	Contaminants may enter food chain through animal consumption.
Secondary wastes are not generated.	
Soil and groundwater remain in place and can be used post-treatment.	

Table 5.3
Phytoremediation Costs

Action	Quantity	Cost per Unit	Total Cost
Capital Costs			
Laboratory/pilot/field studies	LS	$80,000	$80,000
Mobilization/demobilization	LS	$5,000	$5,000
Planting	4 acres	$10,000/acre	$40,000
Soil cover and amendments	4 acres	$7,500	$30,000
Institutional controls	LS	$30,000	$30,000
Engineering/oversight	LS	20%	$37,000
Contingency/miscellaneous	LS	25%	$46,300
Subtotal			**$268,300**
Operations and Maintenance Costs			
Horticulture (plant health)	4 acres	$1,000/acre	$4,000
Pruning	4 acres	$1,000/acre	$4,000
Harvesting	4 acres	$2,000/acre	$8,000
Inspection	LS	$2,000	$2,000
Subtotal			**$18,000**
Present Value at 6% discount rate over 30 years			**$248,000**
Phytoremediation Long-term Monitoring Annual Program			
Soil sampling (field work)	30 hrs	$130/hr	$3,900
Soil analysis	12 samples per year	$200/sample	$2,400
Evaluation	30 hrs	$94/hr	$2,820
Reporting/engineering	LS	20% cost	$1,820
Misc. equipment, supplies, travel	LS	25% cost	$2,280
Subtotal			**$13,220**
Present value subtotal at 6% for 30 years			**$182,000**
Total			**$698,300**

Notes:
Cost estimates developed from Miller, 1996 and Chappell, 1997.
LS — lump sum

Table 5.4
Excavation to Zone A Residential Background Inorganic Site Risk with Offsite Disposal Sample Points Requiring Removal

Sample Point	Estimated Associated Area (ft^2)[a]	Contaminants[b]
None	N/A	N/A
505SB002	1,027	Arsenic, BEQs
042SB017	3,000	Arsenic, BEQs
042SB024	2,356	BEQs
505SB010	2,297	Arsenic
042SB014	3,899	Arsenic, BEQs
042SB046	3,000	Arsenic
042SB016	3,000	Arsenic, BEQs
042SB044	3,000	Arsenic
505SB008	1,730	Arsenic, BEQs
505SB007	795	Arsenic, BEQs

Notes:
a — Associated areas developed using Thiessen polygons.
b — BEQ concentration greater than its calculated background concentration, 590 μg/kg or arsenic concentrations greater than its calculated background concentration, 9.44 mg/kg.

5.2.4.1 Excavation to Zone A Residential Background Inorganic Site Risk with Offsite Disposal: Primary Criteria

Protection of Human Health and the Environment

Excavation and offsite disposal protects human health and the environment by removing contaminated soil posing a risk above calculated background levels. This alternative would reduce risk to human health and the environment due to dermal and gastrointestinal contact to levels comparable to the risk associated with background COC levels.

Short-term risks from inhalation and dermal contact during implementation would be minimal and could be controlled using common engineering techniques and appropriate PPE. This alternative would comply with applicable waste management standards and remedial objectives.

Attainment of Cleanup Standards

Excavation would attain media cleanup standards as established by the project team. In the interim, cleanup levels are assumed to be the calculated background concentrations for each COC. Contaminated soil would be excavated at select locations until confirmation samples satisfy remedial objectives. Excavation is one of the most aggressive remedial technologies and would likely require the least time to attain cleanup standards.

Source Control

This alternative would provide effective source control by eliminating contaminated media that contributes the most to site risk.

Compliance with Applicable Waste Management Standards

Excavation and offsite disposal meets chemical-specific regulations for the associated site-wide remedial objectives protective of future residents. Excavation activities onsite may require compliance with federal, state, and local air emissions and storm water control regulations. Transportation offsite would trigger U.S. Department of Transportation regulations. Land disposal restrictions would be triggered if the contaminated soil were determined to be a hazardous waste. Although it is anticipated that excavated soil would be nonhazardous, it would be analyzed by TCLP for verification. No location-specific regulations would be triggered by this alternative.

5.2.4.2 Excavation to Zone A Residential Background Inorganic Site Risk with Offsite Disposal: Secondary Criteria

Long-term Reliability and Effectiveness

This alternative would ~~eliminate~~ the quantity of soil in which contaminant concentrations exceed calculated ~~background~~ concentrations. ~~Residual risk equivalent to background levels would remain following the completion of this remedial alternative.~~

Removal to a landfill is an established and reliable option because onsite risks are eliminated. However, since the excavated soil would be transferred to a landfill, the waste would not be destroyed.

Reduction in Waste Toxicity, Mobility, or Volume

Excavation would eliminate the source area and contaminants in it that exceed remedial objectives. This alternative includes the removal of the most contaminated soil from the site and disposal in a secure Subtitle C or D landfill (based on TCLP waste analysis). Because the source would no longer remain onsite after this technology is employed, excavation is considered to be irreversible. Although the waste's overall mobility, toxicity, and volume would not be reduced with this alternative, it would eliminate access to contaminants by future site residents.

Short-term Effectiveness

The excavation operation would be sufficiently removed from the public to reduce health and safety concerns associated with soil removal. Excavation workers would be exposed to increased particulate emissions and might also have more dermal contact with low concentrations of hazardous constituents. However, worker risks could be reduced by implementing dust control technologies and a site-specific health and safety plan that specifies PPE, respiratory protection, etc. It is anticipated that remedial objectives can be achieved within one month. Consequently, worker exposure to the contaminants would be minimal.

Implementability

Excavation with offsite disposal is technically and administratively feasible at SWMU 42/AOC 505. Removal and offsite disposal are common remedial alternatives that have been applied at previous sites. The only potential technical problems that might slow removal activities are materials handling and disposal (standby time between confirmatory sampling and disposal), and working around the existing railroad tracks. The soil volumes are moderate (approximately 900 yd^3) and removal activities are anticipated to be easily implemented in most areas. Some areas to be excavated are readily accessible, while others may require working around the railroad tracks. No future remedial actions would be required after this alternative is completed.

Excavation with offsite disposal would not require any extraordinary services or materials. The Bee's Ferry Road Landfill is a Class D facility in Charleston, South Carolina, that has accepted nonhazardous soil from interim removal actions on the base. The Safety-Kleen (Pinewood) Inc. Landfill is a Class C facility in Pinewood, South Carolina, that would accept hazardous waste.

Cost

Costs associated with excavation and offsite disposal are presented in Table 5.5. The total cost for excavation and disposal to the nonhazardous, Subtitle D landfill would be $103,600. Alternatively, the total cost for excavation and disposal to the hazardous, Subtitle C landfill would be $485,700. If the excavated soil is distributed between the nonhazardous and hazardous landfills based on TCLP characterization, the actual total cost would fall between these two extremes. No O&M costs are associated with this alternative.

Table 5.5
Excavation to Zone A Residential Background
Inorganic Site Risk with Offsite Disposal Costs

Action	Quantity	Cost per Unit	Total Cost
Removal Action			
Excavation	900 yd^3	\$20/yd^3	\$18,000
Confirmation/TCLP samples	30 samples	\$100/sample	\$3,000
Backfill	900 yd^3	\$15/yd^3	\$13,500
Subtotal			**\$34,500**
Subtitle D Disposal Facility			
Transportation	900 yd^3	\$8/yd^3	\$7,200
Soil disposal	1,350 tons	\$30/ton	\$40,500
Engineering/oversight	LS	20% cost	\$9,500
Contingency/miscellaneous	LS	25% cost	\$11,900
Subtotal			**\$69,100**
Total (Subtitle D)			**\$103,600**
Subtitle C Disposal Facility			
Transportation	900 yd^3	\$8/yd^3	\$7,200
Soil disposal	1,350 tons	\$225/ton	\$304,000
Engineering/oversight	LS	20% cost	\$62,200
Contingency/miscellaneous	LS	25% cost	\$77,800
Subtotal			**\$451,200**
Total (Subtitle C)			**\$485,700**

Note:
LS — lump sum

5.2.5 Alternative 5: Excavation of Areas Exceeding Zone A Background Concentrations with Offsite Disposal

Soil in which arsenic and BEQ concentrations exceed calculated background reference concentrations would be excavated to 1 foot bgs and disposed of in an offsite landfill. To achieve calculated background conditions for SWMU 42/AOC 505 COCs, approximately 2,300 yd^3 of soil would be removed and disposed of. Sample points to be removed, estimated areas, and COCs for each point are listed in Table 5.6.

Since contaminated soil would be addressed on a point-risk basis, more soil would require excavation and disposal (2,300 yd^3 vs 900 yd^3) than the site risk remedial scenario presented in Section 5.2.4 (Alternative 4). Excavated soil would be placed in discrete stockpiles for TCLP sampling and analysis. Based on the sampling results, the stockpiles would be designated as either hazardous or nonhazardous and disposed of accordingly. It is anticipated that all of the excavated soil would be nonhazardous.

After the contaminated soil is removed, clean backfill would be placed in the excavated areas and graded. Alternative 5 proposed excavation locations are shown in Figure 5.2.

5.2.5.1 Excavation of Areas Exceeding Zone A Background Concentrations with Offsite Disposal: Primary Criteria

Protection of Human Health and the Environment

Excavation with offsite disposal protects human health and the environment by removing contaminated soil in which risk exceeds calculated background levels. This alternative would eliminate risk to human health and the environment due to dermal and gastrointestinal contact.

Short-term risks from inhalation and dermal contact during implementation would be minimal and could be controlled using common engineering techniques and appropriate PPE. This alternative would comply with applicable waste management standards and remedial objectives. Figure 5.2 shows the proposed excavation areas.

I still don't understand the difference between what needs digging between 4 & 5.

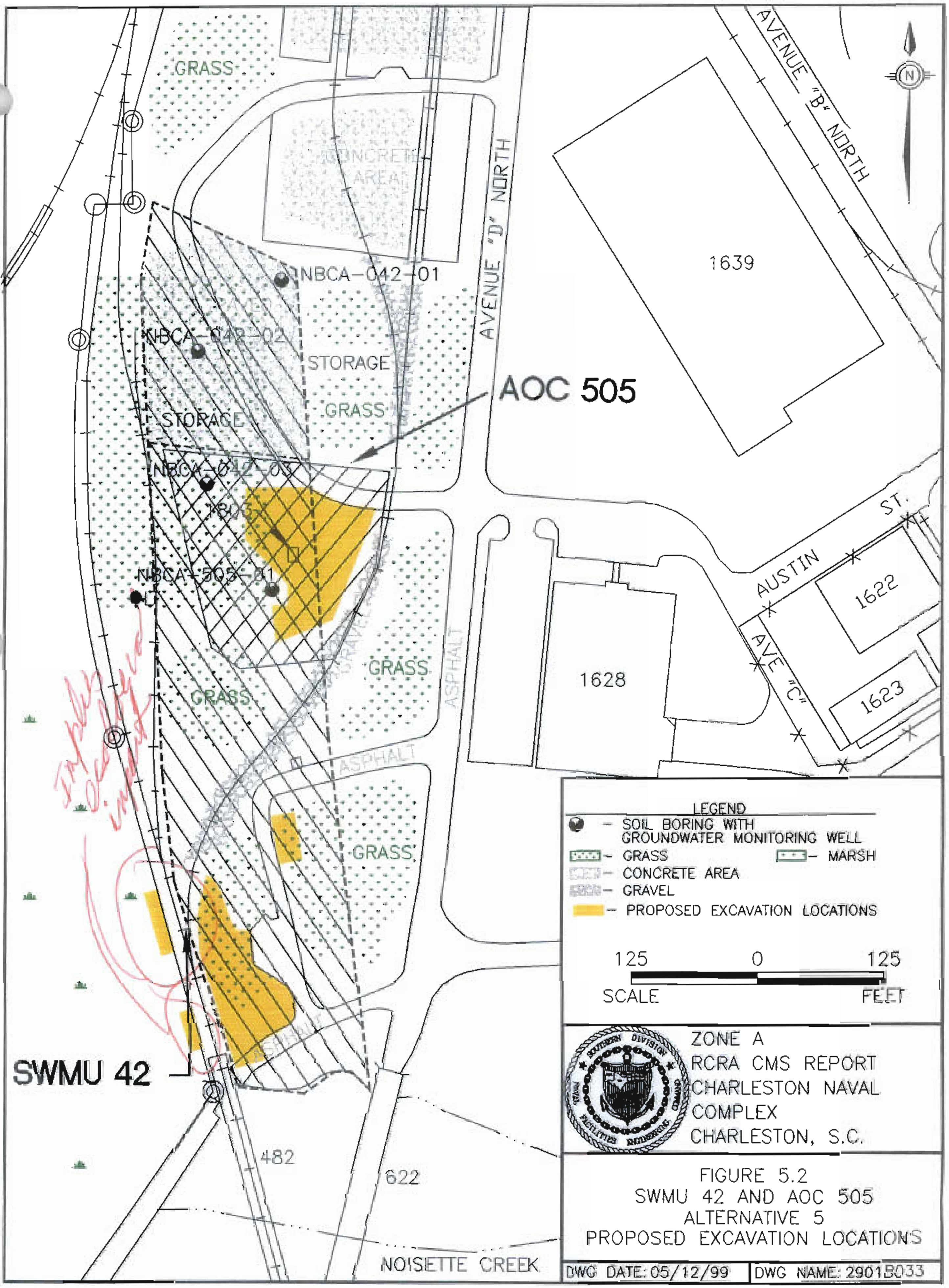

GRASS
CONCRETE AREA
AVENUE "B" NORTH
AVENUE "D" NORTH
1639
NBCA-042-01
NBCA-042-02
STORAGE
GRASS
AOC 505
STORAGE
NBCA-042-03
NBCA-505-01
GRAVEL
GRASS
ASPHALT
AUSTIN ST.
AVE "C"
1622
1623
1628
ASPHALT
GRASS
SWMU 42
482
622
NOISETTE CREEK
LEGEND
SOIL BORING WITH GROUNDWATER MONITORING WELL
GRASS
MARSH
CONCRETE AREA
GRAVEL
PROPOSED EXCAVATION LOCATIONS
125 0 125
SCALE
FEET
ZONE A
RCRA CMS REPORT
CHARLESTON NAVAL COMPLEX
CHARLESTON, S.C.
FIGURE 5.2
SWMU 42 AND AOC 505
ALTERNATIVE 5
PROPOSED EXCAVATION LOCATIONS
DWG DATE: 05/12/99
DWG NAME: 2901B033

Table 5.6
Excavation of Areas Exceeding Zone A Background Concentrations with Offsite Disposal
Sample Points Requiring Removal

Sample Point	Estimated Associated Area (ft^2) [a]	Contaminants[b]
None	N/A	N/A
505SB002	1,027	Arsenic, BEQs
042SB017	3,000	Arsenic, BEQs
042SB024	2,356	BEQs
505SB010	2,297	Arsenic
042SB014	3,899	Arsenic, BEQs
042SB046	3,000	Arsenic
042SB016	3,000	Arsenic, BEQs
042SB044	3,000	Arsenic
505SB008	1,730	Arsenic, BEQs
505SB007	795	Arsenic, BEQs
504SB006	4249	BEQs
042SB047	3000	Arsenic
505SB005	1999	Arsenic
042SB013	1071	Arsenic, BEQs
042SB007	3000	Arsenic, BEQs
505SB004	3000	Arsenic, BEQs
505SB006	3000	Arsenic, BEQs
042SB042	3000	Arsenic, BEQs
042SB009	3000	Arsenic, BEQs
042SB012	795	Arsenic, BEQs
042SB015	3203	Arsenic, BEQs

Notes:

a — Associated areas developed using Thiessen polygons.

b — BEQ concentration greater than its calculated background concentration, 590 μg/kg or arsenic concentrations greater than its calculated background concentration, 9.44 mg/kg.

Why is there such a difference table 5.4 + 5.6? Under "Contaminants" ARS or BEQ should only be 1, state if are 7 Backgrd.

Attainment of Cleanup Standards

Excavation would attain media cleanup standards as established by the project team (in the interim, cleanup levels are assumed to be the calculated background concentrations for each COC). Contaminated soil would be excavated at select locations until confirmation samples satisfy remedial objectives. Excavation is one of the most aggressive remedial technologies and would likely require the least time to attain cleanup standards.

Source Control

This alternative would provide effective source control by eliminating contaminated media exceeding calculated background concentrations for each of the COCs.

Compliance with Applicable Waste Management Standards

Excavation and offsite disposal would meet site-wide remedial objectives protective of future residents. Onsite excavation activities may require compliance with federal, state, and local air emissions and storm water control regulations. Transportation offsite would trigger U.S. Department of Transportation regulations. Land disposal restrictions would be triggered if the contaminated soil were determined to be a hazardous waste. Although it is anticipated that excavated soil would be nonhazardous, it would be analyzed by TCLP for verification. No location-specific regulations would be triggered by this alternative.

5.2.5.2 Excavation of Areas Exceeding Zone A Background Concentrations with Offsite Disposal: Secondary Criteria

Long-term Reliability and Effectiveness

This alternative would eliminate the quantity of soil in which contaminant concentrations exceed calculated background concentrations. Removal to a landfill is an established and reliable option because onsite risks are eliminated. However, since the excavated soil would be transferred to a landfill, the waste would not be destroyed.

Reduction of Toxicity, Mobility, or Volume

Excavation would eliminate the source area and contaminants in it that exceed remedial objectives. This alternative includes the removal of the most contaminated soil from the site and disposal in a secure Subtitle C or D landfill (based on TCLP waste analysis). Because the source would no longer remain onsite after this technology is employed, excavation is considered to be irreversible. However, the waste's overall mobility, toxicity, and volume would not be reduced with this alternative.

Short-term Effectiveness

The excavation operation would be sufficiently removed from the public to reduce health and safety concerns associated with soil removal. Excavation workers would be exposed to increased particulate emissions and might also have more dermal contact with hazardous constituents. However, worker risks could be reduced by implementing dust control technologies and a site-specific health and safety plan that specifies PPE, respiratory protection, etc. It is anticipated that remedial objectives could be achieved within one month. Consequently, worker exposure to the contaminants would be minimal.

Implementability

Excavation with offsite disposal is technically and administratively feasible at SWMU 42/AOC 505. Removal and offsite disposal are common remedial alternatives that have been applied at previous sites. The only potential technical problems that might slow removal activities are materials handling and disposal (standby time between confirmatory sampling and disposal), and potential foundation support measures (if required). The soil volumes are moderately small (approximately 2,300 yd^3) and removal activities are anticipated to be easily implemented. Areas to be excavated are readily accessible. No future remedial actions would be required after this alternative is completed.

Excavation with offsite disposal would not require any extraordinary services or materials. The Bee's Ferry Road Landfill in Charleston, South Carolina, is a Class D facility and has accepted nonhazardous soil from interim removal actions on the base. The Safety-Kleen (Pinewood) Inc. Landfill is a Subtitle C facility in Pinewood, South Carolina, that would accept hazardous waste.

Cost

Costs associated with excavation and offsite disposal are presented in Table 5.7. The total cost for excavation and disposal to a nonhazardous, Subtitle D landfill would be $265,300. Alternatively, the total cost for excavation and disposal to a hazardous, Subtitle C landfill would be $1,241,200. If the excavated soil is distributed between the nonhazardous and hazardous landfills based on TCLP characterization, the actual total cost would fall between these two extremes. No O&M costs are associated with this alternative.

5.3 Development and Evaluation of Groundwater Remedial Alternatives

Development and evaluation of groundwater remedial alternatives was not required during the CMS. SWMU 42/AOC 505 shallow groundwater is in compliance with MCLs or RBCs and requires no further action because the source was removed by the DET and because of the results of additional groundwater sampling during the CMS.

5.4 Comparison of Alternatives

After the alternatives have been fully described and individually assessed against the nine criteria, each alternative's performance relative to the evaluation criteria is assessed. The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative relative to one another. This section highlights differences between alternatives as they meet each of the criteria, especially the secondary criteria since the primary criteria must be met for an alternative to be considered. The focus should help determine which options are cost-effective and which remedy uses permanent solutions and treatment to the maximum extent practicable.

Table 5.7
Excavation of Areas Exceeding Zone A Background Concentrations with Offsite Disposal Costs

Action	Quantity	Cost per Unit	Total Cost
Removal Action			
Excavation	2,300 yd^3	\$20/yd^3	\$46,000
Confirmation/TCLP samples	80 samples	\$100/sample	\$8,000
Backfill	2,300 yd^3	\$15/yd^3	\$34,500
Subtotal			**\$88,500**
Subtitle D Disposal Facility			
Transportation	2,300 yd^3	\$8/yd^3	\$18,400
Soil disposal	3,450 tons	\$30/ton	\$103,500
Engineering/oversight	LS	20% cost	\$24,400
Contingency/miscellaneous	LS	25% cost	\$30,500
Subtotal			**\$176,800**
Total (Subtitle D)			**\$265,300**
Subtitle C Disposal Facility			
Transportation	2,300 yd^3	\$8/yd^3	\$18,400
Soil disposal	3,450 tons	\$225/ton	\$776,300
Engineering/oversight	LS	20% cost	\$159,000
Contingency/miscellaneous	LS	25% cost	\$199,000
Subtotal			**\$1,152,700**
Total (Subtitle C)			**\$1,241,200**

Note:
LS — lump sum

5.4.1 Comparative Analysis of Soil Alternatives

This section comparatively analyzes soil remedial alternatives, examining potential advantages and disadvantages according to each of the nine criteria. The five soil alternatives evaluated in Section 5.2 are technically feasible and have been developed and used at other sites. Because existing site risk is within an acceptable range (1E-06 to 1E-04), the alternatives are generally protective of human health and the environment. State and community acceptance are determined in the same manner for each alternative. Primary and secondary criteria are detailed in Sections 5.4.1.1 and 5.4.1.2.

5.4.1.1 Primary Criteria

Alternatives considered for selection must comply with the primary criteria. These are:

- protection of human health and the environment,
- attainment of cleanup standards,
- source control, and
- compliance with applicable waste management standards.

Protection of Human Health and the Environment

This criterion evaluates the overall degree of protectiveness afforded to human health and the environment. The overall assessment of protection draws on the assessments conducted under other evaluation criteria, especially the other three primary criteria.

Alternative 1, no further remedial action, provides no additional protection to receptors. The soil would remain onsite. Current site risk is within the USEPA acceptable residential risk range of 1E-06 to 1E-04.

Alternative 2, institutional controls, protects receptors by controlling land use. The soil would remain onsite, but risks to future residents would be reduced by elimination of dermal contact and ingestion pathways that exist with uncontrolled access. Additionally, current site risk is within the USEPA acceptable residential risk range of 1E-06 to 1E-04.

Alternative 3, phytoremediation, protects human health and the environment by slowly removing, transforming, or immobilizing contaminants that contribute to site risk. Coupled with institutional controls, this alternative eliminates dermal contact and ingestion pathways over time.

Alternatives 4 and 5, excavation with offsite disposal, protect human and health and the environment through removal of affected soil media. Excavation and offsite disposal, coupled with risk reduction methods that focus removal activities, aim to efficiently reduce site risk and achieve remedial objectives by maximizing contaminant removal and minimizing soil removal.

Attainment of Cleanup Standards

Since current site risk is within the USEPA acceptable residential risk range of 1E-06 to 1E-04, alternative 1 can be considered compliant with remedial objectives. However, the contaminated soil would remain onsite.

Alternative 2 complies with remedial objectives for protection of human health and the environment because the risk pathway is eliminated by institutional controls. However, the contaminated soil would remain onsite.

Alternative 3 complies with remedial objectives; however, this technology would require years to attain cleanup standards.

Alternatives 4 and 5 comply with remedial objectives by removing the affected soil. Alternatives 4 and 5 reduce site risk by removing the most contaminated areas using the risk reduction evaluation to focus removal actions on areas that exceed remedial objectives. These alternatives would require approximately one month to achieve cleanup standards.

Source Control

Although Alternatives 1 and 2 do not specifically address source control, there are no known sources of additional contaminants present at SWMU 42/AOC 505 and current site risk is within the USEPA acceptable residential risk range of 1E-06 to 1E-04. Although existing contaminated soil would remain onsite, sources of additional contamination have been removed. The removal of chemicals stored in the golf course maintenance building and related contaminant sources in AOC 505 and the interim response actions performed by the DET have eliminated sources of contamination.

Alternative 3 would provide effective source control by slowly removing, transforming, or immobilizing contaminants in the soil that contribute to site risk. Disposal of resulting affected plant material would eliminate the contaminants from the site.

Alternatives 4 and 5 would provide effective source control by eliminating the most contaminated soil. However, contaminated soil that contributes to acceptable residual site risk equivalent to background levels would remain onsite. These alternatives would effectively control the source by eliminating media in which contaminants exceed remedial objectives.

Compliance with Applicable Waste Management Standards

No waste would be managed under Alternatives 1 and 2. Therefore, the waste management standards do not apply.

Alternative 3, phytoremediation, might trigger transportation and land disposal restrictions if contaminated harvested materials require offsite disposal.

Alternatives 4 and 5, excavation with offsite disposal, might require compliance with federal, state, and local air emissions and storm water control regulations. Transportation and land disposal restrictions would be triggered by disposal of contaminated soil offsite. Due to relatively low-level contamination, it is anticipated that excavated soil is nonhazardous. However, it would be verified by TCLP analysis to determine proper disposal options.

5.4.1.2 Secondary Criteria

The criteria that distinguish the soil alternatives are the secondary criteria since the primary criteria must be met for an alternative to be considered. The secondary criteria are:

- long-term reliability and effectiveness,
- reduction of mobility, toxicity, and volume,
- short-term effectiveness,
- implementability, and
- cost.

Long-term Reliability and Effectiveness

Alternatives 1 and 2 lack treatment actions that would require reliability and effectiveness. Institutional controls are limited to the ability to control access to contaminated soil.

Alternative 3 is limited to research and minimal field testing. However, only institutional controls would be required to prevent exposure to human and environmental receptors during the application of phytoremediation.

Alternatives 4 and 5, excavation with offsite disposal, would reduce the quantity of soil in which contaminant concentrations exceed site-wide risk reduction remedial objectives. As such, background residual risk would remain following the completion of these remedial alternatives.

Reduction in Waste Toxicity, Mobility, or Volume

Alternatives 1 and 2 do not reduce contaminant toxicity, mobility, or volume. The volume and concentration of contaminants in the soil would remain unchanged, but current site risk is within the USEPA acceptable residential risk range of 1E-06 to 1E-04.

Alternative 3 effectively reduces toxicity, mobility, and volume by slowly removing, transforming, or immobilizing contaminants in the soil that contribute to site risk. With appropriate monitoring and maintenance, these processes would be irreversible.

Alternatives 4 and 5, excavation with offsite disposal, eliminate the contaminants that affect site remedial objectives. However, since the contaminated soil would be transferred to another location (Subtitle C or D landfill), the waste's overall toxicity, mobility, and volume would not be reduced with these alternatives.

Short-term Effectiveness

No short-term effects are associated with Alternatives 1 and 2.

Alternatives 3, 4, and 5 include exposure to workers, which can be effectively controlled using engineering controls and appropriate PPE during planting, grading, or excavating activities. The remedial time frame for Alternative 3 is relatively long since it relies on biological and assimilative processes. However, worker exposure during O&M activities would be minimal. The remedial time frames for Alternatives 4 and 5 are relatively short (likely less than one month).

Implementability

All five alternatives can be implemented at Combined SWMU 42/AOC 505 and are technically and administratively feasible.

Cost

Capital (indirect and direct), O&M, and net present worth for the five alternatives are presented in Table 5.8. Alternatives range in cost from none for no further remedial action to $1,241,200 for excavation of areas exceeding Zone A background concentrations with offsite disposal at a Subtitle C landfill.

5.4.2 Comparative Analysis of Groundwater Alternatives

There are no groundwater remedial alternatives to compare.

5.5 Summary and Ranking of Alternatives

Per the projects team's request, each soil alternative was scored for each of the primary and secondary criteria based on the comparative analysis of alternatives in Section 5.3. Primary and secondary criteria scoring methodologies are presented as:

Primary Criteria		**Secondary Criteria**	
0 — criteria not met	**2** — criteria met	**0** — poor	**2** — average
1 — criteria may be met	**3** — criteria exceeded	**1** — below average	**3** — above average

The scores can be multiplied by a weighting factor to emphasize their importance. At this time, the primary criteria have been weighted more heavily than the secondary criteria. A comment is included to justify each score and summarize the comparative analysis discussed in Section 5.3.

Finally, the scores for each criteria are summed to develop an overall score for each alternative, which is used to rank the five remedial alternatives and provide a tool for selecting the final site remedy. The results are summarized in Tables 5.9 through 5.13.

The recommended final site remedy is discussed in Section 6.

Table 5.8
Soil Alternatives Cost Comparison

	Alternative	Capital Costs	Annual O&M	Net Present Worth
1	No Further Remedial Action	none	none	none
2	Institutional Controls	$50,000	$10,000 (every five years)	$74,000
3	Phytoremediation	$268,300	$31,220	$698,300
4a	Excavation to Zone A Residential Background Inorganic Site Risk with offsite disposal (Subtitle D)	$103,600	none	$103,600
4b	Excavation to Zone A Residential Background Inorganic Site Risk with offsite disposal (Subtitle C)	$485,700	none	$485,700
5a	Excavation of Areas Exceeding Zone A Background Concentrations with Offsite Disposal (Subtitle D)	$265,300	none	$265,300
5b	Excavation of Areas Exceeding Zone A Background Concentrations with Offsite Disposal (Subtitle C)	$1,241,200	none	$1,241,200

Table 5.9
Summary of Evaluation of Soil Alternative: No Further Remedial Action

Evaluation Criteria	Weighting Factor[1]	Comments	Score[2]	Score x WF
Primary Criteria				
Protection of human health and the environment	2	Soil would remain onsite, but risk is within the USEPA acceptable range of 1E-06 to 1E-04.	~~2~~ 0	4
Attainment of cleanup standards	2	Existing site residential risk is within the USEPA acceptable range of 1E-06 to 1E-04.	~~2~~ 0	4
Source control	2	No known contaminant sources exist.	2	4
Compliance with applicable waste management standards	2	No waste is managed under this alternative. Therefore, the waste management standards do not apply.	2	4
Secondary Criteria				
Long-term reliability and effectiveness	1	Lacks treatment actions that would require reliability and effectiveness. The volume and concentration of contaminants would be left in place, ~~but site risk is within the USEPA acceptable range of 1E-06 to 1E-04~~. delete	1	1
Reduction in waste toxicity, mobility, and volume	1	Does not reduce toxicity, mobility, ~~or~~ volume of waste, ~~but site risk is within the USEPA acceptable range of 1E-06 to 1E-04~~. delete	1	1
Short-term effectiveness	1	There are no short-term effects associated with this alternative.	3	3
Implementability	1	Technically and administratively feasible. Most rapid alternative to implement.	3	3
Cost	1	none	3	3
Ranking Score				**27**

Notes:
PW — present worth
1 — Weighting factor assigned by project team consensus.
2 — Primary criteria-specific evaluation score: 0 — criteria not met; 1 — criteria may be met; 2 — criteria met; 3 — criteria exceeded
Secondary criteria-specific evaluation score: 0 — poor; 1 — below average; 2 — average; 3 — above average

Table 5.10
Summary of Evaluation of Soil Alternative: Institutional Controls

Evaluation Criteria	Weighting Factor[1]	Comments	Score[2]	Score x WF
Primary Criteria				
Protection of human health and the environment	2	Protects receptors by preventing land use. Soil would remain onsite, but risks would be reduced by eliminating exposure pathways.	2	4
Attainment of cleanup standards	2	Existing site residential risk is within the USEPA acceptable range of 1E-06 to 1E-04.	2	4
Source control	2	Eliminates access to contaminant sources, if they exist.	2	4
Compliance with applicable waste management standards	2	No waste is managed under this alternative. Therefore, the waste management standards do not apply.	2	4
Secondary Criteria				
Long-term reliability and effectiveness	1	Lacks treatment actions that would require reliability and effectiveness. The volume and concentration of contaminants would be left in place, but site risk is within the USEPA acceptable range of 1E-06 to 1E-04.	1	1
Reduction in waste toxicity, mobility, and volume	1	Does not reduce toxicity, mobility, or volume of waste, but site risk is within the USEPA acceptable range of 1E-06 to 1E-04.	1	1
Short-term effectiveness	1	There are no short-term effects associated with this alternative.	3	3
Implementability	1	Technically and administratively feasible.	3	3
Cost	1	PW = $74,400	2	2
Ranking Score				**26**

Notes:
PW — present worth
1 — Weighting factor assigned by project team consensus.
2 — Primary criteria-specific evaluation score: 0 — criteria not met; 1 — criteria may be met; 2 — criteria met; 3 — criteria exceeded
Secondary criteria-specific evaluation score: 0 — poor; 1 — below average; 2 — average; 3 — above average

Table 5.11
Summary of Evaluation of Soil Alternative: Phytoremediation

Evaluation Criteria	Weighting Factor[1]	Comments	Score[2]	Score x WF
Primary Criteria				
Protection of human health and the environment	2	Protects human health and the environment by slowly removing, transforming, or immobilizing contaminants. Coupled with institutional controls.	2	4
Attainment of media cleanup standards	2	Complies with remedial objectives. Requires relatively lengthy treatment period.	2	4
Source control	2	Slowly removes or immobilizes existing contamination.	2	4
Compliance with applicable waste management standards	2	Meets remedial objectives. Transportation and land disposal restrictions might be triggered if contaminated harvested materials require offsite disposal.	2	4
Secondary Criteria				
Long-term reliability and effectiveness	1	Limited to research and limited field testing.	1	1
Reduction in waste toxicity, mobility, and volume	1	Effective reduction of toxicity, mobility, and volume. With appropriate monitoring and maintenance, process should be irreversible.	2	2
Short-term effectiveness	1	Minimal worker exposure, which can be effectively controlled with engineering controls and PPE.	2	2
Implementability	1	Technically and administratively feasible. The slowest alternative to implement.	1	1
Cost	1	PW = $698,300	0	0
Ranking Score				**22**

Notes:
PW — present worth
1 — Weighting factor assigned by project team consensus
2 — Primary criteria-specific evaluation score: 0 — criteria not met; 1 — criteria may be met; 2 — criteria met; 3 — criteria exceeded
Secondary criteria-specific evaluation score: 0 — poor; 1 — below average; 2 — average; 3 — above average

Table 5.12
Summary of Evaluation of Soil Alternative:
Excavation to Zone A Residential Background
Inorganic Site Risk with Offsite Disposal

Evaluation Criteria	Weighting Factor[1]	Comments	Score[2]	Score x WF
Primary Criteria				
Protection of human health and the environment	2	Removes soil to a restricted access area (landfill) where exposure pathways are minimal.	~~3~~ 0	6
Attainment of cleanup standards	2	Complies with risk reduction remedial objectives.	~~3~~ 0	6
Source control	2	Effective source control by eliminating most contaminated media. Soil exceeding calculated background concentrations would be removed.	~~3~~ 2	6
Compliance with applicable waste management standards	2	Meets remedial objectives. Remedial activities must comply with air emissions and storm water regulations, and transportation and land disposal restrictions.	2	4
Secondary Criteria				
Long-term reliability and effectiveness	1	Residual site risk would be reduced to the background inorganic risk level.	2	2
Reduction in waste toxicity, mobility, and volume	1	Eliminates soil that exceeds site risk remedial objectives. However, overall toxicity, mobility, or volume would not be reduced.	1	1
Short-term effectiveness	1	Minimal worker exposure, which can be effectively controlled with engineering controls and PPE.	2	2
Implementability	1	Technically and administratively feasible. Would require 900 yd^3 clean fill.	2	2
Cost	1	PW = $103,600 (nonhazardous soil) PW = $485,700 (hazardous soil)	2 1	2 1
Ranking Score				**30 to 31**

Notes:
PW — present worth
1 — Weighting factor assigned by project team consensus.
2 — Primary criteria-specific evaluation score: 0 — criteria not met; 1 — criteria may be met; 2
3 — criteria exceeded
Secondary criteria-specific evaluation score: 0 — poor; 1 — below average; 2 — average; 3 — above

Table 5.13
Summary of Evaluation of Soil Alternative:
Excavation of Areas Exceeding Zone A Background
Concentrations with Offsite Disposal

Evaluation Criteria	Weighting Factor[1]	Comments	Score[2]	Score x WF
Primary Criteria				
Protection of human health and the environment	2	Removes soil to a restricted access area (landfill) where exposure pathways are minimal.	3	6
Attainment of cleanup standards	2	Complies with risk reduction remedial objectives.	3	6
Source control	2	Effective source control by eliminating most contaminated media. Soil exceeding calculated background concentrations would be removed.	3	6
Compliance with applicable waste management standards	2	Meets remedial objectives. Remedial activities must comply with air emissions and storm water regulations, and transportation and land disposal restrictions.	2	4
Secondary Criteria				
Long-term reliability and effectiveness	1	Residual site risk would be reduced to below the background inorganic risk level.	2	2
Reduction in waste toxicity, mobility, and volume	1	Eliminates soil that exceeds site risk remedial objectives. However, overall toxicity, mobility, or volume would not be reduced.	1	1
Short-term effectiveness	1	Minimal worker exposure, which can be effectively controlled with engineering controls and PPE.	2	2
Implementability	1	Technically and administratively feasible. Would require 2,300 yd^3 clean fill.	2	2
Cost	1	PW = $265,300 (nonhazardous soil) PW = $1,241,200 (hazardous soil)	1 0	1 0
Ranking Score				**29 to 30**

Notes:
PW — present worth
1 — Weighting factor assigned by project team consensus
2 — Primary criteria-specific evaluation score: 0 — criteria not met; 1 — criteria may be met; 2 — criteria met; 3 — criteria exceeded
Secondary criteria-specific evaluation score: 0 — poor; 1 — below average; 2 — average; 3 — above average

6.0 RECOMMENDATIONS

Recommendations for the soil and groundwater remedial alternatives are outlined here. Selection of the final alternatives was based on primary and secondary criteria evaluation, remedial alternative comparative analysis, and professional judgment.

6.1 Soil Remedial Alternative

Based on the rationale and decision factors in the previous sections, Alternative 5, Excavation to Zone A Residential Background Inorganic Site Risk with Offsite Disposal, is the recommended remedial alternative for SWMU 42/AOC 505. This alternative was selected for several key reasons:

- It achieved the highest score on the *Project Team Evaluation Table*.
- Residual residential site risk would be 2.5E-05, which is equivalent to inorganic background site risk.
- It would be the least expensive *active* alternative for managing nonhazardous soil ($103,600).
- It would be the most rapid *active* remedial alternative — least site impact.
- No O&M would be required — no remaining liabilities once initial remedial activities are completed.
- It protects human health and the environment overall.

- No institutional controls and encumbrances on the property would be required because impacted media exceeding site background risk would be removed from the site.

- It allows for unrestricted reuse and redevelopment of the site.

6.2 Groundwater Remedial Alternative

Based on the rationale and decision factors in the previous sections, SWMU 42/AOC 505 groundwater does not require remedial action. Therefore, no recommendation is being presented.

7.0 PUBLIC INVOLVEMENT PLAN

7.1 General

The following Public Involvement Plan (PIP) is included as part of this report in accordance with the EPA's guidance on RCRA CMS. This PIP reflects and summarizes information prepared and presented in the Navy's Community Relations Plan (CRP), prepared for Naval Base Charleston in 1995.

Under RCRA, there is no required interaction with the community during the Corrective Measures Study process. Public input is required to be solicited only at the beginning of the permitting process, or during certain permit modifications. Therefore, the Navy has outlined a voluntary program of informing local communities throughout the entire RCRA Corrective Action process. Activities are detailed in the 1995 CRP for the Naval Base Charleston.

However, because the CMS process results in a modification to the facility's RCRA permit, certain provisions are made to solicit the public's input on the preferred alternative (as the reason for the modification). The requirements are identical to those required for a draft permit.

Two primary objectives are stated in the CRP:

- To initiate and sustain community involvement.
- To provide a mechanism for communicating to the public.

7.2 RFI Public Involvement Plan

To achieve these objectives, the CRP identifies public involvement and outreach activities at each step of the Corrective Action process. For example, the following activities have been designated for the completion of the RFI. All have been accomplished.

- Update and publicize the information repository.
- Continue to publicize the point of contact.
- Update the mailing list.
- Distribute fact sheets and/or write articles to explain RFI findings.
- Inform community leaders of the completion and results of the RFI.
- Update and continue to provide, whenever possible, presentations for informal community groups.
- Update the community on results of the RFI through public Restoration Advisory Board meetings.

7.3 CMS Public Involvement Plan

During the Corrective Measures Study, the following activities will be carried out as part of the Navy's current and ongoing community involvement program.

- Distribute a fact sheet and/or write articles for publication that report CMS recommendations.
- Continue to update the mailing list.
- Continue to respond to requests for speaking engagements.

- Update the community on CMS status through public Restoration Advisory Board meetings.

7.4 Statement of Basis Public Involvement Plan

Upon completion of the Corrective Measures Study (when the preferred alternative has been selected) the following activities are required:

- A Statement of Basis will be prepared, explaining the proposed remedy and the method by which it was chosen.
- A 45-day comment period will be provided to allow community members the opportunity to review and comment on the preferred alternative.
- The availability of the comment period and Statement of Basis will be announced in a public notice.
- The community will be provided an update on the preferred remedy through the informal and publicized Restoration Advisory Board meetings.

In addition, the following activities will be carried out, as identified in the CRP:

- Update and publicize the information repository.
- Publicize the environmental point of contact.
- Continue to update the mailing list.

7.5 Restoration Advisory Board

The RAB is a key component of this community outreach program. It is through the RAB that the Navy has a regular, scheduled, and publicized forum for interfacing with community members on the progress of the environmental program, including CMS. In addition, RAB members are key instruments in measuring community interest in specific issues and knowledge of them. A Community Relations Subcommittee to the RAB has been tasked with identifying issues and information to be addressed by the Navy.

8.0 REFERENCES

EnSafe/Allen & Hoshall, Inc. (1997). *Final Comprehensive Corrective Measures Study Project Management Plan and Work Plan,* Volumes I and II, Memphis, Tennessee, June 25, 1997.

EnSafe/Allen & Hoshall, Inc. (1998). *Final RCRA Facility Investigation Report Zone A Naval Base Charleston*, Memphis, Tennessee, 1998.

EnSafe Inc. (1998). *Zone A Corrective Measures Study Work Plan*, Memphis, Tennessee, 1998.

Environmental Detachment Charleston, Charleston, South Carolina (1998), *Completion Report, Interim Measure for SWMU 42 Former Asphalt Tanks*, Naval Base Charleston, Charleston, South Carolina; July 17, 1997.

SCDHEC *Bureau of Solid Waste Management Assessment and Remediation Criteria*, Memorandum issued from H.W. Truesdale, Bureau Chief, to Division Directors, July 31, 1995.

9.0 SIGNATORY REQUIREMENT

Condition I.E. of the Hazardous and Solid Waste Amendments (HSWA) portion of the RCRA Part B Permit (EPA SCO 170 022 560) states: All applications, reports, or information submitted to the Regional Administrator shall be signed and certified in accordance with Section 40 CFR 270.11. The certification reads as follows:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

________________________________ Date ________________

Henry N. Sheppard II, P.E.
Caretaker Site Office, Charleston