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CORRECTIVE MEASURES STUDY REPORT ZONE H COMBINED SOLID WASTE  
MANAGEMENT UNIT 14 (SWMU 14) CNC CHARLESTON SC  
5/18/1999  
ENSAFE

**ZONE H  
COMBINED SWMU 14  
CORRECTIVE MEASURES STUDY REPORT  
CHARLESTON NAVAL COMPLEX  
CHARLESTON, SOUTH CAROLINA**



**CONTRACT NUMBER: N62467-89-D-0318  
CTO-029**

**Prepared for:**

**Department of The Navy  
Southern Division  
Naval Facilities Engineering Command  
Charleston, South Carolina**



**Prepared by:**

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**May 18, 1999**

## Dodds, David P

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**From:** Dodds, David P  
**Sent:** Monday, June 28, 1999 11:54 AM  
**To:** Larry (E-mail); Thaverkost (E-mail)  
**Cc:** Hunt, M A (Tony)  
**Subject:** Zone H , SWMU 14 CMS Report comments

### General:

- 1) Where you state a risk calculation for a site or point, you need to either present the calculation (in an appendix?), reference the RFI section where it can be found, etc. We should expect DHEC to duplicate these calculations so they should be able to find the equations and default values we used.
- 2) Any data not in the RFI should be presented in detail. We should state what additional sampling was taken and present the data in full, data sheets, chain of custody, and validation reports. All supporting information for the data that was required for the RFI should be presented in the CMS if that is the first time anyone will see it. Otherwise, we will not have this supporting information in the record.
- 3) When an IM has been done, as it has with this site, the risk assessment should be redone and presented in the CMS report and that should be the basis for alternative evaluation.

### Comments:

- 1) Page 1-1. Please identify in parenthesis what Combine SWMU 14 is the first time you state it as opposed to waiting until section 2.
- 2) page 2-3. After the RFI discussion please identify any post-cms sampling and any sample locations which were "removed" as a result of the IM. This is a good location to present any additional post-RFI data collected and reference supporting information. Also, make a statement indicating whether "removal"/addition of these samples changes the risk assessment performed in the RFI and if so, how?
- 3) Page 2-4. SWMU 14 discussion. Please reference the supporting information which justifies Lead being added as a COC.
- 4) Page 2-8. AOC 670 and 684 paragraph. This seems to be the place to discuss the elimination of beryllium. Also, you need to explain, provide supporting information as to why Lead was added.
- 5) Page 2-17. Please make sure that this section takes into account all points removed by IM and added by CMS sampling. The text of this section does not discuss risk numbers but the figures show point risks. It would seem appropriate to discuss 95% UCL site wide risk in this section as the basis for selecting the No Further Action. Based on informal discussions with DHEC it appears that they will request/require us to cleanup or justify no-action for any site in the risk range. Therefore, we should be laying the ground now for showing that there is only minimal risk above background presented by certain compounds at sites where that is the case. This may be used for reducing the number of COCs we need to address. For example, if the site -wide Arsenic UCL for Combined SWMU 14 is below background, it should be eliminated from further consideration in the CMS. So, I recommend presenting 95 % UCL in this section and looking at UCLs as Combined UCLs not per AOC or SWMU within the Combined 14.
- 6) Page 2-20. Aroclor 1260. I suggest that when we talk about exceedences of the PCB we add the statement. "However, none of the sample locations exceeded the preliminary remediation goal (40 CFR 761.120)." We might as well start covering this to acknowledge that we would not cleanup concentrations less than that for PCBs. Please include the Combined SWMU 14 95% UCL for all compounds.
- 7) Page 2-25, Corrective Measures Investigation. I suggest that you add a statement in this paragraph that the DET is completing an ISM to remove Lead shot "hot spots" and the berm and reference a schedule and the workplan title/date. This is so that the reader immediately sees the solution to this problem instead of waiting until later in the document. Also, please include all data support information here or in an appendix.
- 8) Page 2-32. The paragraph on well sampling is not clear as to which wells correspond to which samples. We should acknowledge here that the first round of Well NBCH014006 had exceedences of MCLs and RBCs for Vinyl Chloride but that the next round of sampling was non detect for these. We should really consider another VOC round here in that well. A bigger deal should be made that follow-up rounds were non-detect for VOCs. Also, additional data support information should be provided and referenced.
- 9) Page 2-33. Second paragraph. I suggest that you use the words "would not be expected" instead of "can not be predicted". You can add "The Navy's opinion is..." if you wish.
- 10) Page 2-34. Second paragraph. I suggest that on the last line you change may to "was thought to have" because we should know by know whether the DANC containers did or did not impact the media. Please make sure you reference the specific DET report discussing the DANC removal. In the Third full paragraph I suggest you add "as stated above, confirmation sampling has demonstrated that all residuals in soil have since been removed from the site." after the third sentence. I am assuming that this is the case. If the DET did not pump-out the hole prior to backfill or take another action that would eliminate these detected compounds in ground water we may very well be open to criticism. I suggest

the forth sentence be revised to read "Furthermore, groundwater samples from wells within the former burial location collected during the CMS..."

11) Page 2-37. Please refer to the specific DET Workplan for this action. The W/P was passed out at the June 99 PT mtg. Also, indicate in the paragraph that all lead above 400 ppm will be removed.

12) Page 3-1 Arsenic discussion. Based on recent discussions w/ DHEC they will want to know when the "release" occurred to make a judgment whether it is likely it will migrate to groundwater. Use best information/judgment to state when a release is likely to have occurred. Something like, "Operations on the site which are likely to be the source of an arsenic release occurred on the site from approximately 19xx to 19xx." Perhaps section 3.1 is where we should make our case that Combined SWMU 14 Site Wide UCLs, not per AOC/SWMU are less than reference/screening levels and eliminate them. To do this we need to give the 95% UCL numbers, not just state it is less than the reference as we did for Thallium. Again, if we are going to use the argument that groundwater has not been impacted "in all this time" we need to be prepared to state how long it has been.

13) Page 3-3. For PCBs please add the statement that they are below preliminary cleanup goals. The last paragraph on this page covers "antimony contamination". Should we refer to "detections" vs. "contamination". Also, is it likely that there is an antimony plume? I am assuming we are looking at low flow sampling to address groundwater. This last bullet does not take away any of my concern for Thallium. Instead, it causes me to wonder where I'm going to see antimony addressed. I suggest deleting this last bullet on page 3-3, second of three.

14) Page 3-4, Section 3.2. Again, I suggest getting another round of VOC data from well 006.

15) Page 3-5. I like the reduction of risk presentation, but isn't reduction of hazard as relevant?

16) Table 3-1. I suggest inserting the background risk levels as you did on the figure for presentation. It has a strong impact.

17) Table 3-2. Please Bold or other indication of the proposed RGOs so we can let the PT know what we want to use.

18) Section 4. At the end of Section 4 please add a summary table presenting the alternatives which passed the screening process.

19) Section 5. Throughout section 5 HQ should be considered when determining acceptance of risk and attainment of cleanup goals. For instance I don't agree that Alternative 1 is acceptable because it presents an acceptable exposure based on Hazard.

20) Page 5-18, Section 5.2.3. Shouldn't Landfarming be screened out in section 4 because it is not effective for inorganics? At least this weakness should be acknowledged throughout section 5.2.3. I see where inorganics are "immobilized". We would need to show that this occurred and that the situation would remain constant in perpetuity, I suppose, for this to be an effective remedy for inorganics. I am skeptical. I do not suggest any changes except that HQ discussions be included.

21) Figure 5.2. What is the difference between Excavation Areas and Areas Requiring Excavation?

22) Page 5-44. Attainment of Cleanup Goals. Based on my understanding of HQ at the site Alt. 1 would not be acceptable.

23) Table 5-10a. I would give Alt. 1 a ) for Protection since HQ is exceeded and state that in the Comment section. In 5-10b, I would give Alt.2 a 1 for attainment since it is questionable whether the cleanup objectives would be met. In 5-10c, I would give Landfarming a 1 for Attainment since it is questionable whether the inorganic levels would be demonstrated. Also, at the end of this section I suggest adding a summary table with the final scores bolding the proposed alternative.

24) I question how Alt. 1 can be proposed when the HQ is exceeded. But we will need to demonstrate clearly that there is not significant risk above background or this will never fly. I suggest emphasis on risk above background, on a per compound basis if necessary. Also, section 5 seems to emphasize the score as being the criteria but Alt. has the lowest? Some clarification will be needed.

Feel free to call to discuss any of these. Thanks, David

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Memphis, Tennessee 38134  
(901) 383-9115**

**May 18, 1999**

*Need to directly  
reference ~~the~~ paragraph  
in an approved document  
for the risk assessment  
process you used and  
expect DTRC to  
want to  
duplicate.*

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## 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 Combined SWMU 14 at the Charleston Naval Complex (CNC) Charleston, South Carolina.

*What is  
this needed?*

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 Combined SWMU 14's 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**

Combined SWMU 14 encompasses SWMUs 14 and 15, and AOCs 670 and 684 as shown on Figure 2-1. SWMU 14 is an abandoned chemical disposal area where miscellaneous chemicals, warfare decontaminating agents, and possibly industrial wastes are reported to have been buried. SWMU 15 is the site of a former propane-fired incinerator reported to have been used to destroy classified documents. Only the concrete slab and concrete propane tank saddles remain. AOC 670 is a former outdoor trap and skeet range in use from approximately 1960 until the late 1970s. Lead shot and clay targets were not recovered during its operation. AOC 684 is a former outdoor pistol range that operated from the early 1960s until 1981. Firearms were discharged into a soil berm; spent ammunition was not recovered. The discussion of nature and extent of contamination in the RFI included all samples collected in the Combined SWMU 14 area prior to ISM and the CMS.

### **Current and Future Use**

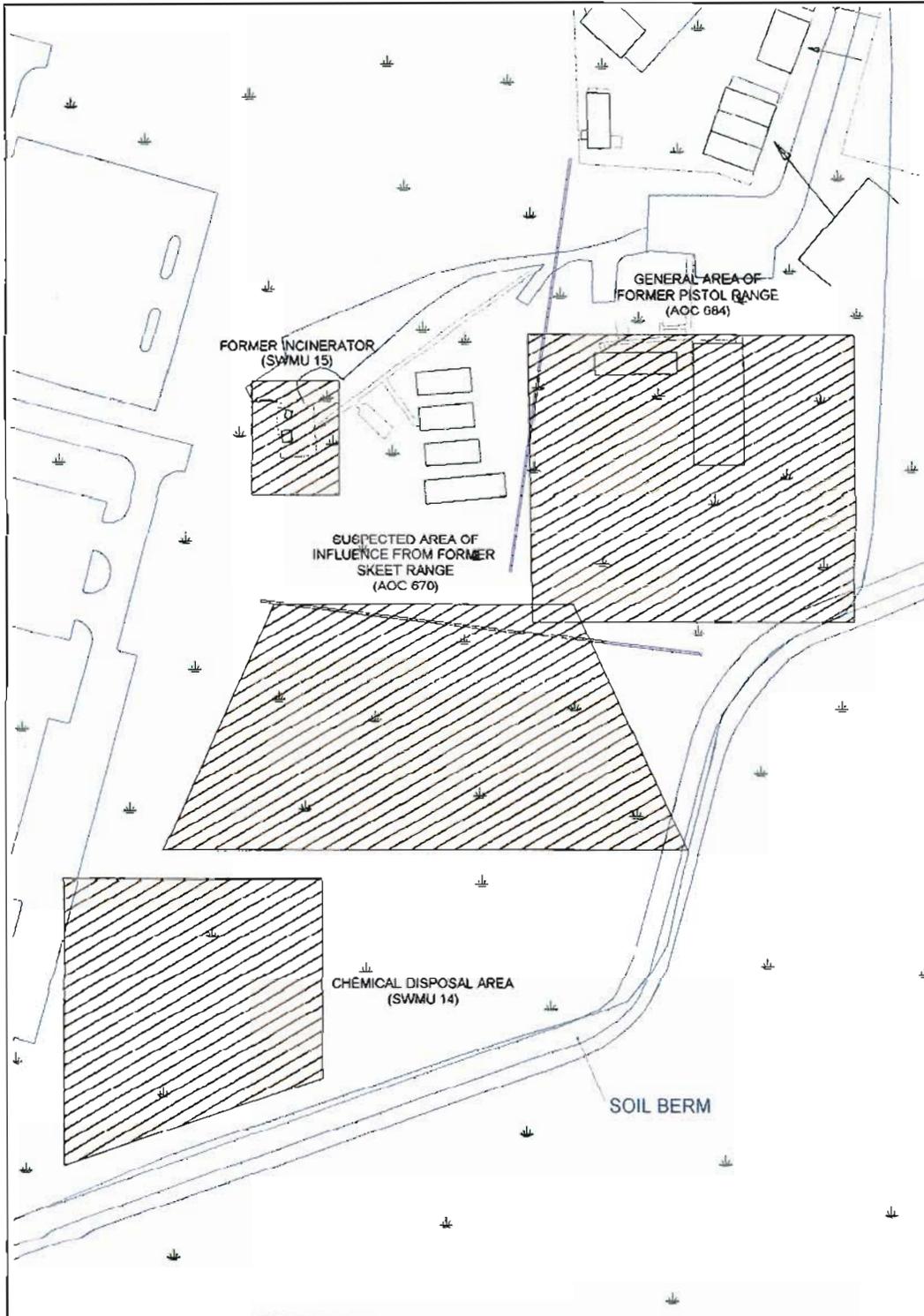
The Combined SWMU 14 site is not currently used by either federal or nonfederal tenants. According to the Charleston Naval Complex Redevelopment Authority, this area may be used for industrial or recreational purposes in the future.

## **2.2 Sampling Results**

### **2.2.1 Soil Sampling and Analysis**

#### **Geophysical and Soil-Gas Survey**

A 1992 geophysical and soil-gas survey (E/A&H, 1994) investigated the presence of buried containers and/or contaminant plumes in the Combined SWMU 14 area. Geophysical and soil-gas samples were collected on a 100-by-100-foot grid, with some additional samples taken to detail plan-view anomalies. Geophysical anomalies identified during the geophysical survey were used



**LEGEND**

- BUILDING BOUNDARY
- FENCE
- ROAD
- SIDE-WALKS
- DRAINAGE DITCH
- GRASS
- AOCs and SWMUs



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 Charleston, SC



Figure 2.1  
 Site Map

as a basis for subsequent RFI and ISM sampling. Most of the soil-gas stations returned below-detection concentrations for individual analytes and total volatiles. As such, the soil-gas data suggest that the contaminants in the soil itself were not significant; several explanations were provided:

- Spills may have never occurred.
- Substances not analyzed for were spilled.
- Contamination is deeper than the soil gas sampling.
- Contaminants had migrated or diffused.
- Contaminants are bound up in silty, clayey soils.

The geophysical and soil-gas investigation report was included in Appendix E of the Final RFI Report for Zone H.

### RCRA Facility Investigation

Soil was sampled during the RFI to identify whether contamination resulted from chemicals and other waste disposal in the Combined SWMU 14 area and whether residual chemical contamination resulted from small arms activities nearby. One hundred and thirty-five (72 upper-interval and 63 lower-interval) soil samples were collected during the first round of soil sampling near SWMU 14. Most of the contamination detected in RFI soil samples at Combined SWMU 14 was apparently related to the former incinerator (SWMU 15) and the former skeet range

(AOC 670).

*Include text/figures describing any "past -RFI" sampling completed and refer to complete data package/ validation package in the appendix.*

Identification of Contaminants of Concern in Soil

COCs in the Combined SWMU 14 area were based on the soil sampling results, fate-and-transport analysis, and risk-based calculations conducted during the RFI.

### ***SWMU 14 Contaminants of Concern***

Six COCs were identified in the samples collected from the SWMU 14 portion of the Combined SWMU 14 sampling area: 1,2,3-trichloropropane, benzo(a)pyrene equivalents (BEQs), aluminum, arsenic, beryllium, and vanadium. The primary contributors to surface soil risk were arsenic, BEQs, and beryllium. The primary hazard contributors were aluminum, arsenic, and vanadium. However, after the RFI was completed, the residential soil RBC for beryllium changed from 0.15 milligrams per kilogram (mg/kg) to 160 mg/kg (USEPA Region III Risk-Based Concentration (RBC) Table, 1998) since it is no longer considered a carcinogenic compound except for ambient air. As a result, beryllium was no longer considered a COC for SWMU 14. Following the corrective measures investigation, lead was classified as an additional COC for SWMU 14. SWMU 14 COC data are summarized in Table 2-1.

*Based on what?  
Where is the data?*

### ***SWMU 15 Contaminants of Concern***

Arsenic and BEQs were identified as COCs in the SWMU 15 portion of the Combined SWMU 14 sampling area. The primary contributors to surface soil risk were arsenic and BEQs. The sole hazard contributor was arsenic. Following the corrective measures investigation (see Section 2.3), lead was classified as an additional COC for SWMU 15. SWMU 15 COC data are summarized in Table 2-2.

**Table 2-1**  
**Zone H Soil Data for COCs at SWMU 14**

Sample Number	Aluminum (mg/kg)	Arsenic (mg/kg)	Lead (mg/kg)	Vanadium (mg/kg)	1,2,3-Trichloropropane ( $\mu$ g/kg) <sup>b</sup>	BEQs <sup>a</sup> ( $\mu$ g/kg)
RBC	7,800	0.43	400	55	91	87
Surface Soil Background	26,000	15.6	118	73	NA	424
Subsurface Soil Background	46,200	22.5	68.7	132	NA	NA
SSL	560,000	15	400	3,000	0.0051	1,600
<b>Upper-interval Soil Samples</b>						
014-S-B-001-01	NS <sup>c</sup>	14.2 UJ	44.5 UJ	50.1	5.0 U	92.1 U
014-S-B-002-01	NS	16.8 UJ	44.6 UJ	65.1	5.0 U	92.1 U
014-S-B-003-01	NS	11.0 UJ	24.8 UJ	68.6	5.0 U	92.1 U
014-S-B-004-01	NS	17.9 UJ	72.5	68.6	5.0 U	92.1 U
014-C-B-004-01	NS	11.9	95.2 J	55.8	5.0 U	92.1 U
014-S-B-005-01	NS	19.2 UJ	915.0	65.7	5.0 U	96.0
014-S-B-006-01	NS	16.8 UJ	808.0	68.8	5.0 U	92.1 U
014-S-B-007-01	NS	13.2 UJ	83.0	62.5	5.0 U	122.7
014-S-B-008-01	NS	16.2 UJ	295.0	40.4	91.2	92.1 U
014-S-B-009-01	NS	13.8 UJ	164.0	63.1	5.0 U	92.1 U
014-S-B-010-01	29,600	19.3 U	656.0	71.9	NS	NS
014-S-B-011-01	14,800	10.7 U	134.0	49.3	NS	NS
014-S-B-106-01	24,600	13.6	320 J	67.9	NS	1,475.2
014S-W-001-14	NS	20.3 UJ	16.7 UJ	41.2	5.0 U	92.1 U

Table 2-1  
 Zone H Soil Data for COCs at SWMU 14

Sample Number	Aluminum (mg/kg)	Arsenic (mg/kg)	Lead (mg/kg)	Vanadium (mg/kg)	1,2,3-Trichloropropane ( $\mu\text{g}/\text{kg}$ ) <sup>b</sup>	BEQs <sup>a</sup> ( $\mu\text{g}/\text{kg}$ )
<b>Lower-interval Soil Samples</b>						
014-S-B-001-02	NS	10.4 UJ	18.1 UJ	29.8 UJ	5.0 U	92.1 U
014-S-B-002-02	NS	10.3 UJ	18.8 UJ	35.0	5.0 U	92.1 U
014-S-B-003-02	NS	8.2 UJ	26.3 UJ	41.1	5.0 U	92.1 U
014-S-B-004-02	NS	7.5 UJ	17.0 UJ	22.9 UJ	5.0 U	92.1 U
014-S-B-005-02	NS	12.8 UJ	27.0 UJ	46.9	5.0 U	92.1 U
014-S-B-006-02	<b>NS</b>	<b>12.8 UJ</b>	<b>33.8 UJ</b>	<b>50.4</b>	<b>5.0 U</b>	<b>92.1 U</b>
014-S-B-007-02	<b>NS</b>	<b>13.6 UJ</b>	<b>44.7</b>	<b>74.0</b>	<b>5.0 U</b>	<b>93.7</b>
014-S-B-008-02	<b>NS</b>	<b>13.8 UJ</b>	<b>21.8 UJ</b>	<b>36.4</b>	<b>5.0 U</b>	<b>92.1 U</b>
014-S-B-009-02	<b>NS</b>	<b>17.3 UJ</b>	<b>31.9 UJ</b>	<b>69.2</b>	<b>5.0 U</b>	<b>92.1 U</b>

**Notes:**

- (a) BEQs are calculated by multiplying the carcinogenic polycyclic aromatic hydrocarbons (cPAH) by their respective toxicity equivalence factors (TEF) and assuming that nondetect 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*, February 5, 1999.
- (b)  $\mu\text{g}/\text{kg}$  = micrograms per kilogram
- (c) NS: Not sampled.
- (d) Data Qualification:  
 U -- Undetected. The analyte was analyzed but not detected.  
 J -- Estimated value. One or more quality control (QC) parameters were outside control limits or the value was detected below the laboratory's quantification limit.  
 UJ -- Undetected and estimated. The analyte was analyzed but not detected and the quantitation limit is estimated because at least one QC parameters was outside control limits.
- (e) **Bold concentrations** -- Indicates upper-interval soil samples with concentrations exceeding the greater of the following: RBC or surface soil background AND lower-interval soil samples with concentrations exceeding the greater of the following: subsurface background concentration or SSL.

**Table 2-2**  
**Zone H Soil Data for COCs at SWMU 15**

Sample ID	Arsenic (mg/kg)	Lead (mg/kg)	BEQs <sup>a</sup> ( $\mu$ g/kg) <sup>b</sup>
RBC	0.43	400	87
Surface Soil Background	15.6	118	424
Subsurface Soil Background	22.5	68.7	NA
SSL	15	400	1,600
<b>Upper-interval Soil Samples</b>			
015-S-B-001-01	<b>6.4</b>	<b>21.0</b> J	<b>157.5</b>
015-S-B-002-01	3.6	7.3 U	92.1 U
015-S-B-003-01	<b>15.0</b>	<b>21.3</b>	<b>444.8</b>
015-S-B-004-01	<b>51.4</b>	<b>83.7</b> J	<b>1,919.4</b>
015-C-B-004-01	<b>54.8</b>	71.8	<b>2,137.4</b>
015-S-B-005-01	NS <sup>c</sup>	NS	293.5
015-S-B-006-01	NS	NS	447.8
015-S-B-007-01	NS	NS	156.0
015-S-B-008-01	NS	NS	92.1 U
<b>Lower-interval Soil Samples</b>			
015-S-B-001-02	12.1	23.6	92.1 U
015-S-B-002-02	13.4	29.5	92.1 U
015-S-B-003-02	12.3	28.7	92.1 U
015-S-B-004-02	12.4	33.0 J	98.6
015-S-B-008-02	NS	NS	92.1 U

**Notes:**

- (a) BEQs are calculated by multiplying the carcinogenic polycyclic aromatic hydrocarbons (cPAH) by their respective toxicity equivalence factors (TEF) and assuming that nondetect 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*, February 5, 1999.
- (b)  $\mu$ g/kg = micrograms per kilogram
- (c) NS: Not sampled.
- (d) Data Qualification:  
 U — Undetected. The analyte was analyzed but not detected.  
 J — Estimated value. One or more quality control (QC) parameters were outside control limits or the value was detected below the laboratory's quantification limit.
- (e) **Bold concentrations** — Indicates upper-interval soil samples with concentrations exceeding the greater of the following: RBC or surface soil background AND lower-interval soil samples with concentrations exceeding the greater of the following: subsurface background concentration or SSL.

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**AOCs 670 and 684 Contaminants of Concern**

Aluminum, antimony, thallium, beryllium, arsenic, Aroclor-1254, Aroclor-1260, and BEQs were identified as COCs in the AOC 670 and 684 portion of the Combined SWMU 14 sampling area. The primary contributors to surface soil risk were arsenic and BEQs. The hazard contributors were arsenic, antimony, and thallium. Following the corrective measures investigation (see Section 2.3), lead was classified as an additional COC for AOCs 670 and 684. COC data are summarized in Table 2-3. AOCs 670 and 684 COC data are summarized in Table 2-4.

② ELIM.  
 Beryllium here - explain,

Why?

**Table 2-3**  
 Zone H Soil Data For COCs at AOC 670

Sample ID	Antimony (mg/kg)	Arsenic (mg/kg)	Aluminum (mg/kg)	Lead (mg/kg)	Thallium (mg/kg)	Aroclor-1254 (µg/kg) <sup>a</sup>	Aroclor-1260 (µg/kg)	BEQs <sup>a</sup> (µg/kg)
RBC	3.1	0.43	7,800	400	0.55	320	320	87
Surface Soil Background	NA	15.6	26,000	118	1.1	NA	NA	424
Subsurface Soil Background	NA	22.5	46,200	68.7	1.3	NA	NA	NA
SSL	2.7	15	560,000	400	0.35	1,000	1,000	1,600

**Upper-interval Soil Samples**

670-S-B-001-01	1.4 UR	15.6	14,200.0	21.0	2.3 U	50.0 U	50.0 U	92.1 U
670-S-B-002-01	1.6 UR	9.7	11,400.0	94.2	2.7 U	50.0 U	50.0 U	351.2
670-S-B-003-01	NS	NS	NS	NS	NS	50.0 U	50.0 U	7,762.0
670-C-B-003-01	7.6 U	9.9 U	NS	9.8 UF	1.8 U	33.0 U	33.0 U	741.4
670-S-B-004-01	7.4 UF	11.3	13,700.0	9.5 UF	0.5 U	40.0 U	40.0 U	1023.1
670-S-B-005-01	1.6 UJ	15.2	21,700.0	35.3 J	0.5 U	50.0 U	50.0 U	1,590.9
670-S-B-006-01	1.6 UJ	13.8	19,100.0	39.6 J	0.5 U	50.0 U	50.0 U	92.1 U
670-S-B-007-01	7.8 UJ	8.9	6,150.0	10.1 UJ	0.5	20.0 U	20.0 U	96.2
670-S-B-008-01	7.7 UJ	9.7	10,800.0	20.4 J	0.5 U	50.0 U	50.0 U	962.5
670-S-B-009-01	9.5 J	9.1	6,740.0	18.2 J	0.5 U	50.0 U	50.0 U	92.1 U
670-S-B-010-01	8.6 UF	10.4	14,800.0	26.8 J	0.8 J	50.0 U	50.0 U	92.1 U
670-S-B-011-01	6.0 UR	8.9	3,220.0	7.7 UF	2.0 U	50.0 U	50.0 U	92.1 U
670-S-B-012-01	11.4 J	23.7	9,190.0	871.0 J	1.3 U	50.0 U	50.0 U	704.8
670-S-B-013-01	7.2 UR	10.9	9,940.0	9.2 U	1.7 U	50.0 U	50.0 U	92.1 U
670-C-B-013-01	16.3 U	9.3 U	NS	20.6 UF	1.9 U	33.0 U	33.0 U	107.8

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Table 2-3  
 Zone H Soil Data For COCs at AOC 670

Sample ID	Antimony (mg/kg)	Arsenic (mg/kg)	Aluminum (mg/kg)	Lead (mg/kg)	Thallium (mg/kg)	Aroclor- 1254 ( $\mu$ g/kg) <sup>b</sup>	Aroclor- 1260 ( $\mu$ g/kg)	BEQs <sup>a</sup> ( $\mu$ g/kg)
670-S-B-014-01	17.2 UJ	9.5	11,200.0	44.0 J	0.5 U	20.0 U	20.0 U	96.8
670-S-B-015-01	6.6 UJ	8.5	NS	18.6 J	1.6 UJ	33.0 U	33.0 U	148.4
670-C-B-015-01	8.4 UJ	10.9	NS	14.4 J	2.0 UJ	NS	NS	NS
670-S-B-016-01	1.9 U	12.1 J	20,200.0	68.8	0.6 U	50.0 U	50.0 U	258.9
670-S-B-017-01	12.6 U	8.2 J	6,630.0	16.3 U	0.6 U	50.0 U	50.0 U	96.7
670-S-B-018-01	1.6 U	10.1 J	11,000.0	45.0	0.5 U	50.0 U	50.0 U	96.6
670-S-B-019-01	13.8 U	7.0 J	NS	56.8	2.3 UJ	33.0 U	33.0 U	127.1
670-S-B-020-01	9.5 UJ	8.4	NS	12.2 UJ	2.2 UJ	33.0 U	33.0 U	92.1 U
670-S-B-021-01	11.0 U	7.9 J	5,540.0	14.2 U	0.5 U	40.0 U	40.0 U	96.3
670-S-B-022-01	10.2 U	9.3 J	10,800.0	31.2	0.5 U	40.0 UJ	40.0 UJ	96.4
670-S-B-023-01	167.0 R	69.0	14,900.0	20,900	1.4	50.0 U	50.0 U	92.1 U
670-S-B-024-01	1.2 U	13.0 J	20,800.0	63.1	0.4 U	50.0 U	50.0 U	92.1 U
670-S-B-025-01	1.6 UJ	13.7 UJ	NS	133.0	0.6 UJ	NS	NS	NS
670-S-B-026-01	12.0 UJ	12.3 J	NS	1,690 J	0.2 UJ	33.0 UJ	33.0 UJ	762.6
670-S-B-027-01	10.9 U	8.3 J	NS	14.0 UJ	0.2 U	33.0 U	33.0 U	92.1 U
670-S-B-028-01	NS	NS	NS	NS	NS	NS	NS	92.1 U
670-S-B-029-01	NS	NS	NS	NS	NS	NS	NS	7,525.1
670-S-B-030-01	NS	NS	NS	NS	NS	NS	NS	212.0
670-S-B-031-01	NS	NS	NS	NS	NS	NS	NS	3,766.2
670-C-B-031-01	1.6 U	15.4	NS	36.5	0.5 U	33.0 U	33.0 U	51,734.8
670-S-B-032-01	1.3 UJ	17.2	NS	44.4	1.5 U	33.0 U	33.0 U	1,231.1
670-S-B-033-01	NS	NS	NS	NS	NS	NS	NS	92.1 U
670-S-B-034-01	NS	NS	NS	NS	NS	NS	NS	2,136.3
670-S-B-035-01	NS	NS	NS	NS	NS	NS	NS	92.1 U

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Table 2-3  
 Zone H Soil Data For COCs at AOC 670

Sample ID	Antimony (mg/kg)	Arsenic (mg/kg)	Aluminum (mg/kg)	Lead (mg/kg)	Thallium (mg/kg)	Aroclor- 1254 ( $\mu$ g/kg) <sup>b</sup>	Aroclor- 1260 ( $\mu$ g/kg)	BEQs <sup>a</sup> ( $\mu$ g/kg)
<b>Lower-interval Soil Samples</b>								
670-S-B-001-02	1.9 UR	14.2	18,200.0	34.8	0.9 U	60.0 U	60.0 U	92.1 U
670-S-B-002-02	2.0 UR	14.0	11,100.0	20.4 J	0.5 U	60.0 U	60.0 U	92.1 U
670-S-B-003-02	NS		NS	NS	NS	60.0 U	60.0 U	92.1 U
670-S-B-004-02	2.0 UJ	19.5	19,400.0	35.0 J	0.6 U	60.0 U	60.0 U	92.1 U
670-S-B-005-02	2.1 UJ	18.0	22,100.0	39.3 J	0.7 U	60.0 U	60.0 U	92.1 U
670-S-B-006-02	1.2 U	13.6 J	20,800.0	16.0	0.4 U	60.0 UJ	60.0 UJ	97.6
670-S-B-007-02	2.1 UJ	29.4	18,800.0	33.2 J	0.7 U	30.0 U	30.0 U	98.1
670-S-B-008-02	1.9 UJ	22.7	15,300.0	36.1 J	0.6 U	60.0 U	60.0 U	98.3
670-S-B-009-02	2.0 UJ	20.4	27,400.0	35.6 J	0.6 U	30.0 U	30.0 U	92.1 U
670-S-B-010-02	2.3 J	19.5	30,100.0	40.8 J	0.7 U	70.0 U	70.0 U	92.1 U
670-S-B-011-02	2.7 J	13.8	19,100.0	32.6 J	0.9 U	60.0 U	60.0 U	97.5
670-S-B-012-02	1.9 UR	18.2	20,000.0	37.2	0.9 U	50.0 U	50.0 U	92.1 U
670-S-B-013-02	1.9 UJ	23.0	19,100.0	35.4 J	0.6 U	30.0 U	30.0 U	97.9
670-S-B-014-02	1.9 UJ	9.0	13,700.0	11.6 J	0.6 U	30.0 U	30.0 U	98.1
670-S-B-015-02	2.5 UJ	19.2	NS	32.1	0.6 UJ	33.0 U	33.0 U	548.1
670-S-B-016-02	1.8 U	16.2 J	31,200.0	39.3	0.6 U	60.0 U	60.0 U	97.8
670-S-B-017-02	2.1 U	23.3 J	30,200.0	46.5	0.6 U	60.0 U	60.0 U	98.4
670-S-B-018-02	1.9 U	21.6 J	24,400.0	38.3	0.6 U	60.0 U	60.0 U	98.3
670-S-B-019-02	1.8 UJ	16.4	NS	39.8	1.2 U	33.0 U	33.0 U	92.1 U
670-S-B-020-02	1.4 U	20.8	NS	42.0	2.9 U	33.0 U	33.0 U	137.1
670-S-B-021-02	2.2 U	25.4 J	28,100.0	41.2	0.7 U	60.0 UJ	60.0 UJ	97.7
670-S-B-022-02	1.9 U	18.4 J	19,500.0	31.0	0.6 U	60.0 UJ	60.0 UJ	97.7
670-S-B-023-02	1.6 U	18.1 J	26,500.0	47.4	0.5 U	60.0 UJ	60.0 U	92.1 U
670-S-B-024-02	2.3 U	23.1 J	18,700.0	46.3	0.6 U	60.0 U	60.0 U	92.1 U
670-S-B-025-02	1.7 UJ	20.0 UJ	NS	53.1 UJ	0.5 UJ	NS	NS	NS

Table 2-3  
 Zone H Soil Data For COCs at AOC 670

Sample ID	Antimony (mg/kg)	Arsenic (mg/kg)	Aluminum (mg/kg)	Lead (mg/kg)	Thallium (mg/kg)	Aroclor- 1254 ( $\mu$ g/kg) <sup>b</sup>	Aroclor- 1260 ( $\mu$ g/kg)	BEQs <sup>a</sup> ( $\mu$ g/kg)
670-S-B-026-02	1.8 U	19.7 J	NS	46.1	0.3 U	33.0 U	33.0 U	92.1 U
670-S-B-027-02	8.5 U	4.4 J	NS	14.3 J	0.7 U	33.0 U	33.0 U	92.1 U
670-S-B-028-02	NS	NS	NS	NS	NS	NS	NS	92.1 U
670-S-B-030-02	NS	NS	NS	NS	NS	NS	NS	92.1 U
670-S-B-032-02	1.5 UJ	<b>24.9</b>	NS	41.8	1.9 U	33.0 U	33.0 U	114.1
670-S-B-033-02	NS	NS	NS	NS	NS	NS	NS	92.1 U
670-S-B-034-02	NS	NS	NS	NS	NS	NS	NS	92.1 U
670-S-B-035-02	NS	NS	NS	NS	NS	NS	NS	92.1 U

**Notes:**

- (a) BEQs are calculated by multiplying the carcinogenic polycyclic aromatic hydrocarbons (cPAH) by their respective toxicity equivalence factors (TEF) and assuming that nondetect 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*, February 5, 1999.
- (b)  $\mu$ g/kg = micrograms per kilogram
- (c) NS: Not sampled.
- (d) Data Qualification:
  - U — Undetected. The analyte was analyzed but not detected.
  - J — Estimated value. One or more quality control (QC) parameters were outside control limits or the value was detected below the laboratory's quantification limit.
  - UJ — Undetected and estimated. The analyte was analyzed but not detected and the quantitation limit is estimated because at least one QC parameters was outside control limits.
  - R/UR — Unusable data. One of more QC parameters grossly exceeded control limits.
- (e) **Bold concentrations** — Indicates upper-interval soil samples with concentrations exceeding the greater of the following: RBC or surface soil background AND lower-interval soil samples with concentrations exceeding the greater of the following: subsurface background concentration or SSL.

**Table 2-4**  
**Zone H Soil Data For COCs at AOC 684**

Sample ID	Antimony (mg/kg)	Arsenic (mg/kg)	Lead (mg/kg)	Thallium (mg/kg)	Aroclor-1254 ( $\mu\text{g/kg}$ ) <sup>b</sup>	Aroclor-1260 ( $\mu\text{g/kg}$ )	BEQs <sup>a</sup> ( $\mu\text{g/kg}$ )
RBC	3.1	0.43	400	0.55	320	320	87
Surface Soil Background	NA	15.6	118	1.1	NA	NA	424
Subsurface Soil Background	NA	22.5	67.8	1.3	NA	NA	NA
SSL	2.7	15	400	0.35	1,000	1,000	1,600
<b>Upper-interval Soil Samples</b>							
684-S-B-001-01	1.1 UJ	3.3 U	27.3	0.3 UJ	33.0 U	33.0 U	2,919.6
684-S-B-002-01	1.4 UJ	1.9 U	10.3	0.3 UJ	33.0 U	33.0 U	92.1 U
684-C-B-002-01	1.4 UJ	7.0 J	22.9	0.3 UJ	33.0 U	33.0 U	92.1 U
684-S-B-003-01	1.7 UJ	8.5	75.9	0.4 UJ	33.0 U	33.0 U	8,567.0
684-S-B-004-01	1.8 UJ	12.7	67.9	0.4 UJ	33.0 U	33.0 U	4,407.7
684-S-B-005-01	1.2 UJ	7.4	61.6	0.3 UJ	33.0 U	33.0 U	121.7
684-S-B-006-01	1.5 UJ	0.6 U	3.9 J	0.4 UJ	33.0 U	33.0 U	92.1 U
684-S-B-007-01	1.6 UJ	9.0	24.8	0.4 UJ	33.0 U	376.0	92.1 U
684-S-B-008-01	6.0 U	1.9	11.2	0.1 J	33.0 U	33.0 U	92.1 U
684-S-B-009-01	5.6 J	12.9	38.9	2.9 J	33.0 U	33.0 U	92.1 U

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Table 2-4  
 Zone H Soil Data For COCs at AOC 684

Sample ID	Antimony (mg/kg)		Arsenic (mg/kg)		Lead (mg/kg)		Thallium (mg/kg)		Aroclor-1254 ( $\mu$ g/kg) <sup>b</sup>		Aroclor-1260 ( $\mu$ g/kg)		BEQs <sup>a</sup> ( $\mu$ g/kg)	
684-S-B-010-01	6.0	U	5.2		117.0		0.1	J	330.0	U	330.0	U	92.1	U
684-S-B-011-01	6.0	U	1.4		46.4		1.0	U	330.0	U	330.0	U	92.1	U
684-S-B-012-01	6.2	J	0.9	J	4.1		1.0	U	330.0	U	330.0	U	92.1	U
684-S-B-013-01	4.6	J	2.8		8.5		1.0	U	33.0	U	33.0	U	92.1	U
684-S-B-014-01	12.4		11.7		35.1		1.2	J	33.0	U	33.0	U	92.1	U
684-S-B-015-01	11.9		13.5		47.2		1.3	J	330.0	U	330.0	U	1,515.5	
684-S-B-016-01	5.3	J	4.8		4.0		1.5	J	33.0	U	33.0	U	92.1	U
684-S-B-017-01	7.7		3.6		10.2		1.0	U	330.0	U	330.0	U	167.0	
684-S-B-018-01	10.1		6.4		22.3		1.0	U	33.0	U	33.0	U	169.4	
684-S-B-019-01	11.3	UJ	5.1	UJ	24.7	U	0.8	U	165.0	U	165.0	U	241.5	
684-S-B-020-01	1.9	UJ	11.3	UJ	57.2		0.9	U	165.0	U	165.0	U	2,153.5	
684-S-B-021-01	1.8	UJ	3.8	UJ	14.1	UJ	0.8	U	165.0	U	165.0	U	25,501.3	
684-S-B-022-01	11.3	UJ	5.1	UJ	16.1	UJ	0.6	U	165.0	U	165.0	U	395.1	
684-S-B-023-01	1.6	UJ	11.6	UJ	62.5		0.7	U	33.0	U	33.0	U	1,236.7	
684-S-B-024-01	1.9	UJ	16.2	UJ	39.0		1.0	U	33.0	U	33.0	U	4,270.4	
684-S-B-025-01	1.5	UJ	10.6	UJ	50.7		1.0	U	33.0	U	33.0	U	329.2	
684-S-B-026-01	1.7	U	16.3	J	50.8		0.3	U	33.0	U	33.0	U	1,962.9	
684-S-B-027-01	1.4	U	9.9	J	32.4		0.3	U	33.0	U	33.0	U	544.5	
684-S-B-028-01	1.8	UR	11.2	UJ	21.6	UJ	0.5	UJ	33.0	U	33.0	U	274.1	
684-S-B-029-01	1.6	UJ	9.0	UJ	16.0	UJ	0.7	UJ	33.0	U	33.0	U	92.1	U

Table 2-4  
 Zone H Soil Data For COCs at AOC 684

Sample ID	Antimony (mg/kg)		Arsenic (mg/kg)		Lead (mg/kg)		Thallium (mg/kg)		Aroclor-1254 ( $\mu$ g/kg) <sup>b</sup>		Aroclor-1260 ( $\mu$ g/kg)		BEQs <sup>a</sup> ( $\mu$ g/kg)	
684-S-B-030-01	9.0	UJ	7.5	UJ	11.5	UJ	0.6	UJ	33.0	U	33.0	U	92.1	U
684-S-B-031-01	1.8	UJ	18.6	UJ	43.0	UJ	0.5	UJ	33.0	U	33.0	U	92.1	U
684-S-B-032-01	NS <sup>c</sup>		NS		NS		NS		50.0		60.0		217.5	
684-S-B-033-01	NS		NS		NS		NS		160.0		71.0		301.1	
684-S-B-034-01	NS		NS		NS		NS		50.0	U	50.0	U	237.7	
684-S-B-035-01	NS		NS		NS		NS		50.0	U	50.0	U	29,871.0	
684-S-B-036-01	NS		NS		NS		NS		40.0	U	40.0	U	1,626.1	
684-C-B-036-01	6.9	U	11.7		27.6		0.4	U	33.0	U	33.0	U	698.4	
684-S-B-037-01	NS		NS		NS		NS		40.0	U	40.0	U	92.1	U
684-S-B-038-01	NS		NS		NS		NS		40.0	U	40.0	U	92.1	U
684-S-B-039-01	NS		NS		NS		NS		40.0	U	40.0	U	92.1	U
684-S-B-040-01	NS		NS		NS		NS		NS		NS		696.1	
684-S-B-041-01	NS		NS		NS		NS		NS		NS		96.0	
684-S-B-042-01	NS		NS		NS		NS		NS		NS		95.8	
684-S-B-043-01	NS		NS		NS		NS		NS		NS		4,266.7	
684-S-B-044-01	NS		NS		NS		NS		NS		NS		10,311.0	
684-C-B-044-01	NS		NS		NS		NS		NS		NS		8,119.4	

Table 2-4  
 Zone H Soil Data For COCs at AOC 684

Sample ID	Antimony (mg/kg)		Arsenic (mg/kg)		Lead (mg/kg)		Thallium (mg/kg)		Aroclor-1254 (µg/kg) <sup>b</sup>		Aroclor-1260 (µg/kg)		BEQs <sup>a</sup> (µg/kg)	
<b>Lower-interval Soil Samples</b>														
684-S-B-001-02	1.3	UJ	5.0		7.2		0.3	UJ	33.0	U	33.0	U	92.1	U
684-S-B-002-02	1.1	UJ	2.8	U	5.8		0.3	UJ	33.0	U	33.0	U	92.1	U
684-S-B-003-02	1.3	UJ	1.3	U	4.3	J	0.3	UJ	33.0	U	33.0	U	92.1	U
684-S-B-005-02	1.4	UJ	9.4		15.6		0.3	UJ	33.0	U	33.0	U	92.1	U
684-S-B-006-02	1.5	UJ	4.5		4.4	J	0.4	UJ	33.0	U	33.0	U	92.1	U
684-S-B-007-02	4.8	J	2.0		4.8		0.1	J	330.0	U	330.0	U	92.1	U
684-S-B-008-02	6.0	U	5.1		6.5		0.1	J	33.0	U	33.0	U	92.1	U
684-S-B-009-02	6.0	U	2.2		8.9		0.1	J	330.0	U	330.0	U	92.1	U
684-S-B-011-02	7.2	J	3.1		3.0		0.9	J	33.0	U	33.0	U	92.1	U
684-S-B-013-02	6.4	J	2.2		3.6		1.0	U	33.0	U	33.0	U	92.1	U
684-S-B-014-02	8.7		2.8		4.4		1.0	U	33.0	U	33.0	U	92.1	U
684-S-B-015-02	8.6	J	11.2		30.8		1.0	U	33.0	U	33.0	U	92.1	U
684-S-B-016-02	5.1	J	7.7		28.9		1.0	U	33.0	U	33.0	U	92.1	U
684-S-B-018-02	3.5		2.4		5.3		1.0	U	33.0	U	33.0	U	92.1	U
684-S-B-019-02	1.5	UJ	7.3	UJ	1.9	UJ	0.5	U	33.0	U	33.0	U	92.1	U
684-S-B-022-02	2.9	UJ	21.1	UJ	34.3	UJ	0.9	U	33.0	U	33.0	U	737.0	
684-S-B-023-02	1.9	UJ	13.3	UJ	31.5	UJ	1.2	U	33.0	U	33.0	U	92.1	U
684-S-B-024-02	1.6	UJ	15.4	UJ	35.0	UJ	0.8	U	33.0	U	33.0	U	122.7	
684-S-B-025-02	2.4	UJ	23.7	UJ	41.9	UJ	0.8	U	33.0	U	33.0	U	122.7	
684-S-B-027-02	1.9	U	17.8	J	41.6		0.3	U	33.0	U	33.0	U	185.5	

Table 2-4  
 Zone H Soil Data For COCs at AOC 684

Sample ID	Antimony (mg/kg)		Arsenic (mg/kg)		Lead (mg/kg)		Thallium (mg/kg)		Aroclor-1254 ( $\mu\text{g}/\text{kg}$ ) <sup>b</sup>		Aroclor-1260 ( $\mu\text{g}/\text{kg}$ )		BEQs <sup>a</sup> ( $\mu\text{g}/\text{kg}$ )	
684-S-B-029-02	2.5	UJ	14.0	UJ	39.1	UJ	0.6	UJ	33.0	U	33.0	U	92.1	U
684-S-B-030-02	2.0	UJ	22.3	UJ	33.8	UJ	0.7	UJ	33.0	U	33.0	U	92.1	U
684-S-B-035-02	NS		NS		NS		NS		60.0	U	60.0	U	167.8	
684-S-B-036-02	NS		NS		NS		NS		50.0	U	50.0	U	92.1	U
684-S-B-039-02	NS		NS		NS		NS		40.0	U	40.0	U	92.1	U
684-S-B-040-02	NS		NS		NS		NS		NS		NS		232.3	
684-S-B-041-02	NS		NS		NS		NS		NS		NS		92.1	U
684-S-B-042-02	NS		NS		NS		NS		NS		NS		96.9	
684-S-B-043-02	NS		NS		NS		NS		NS		NS		1,284.2	
684-S-B-044-02	NS		NS		NS		NS		NS		NS		97.0	

**Notes:**

- (a) BEQs are calculated by multiplying the carcinogenic polycyclic aromatic hydrocarbons (cPAH) by their respective toxicity equivalence factors (TEF) and assuming that nondetect 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*, February 5, 1999.
- (b)  $\mu\text{g}/\text{kg}$  — micrograms per kilogram
- (c) NS: Not sampled.
- (d) Data Qualification:  
 U — Undetected. The analyte was analyzed but not detected.  
 J — Estimated value. One or more quality control (QC) parameters were outside control limits or the value was detected below the laboratory's quantification limit.  
 UJ — Undetected and estimated. The analyte was analyzed but not detected and the quantitation limit is estimated because at least one QC parameters was outside control limits.  
 R/UR — Unusable data. One of more QC parameters grossly exceeded control limits.
- (e) **Bold concentrations** — Indicates upper-interval soil samples with concentrations exceeding the greater of the following: RBC or surface soil background AND lower-interval soil samples with concentrations exceeding the greater of the following: subsurface background concentration or SSL.

**Compounds in Combined SWMU 14 Soil**

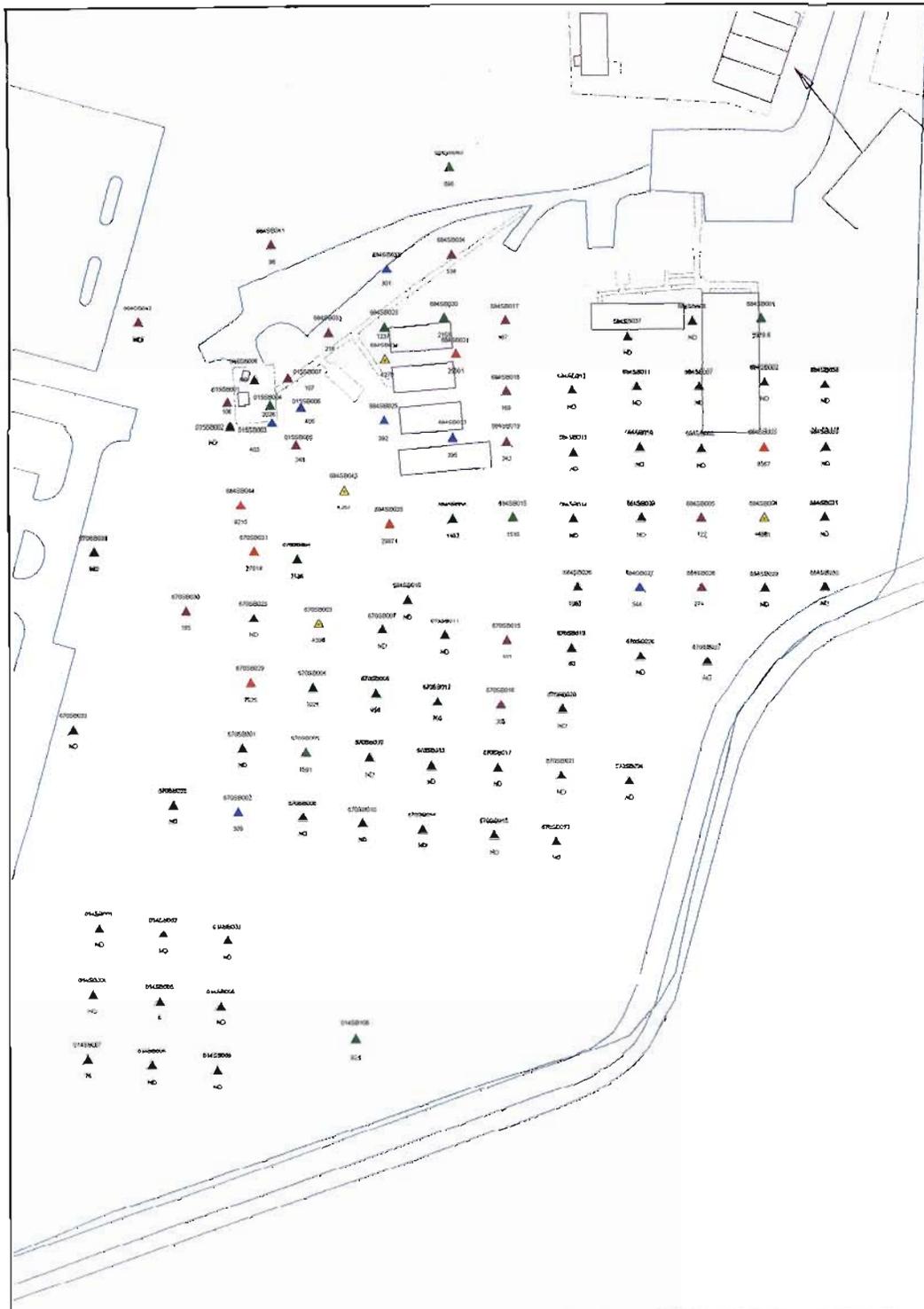
1,2,3-trichloropropane exceeded its RBC (91  $\mu\text{g}/\text{kg}$ ) in only one of 10 upper-interval locations (14SB008).

BEQs were the only semivolatile organic compound (SVOC) detected at concentrations that exceeded surface soil background reference concentrations in the upper-interval. The exceedances were in samples collected south, southeast, and east of the incinerator pad of SWMU 15, roughly located at sample locations 684SB035, 684SB044, and 670SB031. Elevated BEQs concentrations were also detected southeast of former Building 8881. BEQs exceeded their RBC (87  $\mu\text{g}/\text{kg}$ ) and surface soil background reference concentration (424  $\mu\text{g}/\text{kg}$ ) in upper-interval soil samples as shown in Table 2-5.

**Table 2-5  
 BEQs Surface Soil Contamination Distribution**

Location	Number of Exceedances	Total Number of Samples Collected	Range of Concentrations Exceeding BEQs Criteria ( $\mu\text{g}/\text{kg}$ )
SWMU 14	1	11	1,475.2
SWMU 15	3	8	444.8 - 2,137.4
AOC 670	10	33	704.8 - 51,734.8
AOC 684	15	44	544.5 - 29,871
<b>Combined SWMU 14</b>	<b>29</b>	<b>96</b>	<b>444.8 - 51,734.8</b>

The distribution of BEQs in the upper-interval is shown in Figure 2-2. Lower-interval BEQs contamination was confined to a small area centered around former Building 1897. The distribution of BEQs in the lower-interval is shown in Figure 2-3. SWMU 15 was a paper incinerator, which may account for the presence of high concentrations of BEQs in the AOCs 670 and 684 sampling areas.



**LEGEND**

BEQ's (ppb)

- ▲ x < 92.1 (NON DETECT)
- ▲ 92.1 < x < 300 (< 1E-05 Industrial Risk)
- ▲ 300 < x < 600 (< 1E-05 Residential Risk)
- ▲ 600 < x < 3000 (< 1E-05 Industrial Risk)
- ▲ 3000 < x < 8000 (< 1E-04 Residential Risk)
- ▲ 8000 < x < 30000 (1-1E-04 Industrial Risk)

- ▬ BUILDING
- ▬ BOUNDARY
- ▬ FENCE
- ▬ ROAD
- ▬ SIDE-WALKS

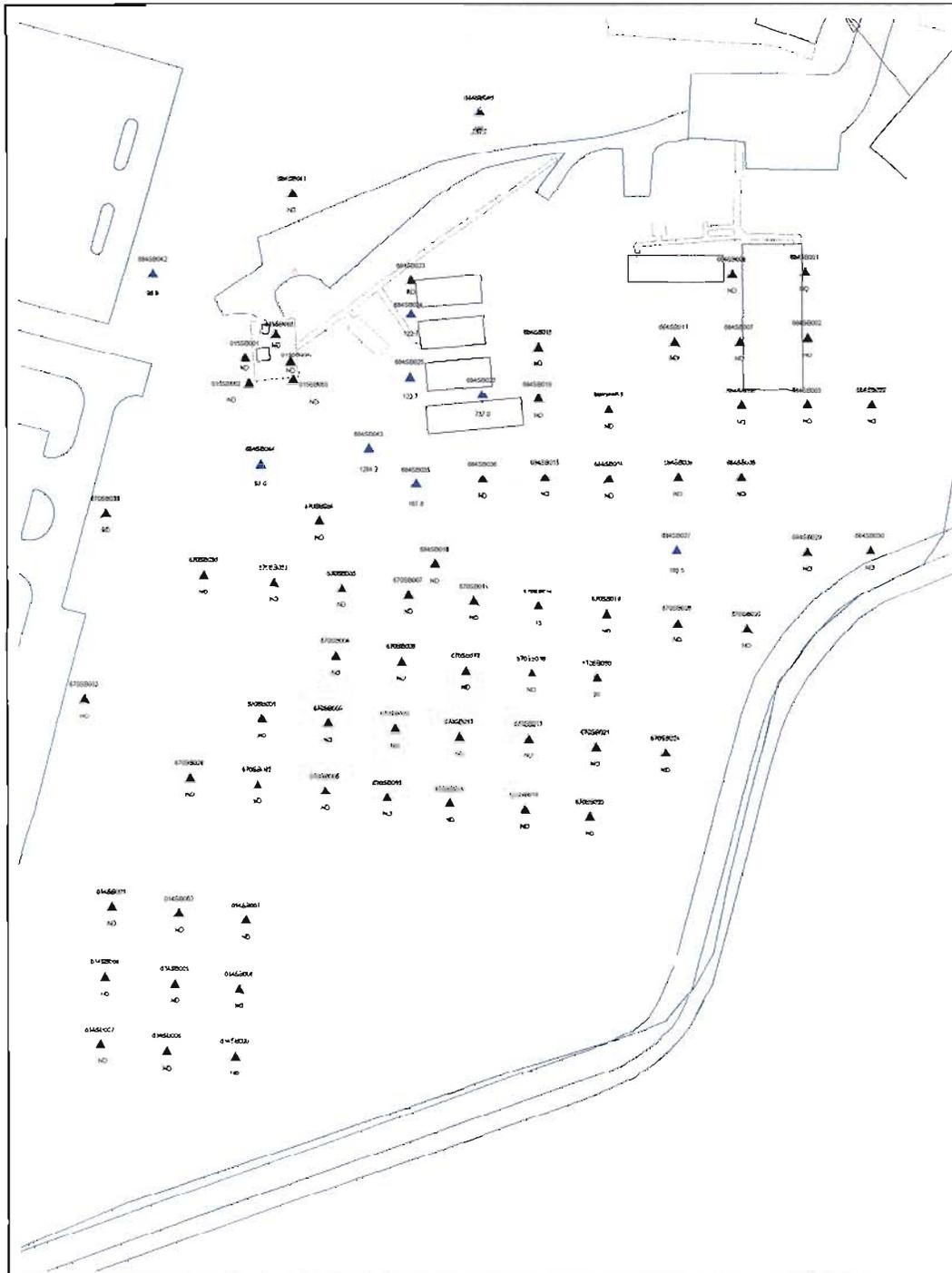


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30 0 30 60 90 Feet



Figure 2.2  
BEQ's in Upper Interval Surface Soils



**LEGEND**

BEQs (ppb):

- ▲ 92.1 (NON DETECT)
- ▲ 92.1 < X < 1600  
( < Groundwater Protection SSL)
- ▲ X > 1600 (> Groundwater Protection SSL)

- ▬ BUILDING BOUNDARY
- - - FENCE
- == ROAD
- ≡≡≡ SIDE WALK



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Charleston, SC

50 0 50 Feet

Figure 2.3  
BEQs in Lower Interval Surface Soil

**Aroclor-1254** did not exceed its RBC (320  $\mu\text{g}/\text{kg}$ ) at any of the 39 upper-interval sample locations.

**Aroclor-1260** exceeded its RBC (320  $\mu\text{g}/\text{kg}$ ) in one of the 39 upper-interval sample locations (684SB007). *However, AT  $\mu\text{g}/\text{kg}$  detection was X times less than the Federal PCB Cleanup STD. of 1ppm.*

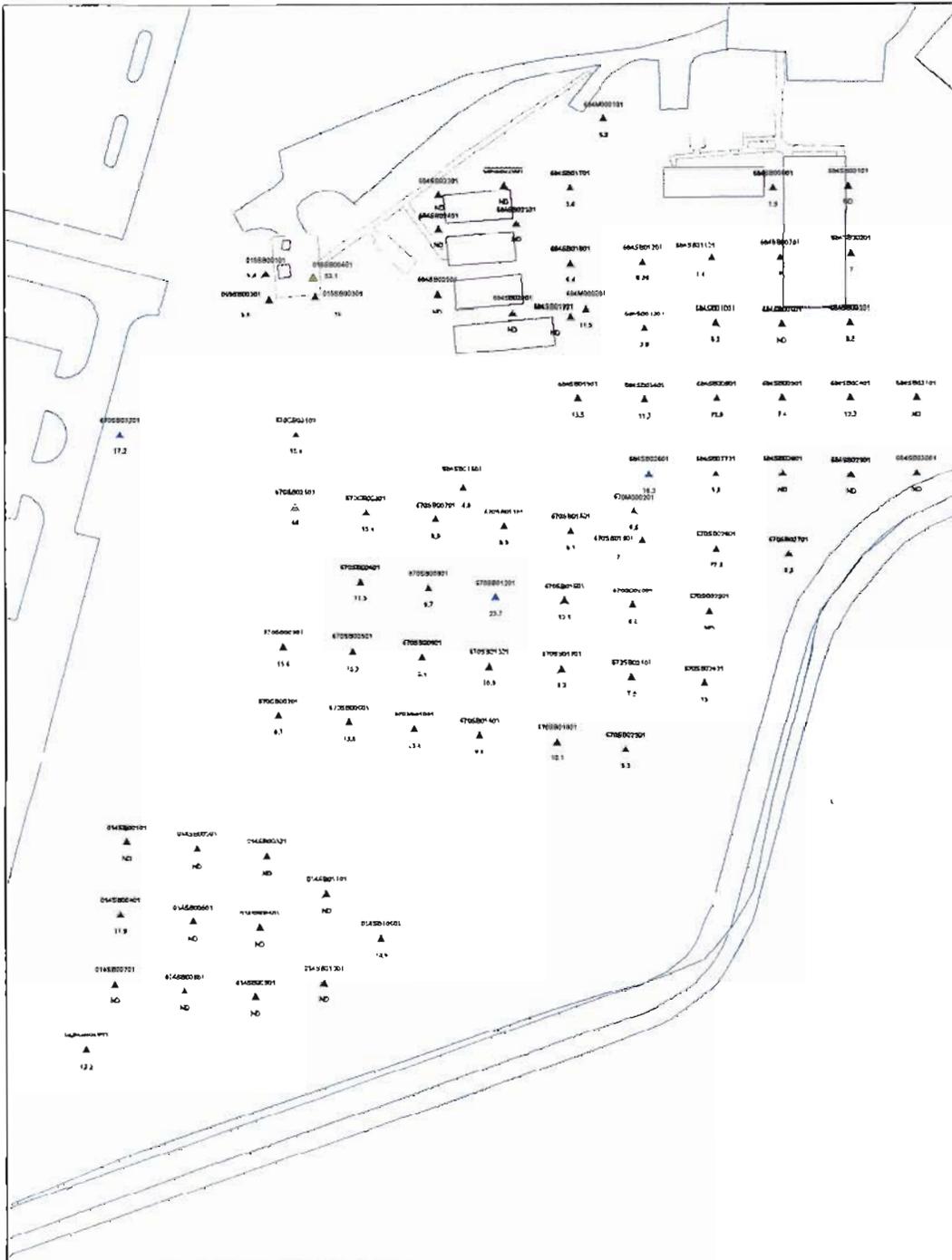
**Aluminum** exceeded its RBC (7,800 mg/kg) and background reference concentration (26,000 mg/kg) in one of three upper-interval sample locations (14SB010).

**Arsenic** exceeded its RBC (0.43 mg/kg) and background reference concentration (15.6 mg/kg) at one of four upper-interval location (15SB004) at SWMU 15, three of 28 upper-interval locations at AOC 670 (670SB012, -023, and -032), and one of 32 upper-interval location (684SB026) at AOC 684. The distribution of arsenic in the upper-interval is shown on Figure 2-4. Arsenic exceeded its RBC and subsurface soil background concentration in seven lower-interval AOC 670 soil samples: 670SB007, -008, -013, -017, -021, -024, and -032. Arsenic's distribution in the lower-interval is shown on Figure 2-5. It exceeded its RBC and background reference concentrations in only one upper- and lower-interval location: 670SB032.

*Does the 95% UCL value help here?*

**Antimony** exceeded its RBC (3.1 mg/kg) in two of 28 upper-interval soil samples at AOC 670 (670SB009 and -012) and eight of 32 upper-interval soil samples at AOC 684 (684SB009, -012, -013, -014, -015, -017, -016, and -018). The distribution of antimony in the upper-interval is shown in Figure 2-6. It exceeded its protection of groundwater soil screening level (SSL) (2.7 mg/kg) at seven of 49 lower-interval sample locations in AOCs 670 and 684 (684SB007, -011, -013, -014, -015, -016, -018). Its distribution in the lower-interval is shown on Figure 2-7.

*95% CL*



**LEGEND**

- ARSENIC (mg/kg)**
- ▲ 0 - 15.6 (Below Background)
  - ▲ 15.61 - 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 - 1000 (> 1E-04 Industrial Risk)

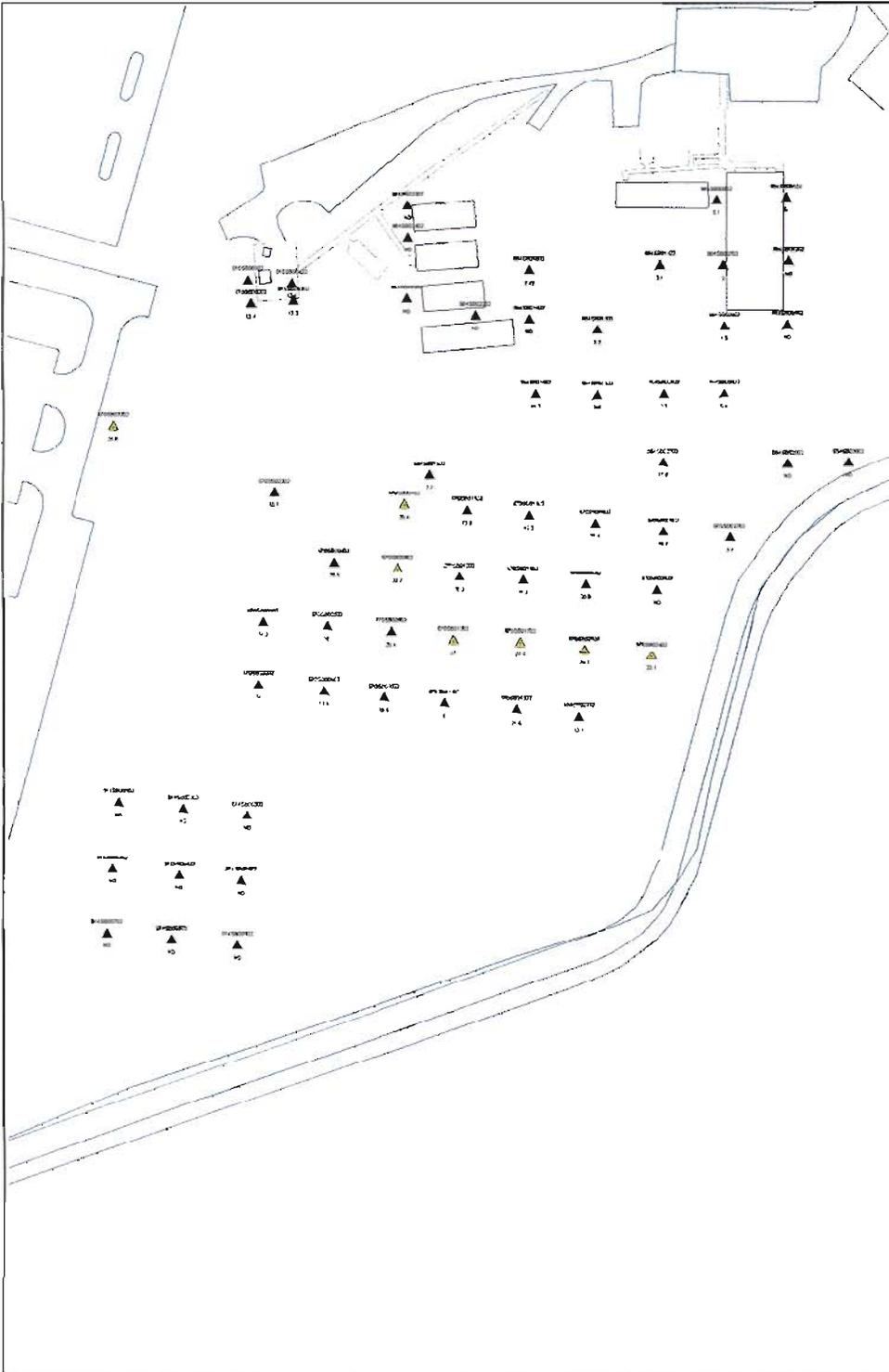
- ZONE H**
- ▭ BUILDING
  - ▭ BOUNDARY
  - ▭ FENCE
  - ▭ ROAD
  - ▭ SIDE-WALKS



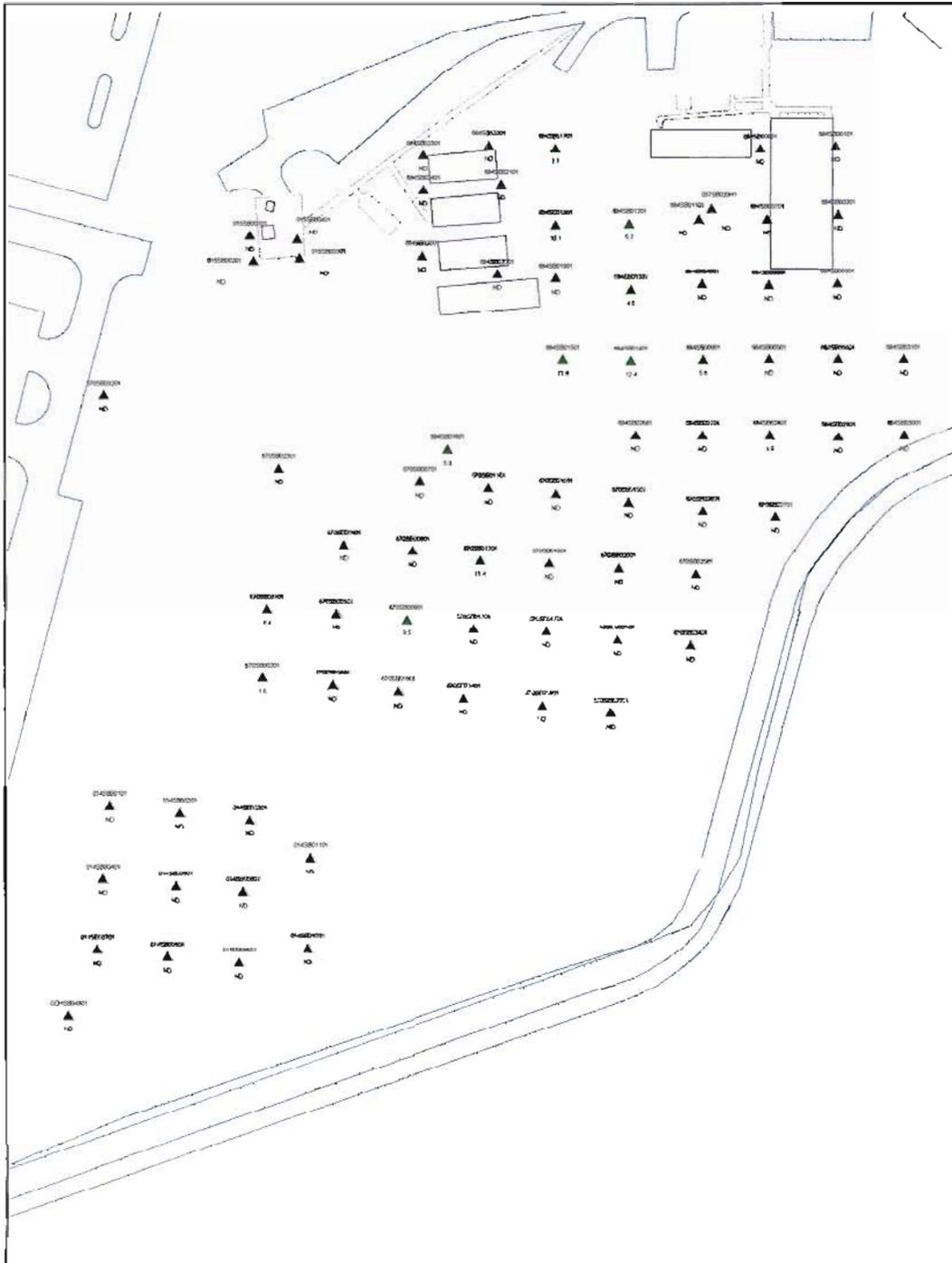
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**Charleston, SC**

30 0 30 Feet

**Figure 2.4**  
**Arsenic in Upper Interval Surface Soil**



<p><b>LEGEND</b></p> <p>ARSENIC (mg/kg)</p> <p>▲ 0 - 22.5 (Below Background)</p> <p>▲ 22.5 - Groundwater Protection Std. (15mg/kg)</p> <p>▭ BUILDING</p> <p>▭ BOUNDARY</p> <p>▭ FENCE</p> <p>▭ ROAD</p> <p>▭ SIDE-WALKS</p>	<p>N</p>		<p>SWMU 14 CMS REPORT CHARLESTON NAVAL COMPLEX Charleston, SC</p>
<p>50 0 50 Feet</p>		<p>Figure 2.5 Arsenic in Lower Interval Surface Soil</p>	
<p><b>ENSAFE</b></p>		<p>g:/projects/charltn/zone h/big_as May 14, 1999</p>	



**LEGEND**

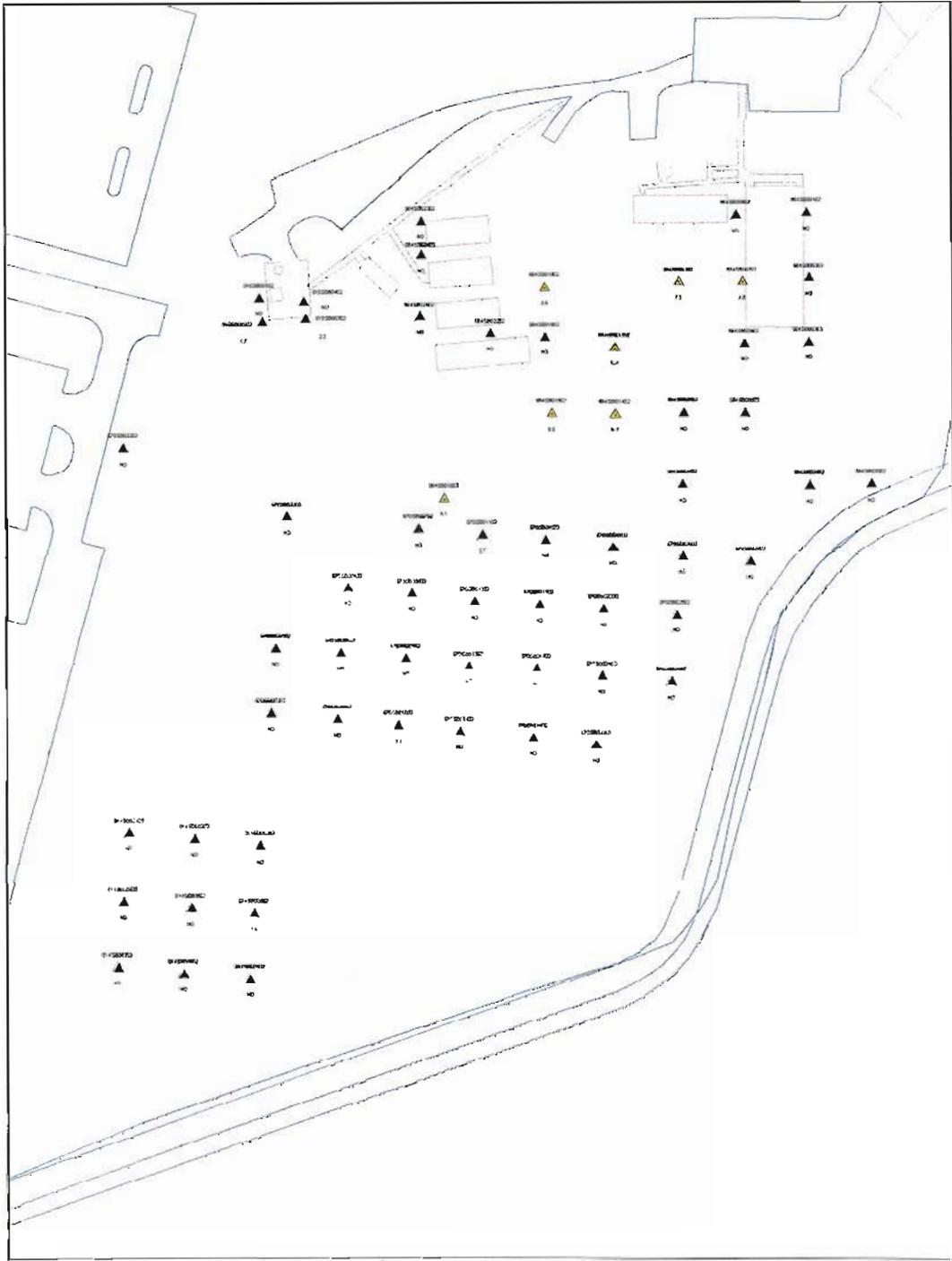
- ANTIMONY (mg/kg)**
- ▲ 0 - 2.9 (< 0.1 Residential Hazard)
  - ▲ 2.91 - 29 (< 1.0 Residential Hazard)
  - ▲ 29.01 - 88 (< 3.0 Residential Hazard)
  - ▲ 88.01 - 300 (> 3.0 Residential Hazard)
- ZONE H**
- ▭ BUILDING
  - ▭ BOUNDARY
  - ▭ FENCE
  - ▭ ROAD
  - ▭ SIDE-WALKS



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**Figure 2.6  
Antimony in Upper Interval Surface Soil**



**LEGEND**

**ANTIMONY (mg/kg)**

- 0 - 27 (Groundwater Protection SSL)
- 271 - 100 (Groundwater Protection SSL)

- ▭ BUILDING
- ▭ BOUNDARY
- ▭ FENCE
- ▭ ROAD
- ▭ SIDE-WALKS



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40 0 40 80 Feet



**Figure 2 7  
Antimony in Lower Interval Surface Soil**

**Lead** exceeded its residential RBC (400 mg/kg) and surface soil background reference concentration (118 mg/kg) at three of 13 upper-interval soil samples at SWMU 14 (014SB005, -06, and -010) and two of 28 upper-interval soil samples at AOC 670 (670SB012 and -023). Lead's distribution in the upper-interval is shown on Figure 2-8.

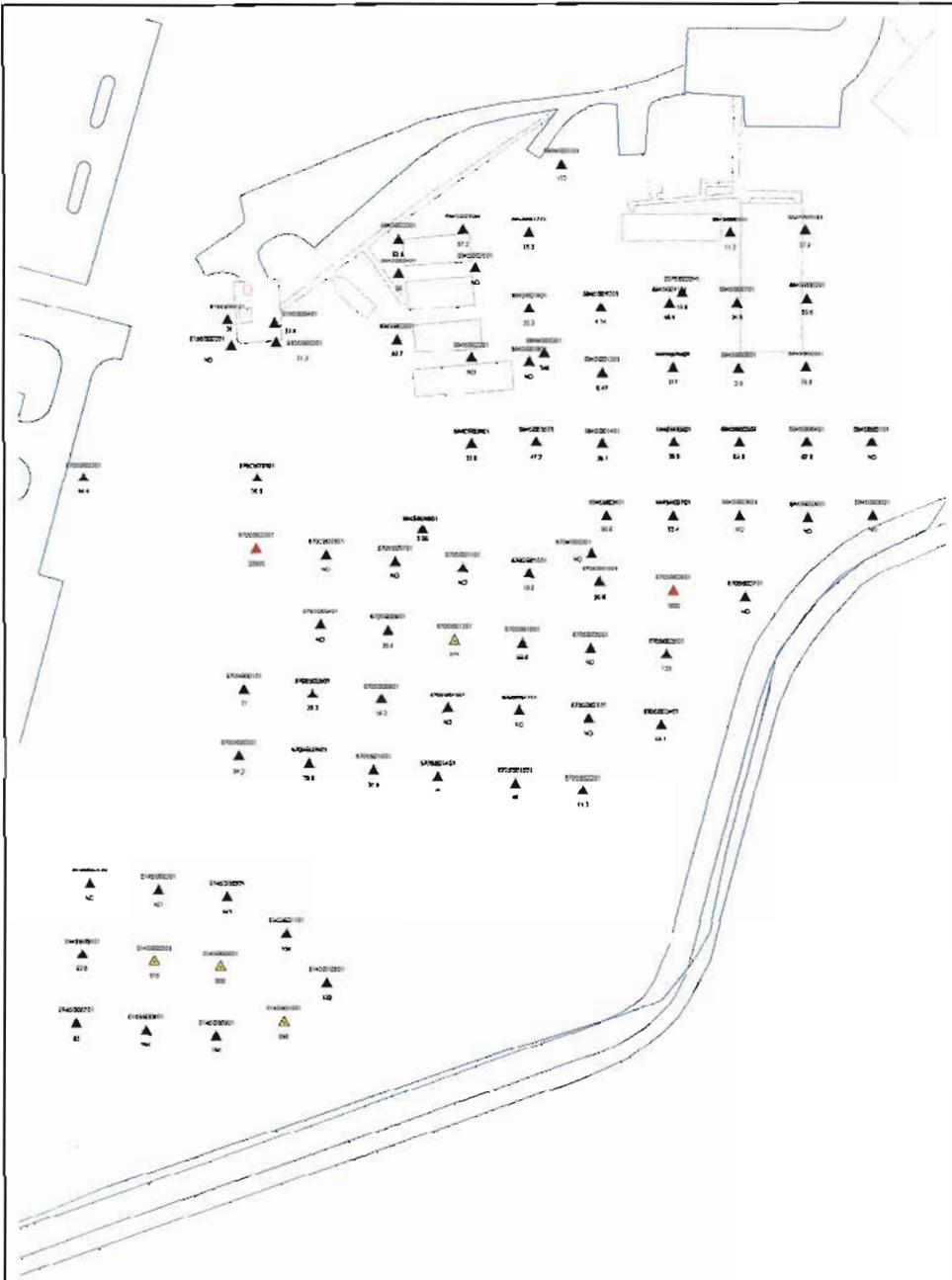
**Thallium** exceeded its RBC (0.55 mg/kg) and surface soil background reference concentration (1.1 mg/kg) at one of 28 upper-interval soil samples at AOC 670 (670SB023) and four of 32 soil samples at AOC 684 (684SB009, -014, -015, and -016). Thallium's distribution in the upper-interval is shown on Figure 2-9. None of the lower-interval soil samples exceeded thallium's subsurface soil background concentration.

**Vanadium** exceeded its RBC (55 mg/kg) in nine of 12 upper-interval soil sample locations at SWMU 14. However, none of the concentrations exceeded vanadium's surface soil background reference concentration (73 mg/kg). None of the lower-interval soil samples exceeded vanadium's subsurface soil background concentration.

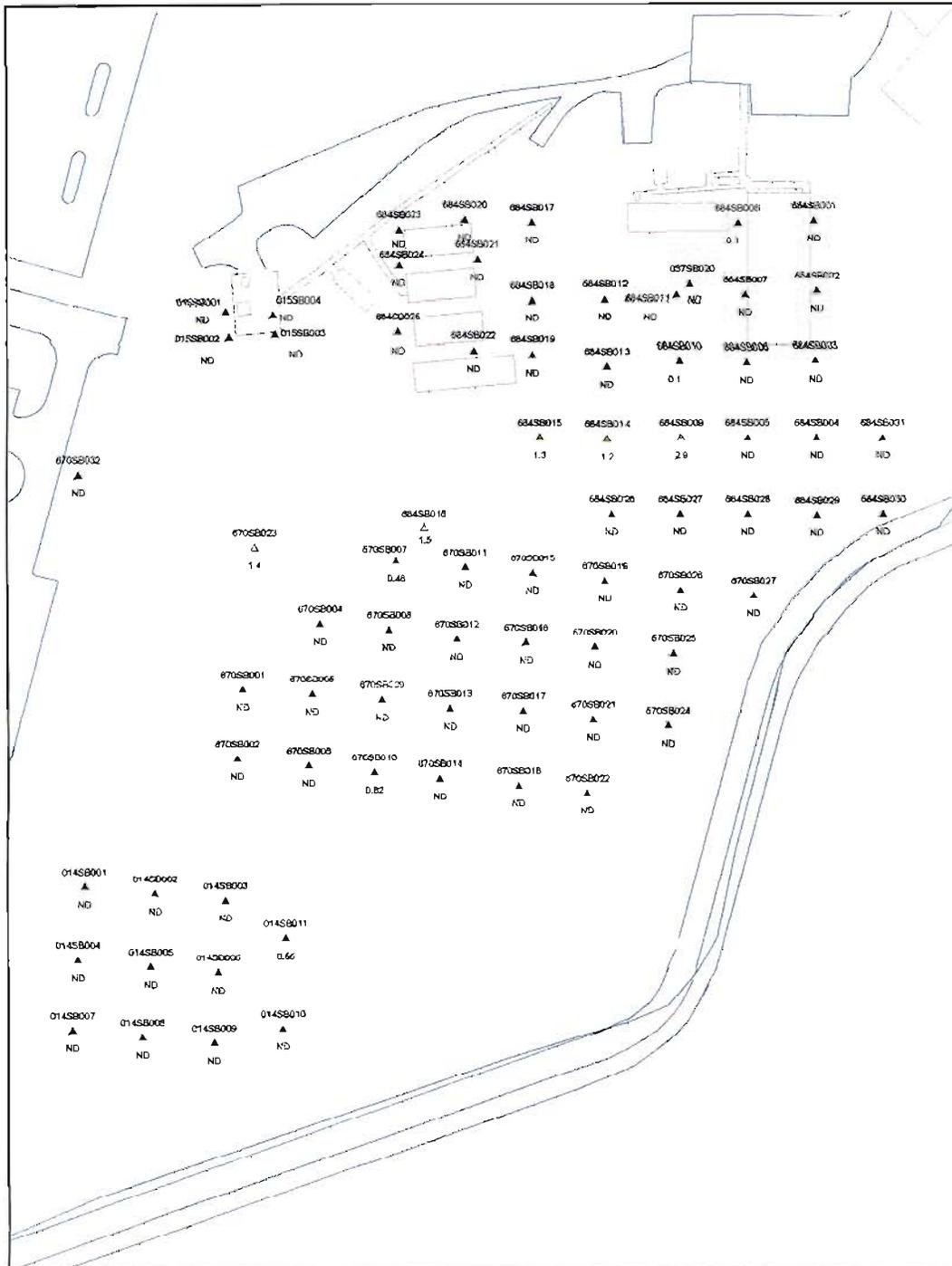
### **Corrective Measures Investigation**

Because the initial RFI investigation focused on residual chemicals, surface soil was not mechanically screened to determine approximate quantities and type of residual lead shot material remaining at the pistol and skeet ranges. Therefore, soil was sampled in this investigation to estimate the area/volume of particulate lead-impacted soil due to nearby firearm discharge in the vicinity.

Thirty-three surface soil samples were collected from the former outdoor trap and skeet range as indicated on Figure 2-10. Samples were collected in three rounds: (1) samples one to 16 (June 23, 1998), (2) samples 17 to 22 (July 28, 1998), and (3) samples 23 to 33 (October 21, 1998) in an attempt to delineate the extent of lead-shot-impacted soil. Initially,



<p><b>LEGEND</b></p> <p><b>LEAD (mg/kg)</b></p> <ul style="list-style-type: none"> <li>▲ 0 - 395 (State Background)</li> <li>▲ 400 - 1200 (Below USEPA Residential Clean Up Standard)</li> <li>▲ 1300 - 10000 (Above USEPA Industrial Clean Up Standard)</li> </ul> <p>  BUILDING BOUNDARY   FENCE   ROAD   SIDEWALKS         </p>	<p>N</p>	<p>SWMU 14 CMS REPORT CHARLESTON NAVAL COMPLEX Charleston, SC</p>
<p>50 0 50 Feet</p>		<p>Figure 2.8 Lead in Upper Interval Surface Soil</p>
<p><b>ENSAFE</b></p>		<p>g:/projects/charlstrn/zone h/big_pb      May 14, 1999</p>



**LEGEND**

**THALLIUM (mg/kg)**

- ▲ 0 - 1.1 (Below Background)
- ▲ 1.11 - 5.81 (< 1.0 Residential Hazard)
- ▲ 5.81 - 18 (< 3.0 Residential Hazard)

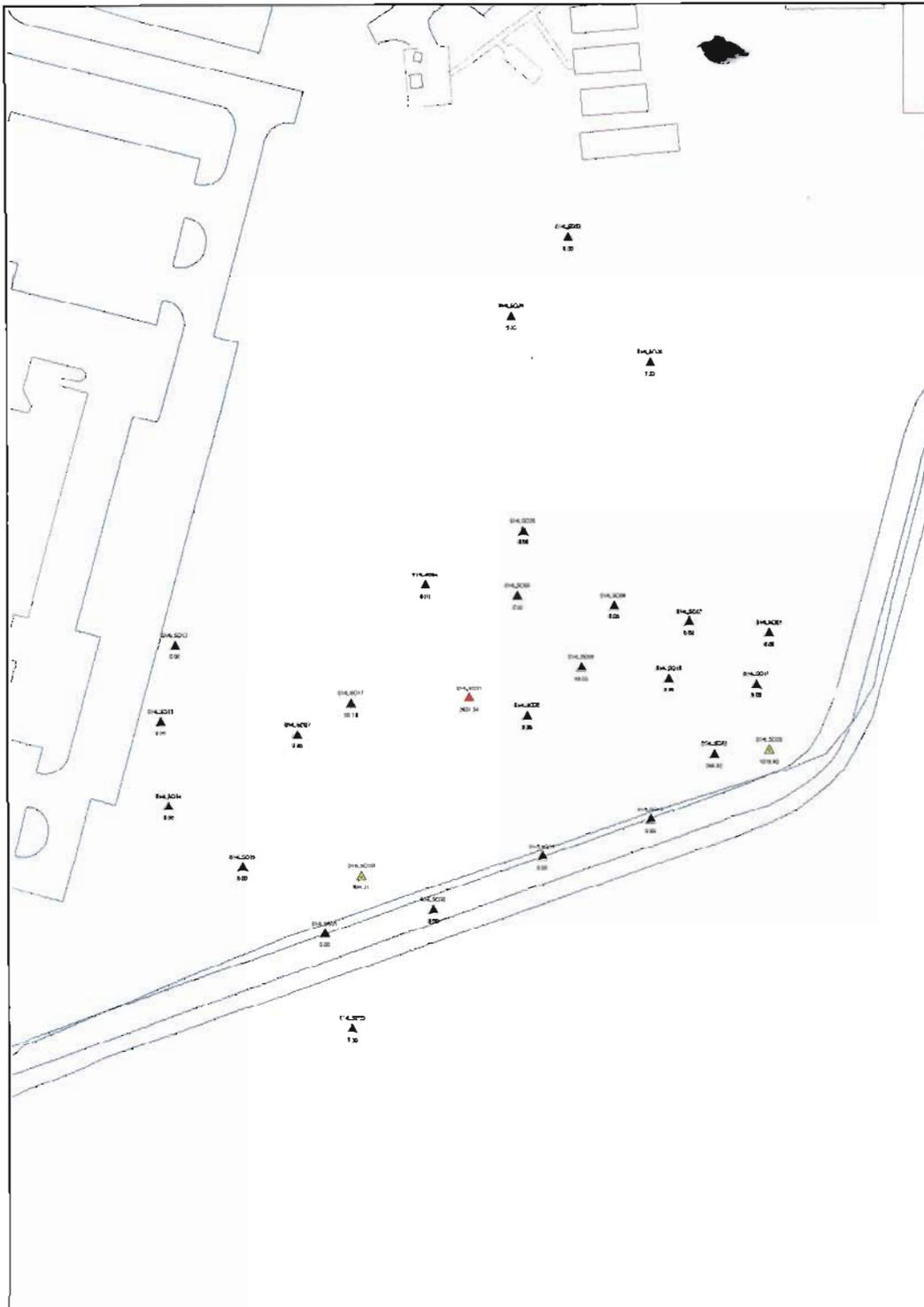
- BUILDING BOUNDARY
- - - FENCE
- == ROAD
- SIDE-WALKS



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Figure 2.9  
 Thallium in Upper Interval Surface Soil



**LEGEND**

**LEAD (mg/kg)**

- 0 - 399.999 (Blank Background)
- ▲ 400 - 1299.999 (Above USEPA Residential Clean Up Standard)
- ▲ 1300 - 1899.999 (Above USEPA Industrial Clean Up Standard)

- ▭ BUILDING
- ▭ BOUNDARY
- ▭ FENCE
- ▭ ROAD
- ▭ SIDE-WALKS



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40 0 40 Feet

**Figure 2.10  
Lead Shot Distribution**

sample locations were based on the areas thought to be impacted by firearm discharge in the southern portion of Combined SWMU 14 and along the dike around the area. Additional sampling locations were based on analytical results.

One-foot by 1-foot by 4-inch surface soil samples were collected at each location and placed in plastic bags. All soil samples were sieve-analyzed for lead-shot concentration and particle-size distribution by Soil Consultants, Inc. Table 2-6 summarizes the analytical data for the soil samples collected from Combined SWMU 14. The 0.0469-inch shot size is equivalent to the commonly known number 7½ or 8 shot, which were fired with shotguns at the skeet range. Lead shot distribution is also shown on Figure 2-10.

### 2.2.2 Groundwater Sampling and Analysis

#### RCRA Facility Investigation

Groundwater was sampled during the RFI to identify whether contamination resulted from chemicals and other waste disposal in the Combined SWMU 14 area, and whether residual chemical contamination resulted from small arms activities nearby.

Five monitoring well pairs (shallow/deep wells) were installed to sample groundwater at Combined SWMU 14. The deep monitoring wells were designed to allow groundwater directly above the Ashley Formation to be sampled. First-round groundwater samples were analyzed for all Appendix IX parameters. Second-round groundwater samples were analyzed for volatile organic compounds (VOCs), pesticides, herbicides, and metals.

What is the presentation of the additional data & validation?

**Table 2-6**  
**Lead Shot Analysis Summary for Combined SWMU 14**

Sample ID	Initial Wet Mass (kg)	Initial Dry Mass (kg)	Shot Size: Sieve and Inches	Lead Shot Mass (mg)	Lead Concentration (mg/kg)
014LSD0101	7.0974	4.9989	—	0	0
014LSD0201	8.3175	7.5204	—	0	0
014LSD0301	9.2996	7.2959	—	0	0
014LSD0401	8.4644	7.2947	—	0	0
014LSD0501	7.2644	6.2844	—	0	0
014LSD0601	9.7939	7.3786	—	0	0
014LSD0701	7.4900	5.3723	—	0	0
014LSD0801	8.7151	6.9537	—	0	0
014LSD0901	8.3601	6.1162	No. 16 sieve; 0.0469 inches	300	49.05
014LSD1001	9.5173	8.1275	—	0	0
014LSD1101	11.5570	8.1426	—	0	0
014LSD1201	6.2177	5.3266	—	0	0
014LSD1301	8.4807	7.8432	—	0	0
014LSD1401	10.5655	8.2790	—	0	0
014LSD1501	11.7710	8.4280	—	0	0
014LSD1601	8.8273	7.0453	No. 16 sieve; 0.0469 inches	6,300	894.21
014LSD1701	6.6222	5.3399	No. 16 sieve; 0.0469 inches	300	56.18
014LSD1801	6.6898	5.3886	No. 16 sieve; 0.0469 inches	1,600	296.92
014LSD1901	7.2834	6.0579	—	0	0
014LSD2001	5.8627	4.8622	—	0	0
014LSD2101	6.9765	5.7990	No. 16 sieve; 0.0469 inches	17,000	2,931.54
014LSD2201	7.0476	5.3642	—	0	0
014LSD2301	4.1665	3.7163	—	0	0
014LSD2401	3.2431	2.3389	—	0	0
014LSD2501	2.7209	1.8122	No. 16 sieve; 0.0469 inches	10	5.52
014LSD2601	4.2111	2.9215	—	0	0
014LSD2701	3.3593	2.4085	—	0	0
014LSD2801	4.1724	2.8367	—	0	0

**Table 2-6  
 Lead Shot Analysis Summary for Combined SWMU 14**

Sample ID	Initial Wet Mass (kg)	Initial Dry Mass (kg)	Shot Size: Sieve and Inches	Lead Shot Mass (mg)	Lead Concentration (mg/kg)
014LSD2901	4.1486	3.0434	No. 16 sieve; 0.0469 inches	3,100	1,018.6
014LSD3001	4.4923	3.5398	—	0	0
014LSD3101	3.8257	2.8192	—	0	0
014LSD3201	3.0422	2.1674	—	0	0
014LSD3301	5.0878	3.5958	—	0	0

*Notes:*

mg — milligram  
 kg — kilogram

The primary contributors to shallow groundwater risk were bis(2-Ethylhexyl)phthalate (BEHP) (common laboratory compound) and 2,3,7,8-TCDD equivalents (TEQs - e.g., dioxins); both detected in first-quarter sampling only. The hazard contributors were aluminum and vanadium. However, due to dioxins' hydrophobic nature, they are not expected to migrate from soil to groundwater. Furthermore, TEQ concentrations reported in the shallow groundwater do not exceed the maximum contaminant level (MCL).

The primary contributors to deep groundwater risk were heptachlor epoxide, BEHP, and TEQs; each was detected in first-quarter sampling only. The hazard contributors were cadmium and thallium, which was also detected exclusively in first quarter samples. Due to hydrophobic nature of heptachlor epoxide and dioxins, neither would be expected to migrate from soil to groundwater. Furthermore, TEQ concentrations reported in the deep groundwater do not exceed its MCL.

The fate-and-transport screening process for Combined SWMU 14 identified chromium and lead at concentrations exceeding their fate-and-transport screening criteria in both soil and groundwater. Shallow groundwater migration is a slow process for Zone H due to low hydraulic gradients. As such, sorption is likely to be the dominant process affecting fate and transport for

lead and chromium rather than groundwater migration. On a site-specific basis, only lead was identified in SWMU 14 for soil-to-groundwater migration concern based on soil concentrations and detections in down gradient monitoring wells. No constituents were identified as soil-to-groundwater migration concerns for SWMU 15, AOC 670, and AOC 684.

No groundwater COCs were identified for Combined SWMU 14.

### Corrective Measures Investigation

An additional nested groundwater monitoring well pair (shallow/deep wells) and a single shallow well were installed near the decontaminating agent non-corrosive (DANC) container excavation area to evaluate the subsurface impact of the formerly buried waste (see Section 2.3 for ISM discussion).

Wells NBCH014006 and NBCH01406D were installed directly in the excavation area; well NBCH014007 was installed approximately 60 to 70 feet downgradient. Table 2-7 summarizes the analytical data for the groundwater samples collected from Combined SWMU 14 during July 1998, February 1999, and March 1999. No VOCs were detected in groundwater samples collected from well NBCH014007 in February 1999 and wells NBCH014006 and -06D in March 1999.

*Present data in appd.*

*what well does this go to?*

Table 2-7  
 Combined SWMU 14 Corrective Measures Investigation Groundwater Samples (µg/L)

Date	Sample ID	Compound	Concentration	MCL	Tap Water RBC
7/98	014GW06D01	4-Methyl-2-Pentanone (MIBK)	3.0	NA	290
	014GW03D05	Carbon disulfide	2.0	NA	100
	014GW00601	Vinyl chloride	17.0	2.0	0.019
2/99	014GW00701	ND			
3/99	014GW06D02	ND			
	014GW00602	ND			

Note:  
 µg/L — micrograms per liter

*This well wasn't re-sampled? VOCs were exceeded but from what is given here it is not possible for me to tell which wells were sampled when? Tie samples to wells.*

### 2.2.3 Sediment Sampling and Analysis

Two sediment samples were collected from an intermittent drainage ditch east of Buildings 1896, 1887, 1893, and former 1897 to measure the potential impact from previous site activities. In addition, two samples were collected from the intermittent drainage ditch that divides AOCs 670 and 684. All sediment samples were collected from 0 to 1 foot below the sediment surface and detections were compared to USEPA Region IV sediment screening values (SSV).

Contaminant concentrations in sediment were essentially equal to respective concentrations in soil, which suggests the potential for surface soil erosion to form a depositional zone within the drainage feature. With no apparent outlet from the drainage feature from which the Combined SWMU 14 sediment samples were collected, further migration of sediments beyond Combined SWMU 14 ~~cannot be predicted.~~ *would not be expected.*

No sediment COCs were identified in the RFI for Combined SWMU 14.

### 2.2.4 Surface Water Sampling and Analysis

One surface water sample was collected from an intermittent drainage ditch that divides AOCs 670 and 684 to measure the potential impact from adjacent SWMUs. Detections were compared to USEPA chronic marine surface water quality criteria.

No surface water COCs were identified in the RFI for Combined SWMU 14.

## 2.3 Interim Stabilization Measures

Interim Stabilization Measures (ISM) were performed by the DET as part of the Navy Installation Restoration Program (IRP) to eliminate sources of environmental contamination or limit the spread of environmental contaminants prior to the completion of the CMS. Specifically, the ISM's primary objective was to investigate and remove anomalies (containers of warfare decontaminating

agents (DANC) particularly) and lead contamination identified in the RFI report dated July 5, 1996. Anomalies detected during geodetic and EM61 surveys were investigated using a trackhoe with personnel in Level B protection.

Approximately 90 five-gallon empty and partially or fully deteriorated DANC containers were removed from a location south of Building 1897. Waste was buried in Combined SWMU 14 from the mid 1940s until 1977. Crystallized residual mass (1,1,2,2-trichloroethane) in the buried DANC containers ~~may~~ have impacted soil and groundwater at the Combined SWMU 14.

*was thought to*

After the building and its foundation were demolished and removed, an additional 50 five gallon DANC containers were excavated from the area within the building's footprint. Affected soil was also excavated during the removal process. Thirty soil samples were collected to confirm the removal of all DANC-contaminated materials that exceeded USEPA Region III industrial RBCs. Two sample points required further excavation to remove residual contamination. Afterwards, the excavated areas were backfilled with clean soil. All other anomalies resulted in construction debris. An additional EM61 survey was performed to ensure that all anomalies were cleared from the site. *(Refer to specific Det Rpt)*

Water intrusion in the bottom of the excavation was sampled and analyzed for Appendix IX VOCs. The following were detected in the groundwater sample: PCE, (92.4  $\mu\text{g/L}$ ), TCE (85.1  $\mu\text{g/L}$ ), cis-DCE (166  $\mu\text{g/L}$ ), trans-DCE (29.4  $\mu\text{g/L}$ ), and vinyl chloride (26.0  $\mu\text{g/L}$ ). However, water intrusion samples may represent *have* sediment-borne contamination released during soil excavation rather than groundwater contamination. Furthermore, groundwater samples *sd* collected during the

CMS (see Section 2.2.2) in February and March 1999 did not contain any VOC contamination. *As stated above Confirmation Sampling has demonstrated all residuals in soil have since been removed from the site,*

The uppermost 6 inches of soil above the anomalies, assumed to be influenced by lead shot in the AOC 670 and 684 area, was required by the ISM work plan to be disposed of as hazardous waste.

*from wells within the former burial location*

Approximately 40 cubic yards (yd<sup>3</sup>) of soil were accumulated during the anomaly excavations. Four grab samples were collected, composited into one sample, and analyzed for total metals and toxicity characteristic leaching procedure (TCLP). Two additional composite samples were collected from the lead-shot-impacted areas. Based on the analytical results and an approval letter from DHEC (September 25, 1997), the soil was placed back into excavations from which miscellaneous non-hazardous metal debris had been removed.

The ISM implemented by the DET was not intended to be the final remedial action taken at Combined SWMU 14; however, it is consistent with the ultimate cleanup of the site. Moreover, it is assumed that soil and water samples collected during the ISM activities could be used to further define the environmental concerns at Combined SWMU 14. Soil and water samples collected during the ISM are summarized in Tables 2-8 and 2-9.

**Table 2-8**  
**Interim Stabilization Measures for Combined SWMU 14**  
**Soil Contamination**

Compound	Detections/ Samples Collected	Concentration Range for Detections	RBC	SSL	Background Reference Concentration
<b>Screening Samples from DANC Excavation (µg/kg)</b>					
1,1,2,2-tetrachloroethane	11/17	1.26 - 313,000	3,200	1.5	NA
1,1,2-trichloroethane	1/17	480	NA	NA	NA
PCE	4/17	2.84 - 2,000	12,000	30	NA
TCE	8/17	1.33 - 27,800	58,000	30	NA
1,2-trans-DCE	3/17	1.84 - 76.9	70,000	200	NA
Vinyl Chloride	1/17	1.66	340	6.7	NA
2-Butanone (MEK)	1/17	13.6	4,700,000	3,900	NA
1,2-dibromo- 3-chloropropane	1/17	2.84	NA	NA	NA
Chloroform	1/17	9.75	105,000	300	NA
Chlorobenzene	1/17	39.2	160,000	650	NA
Methylene Chloride	13/17	1.25 - 28.2	85,000	10	NA

**Table 2-8**  
**Interim Stabilization Measures for Combined SWMU 14**  
**Soil Contamination**

Compound	Detections/ Samples Collected	Concentration Range for Detections	RBC	SSL	Background Reference Concentration
<b>Confirmation Samples from DANC Excavation (<math>\mu\text{g}/\text{kg}</math>)</b>					
1,1,2,2-tetrachloroethane	6/13	2.75 - 45.9	3,200	1.5	NA
Vinyl Chloride	5/13	1.62 - 239	340	6.7	NA
PCE	2/13	15.6 - 250	12,000	30	NA
TCE	9/13	1.13 - 6,670	58,000	30	NA
1,2-cis-DCE	10/13	1.17 - 9,810	70,000	200	NA
1,2-trans-DCE	3/13	9.4 - 1,490	70,000	200	NA
Acetone	7/13	7.16 - 6,700	780,000	8,000	NA
2-Butanone (MEK)	7/13	40.8 - 174	4,700,000	3,900	NA
Methylene Chloride	8/13	1.22 - 298	85,000	10	NA
Ethylbenzene	1/13	54	780,000	6,500	NA
Xylenes (total)	1/13	65.5	16,000,000	70,000	NA
<b>Lead Shot Area Samples (SWMU 14) (mg/kg)</b>					
Antimony	1/1	5.25	3.1	2.7	-
Arsenic	3/3	7.96 - 14.5	0.43	15	15.6
Lead	3/3	52.2 - 200	400	400	118
Thallium	1/1	8.26	0.55	0.35	1.1
Vanadium	1/1	20	55	3,000	73

**Table 2-9**  
**Interim Stabilization Measures for Combined SWMU 14**  
**Water Intrusion Samples ( $\mu\text{g}/\text{L}$ )**

Compound	Detections/ Samples Collected	Concentration Range for Detections	MCL	Tap Water RBC
1,2-cis-DCE	1/1	166	70	NA
1,2-trans-DCE	1/1	29.4	100	NA
TCE	1/1	85.1	5.0	NA
Vinyl Chloride	1/1	26	2.0	NA
1,1,2,2-tetrachloroethane	1/1	92.4	NA	0.053

*Note:*  
 $\mu\text{g}/\text{L}$  — micrograms per liter

### ISM Status

The DET is planning to excavate lead-contaminated soil in 1999 at SWMU 14 (014SB005, -006, -010, and 014LSD16, -18, -21, and -29), AOC 670 (670SB012, -023, and -026), and from the berm around the dike in the southern portion of the site. Soil will be excavated until confirmation samples indicate that the contamination has been removed. Lead contamination includes residual chemical lead and lead particulate matter from Combined SWMU 14 firearms activities.

(refer to the recent Det w/p passed out to the team at the 6/99 PT mtg.)

→ and results are < 400 ppm.

### 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 thereof to significant risks, hazards, or other regulatory standard applicable to this site. In other cases, remedial objectives have been modified in response to calculated Zone H background risk and hazard.

#### 3.1 Soil Contaminants of Concern

Antimony, arsenic, lead, and BEQs are the primary soil COCs at Combined SWMU 14. However, 1,2,3-trichloropropane, aluminum, Aroclor-1254, Aroclor-1260, thallium, and vanadium were also classified as COCs in the RFI because at least one soil sample exceeded regulatory, risk-based, or background criteria.

Surface soil arsenic will be addressed as part of this CMS. However, subsurface soil arsenic will not be further addressed in this CMS for the following reasons:

- Arsenic exceeded its SSL (15 mg/kg) in 24 of 72 soil samples. However, the calculated subsurface background reference concentration (22.5 mg/kg) also exceeds the SSL. Furthermore, arsenic concentrations in groundwater samples are below MCLs, which suggests that subsurface soil-to-groundwater migration is not occurring at a rate that threatens groundwater. *← Include the date (period) of probable Arsenic deposition to help demonstrate a lack of migration.*
- The lower-interval arsenic detections do not correlate to surface soil arsenic detections and are therefore not representative of vertical migration through the soil. Furthermore, the results do not indicate the presence of a spill or other arsenic point release.

- Only 9% of arsenic samples exceed subsurface soil calculated background reference concentration (22.5 mg/kg), and the maximum subsurface soil concentration (29.4 mg/kg) is only 30% higher than the site's calculated subsurface background concentration.

**Lead** will be addressed based on USEPA blood-level model protection numbers of 400 mg/kg residential and 1,300 mg/kg industrial.

**BEQs** in surface soil will be addressed as part of this CMS. However, BEQs will not be addressed in subsurface soils. No samples exceeded the SSL for BEQs (1,600  $\mu\text{g}/\text{kg}$ ), and BEQs were not detected in any groundwater samples collected at Combined SWMU 14. The maximum lower-interval concentration is 1,284.2  $\mu\text{g}/\text{kg}$ .

**1,2,3-trichloropropane** exceeded its RBC (91  $\mu\text{g}/\text{kg}$ ) in only one of nine surface soil samples (014SB008); it was not detected in the other eight samples. This lone detection (91.2  $\mu\text{g}/\text{kg}$ ) was essentially equivalent to the residential RBC. Trichloropropane was originally retained as a COC because its concentration at soil sampling location 014SB008 exceeded its soil-to-air volatilization screening level (30  $\mu\text{g}/\text{kg}$ ). However, due to the limited extent of detections, impacts to ambient air related to trichloropropane volatilization are unlikely to exceed acceptable risk-based air concentrations. Consequently, this compound will not be addressed further in this CMS.

Calc.  
95%  
UCL

**Aluminum** exceeded its RBC (7,800 mg/kg) and background reference concentration (26,000 mg/kg) in one of three upper-interval locations (14SB010). However, aluminum concentrations are essentially equal to background concentrations which suggests that a spill or other point release did not impact the site. Furthermore, aluminum soil concentrations are typically elevated in the clayey soils like those found at Combined SWMU 14. Consequently, aluminum will not be addressed further as part of this CMS.

**Aroclor-1254 and Aroclor-1260** were originally retained as COCs because two samples contained these compounds at concentrations exceeding their risk-based screening levels (RBSLs). However, Aroclor-1254 did not exceed its residential RBC (320  $\mu\text{g}/\text{kg}$ ) at any of the 39 upper-interval sample locations. Aroclor-1260 only exceeded its residential RBC (320  $\mu\text{g}/\text{kg}$ ) in one of 39 upper-interval locations (684SB007) at a concentration of 376  $\mu\text{g}/\text{kg}$ ; the industrial RBC for polychlorinated biphenyls (PCBs) is 2,900  $\mu\text{g}/\text{kg}$ . This sample concentration and frequency of detection is not reflective of a release. Therefore, Aroclor-1260 will not be further directly addressed in this CMS.

include  
95%  
UK  
↓  
1 ppm Fed  
level

**Thallium** exceeded its RBC (0.55 mg/kg) and surface soil background reference concentration (1.1 mg/kg) at one of 28 upper-interval soil samples at AOC 670 (670SB023) and four out of 32 soil samples at AOC 684 (684SB009, -014, -015, and -016). It did not exceed its subsurface soil background concentration in any lower-interval soil samples and will not be addressed for the following reasons:

~~SEE~~

- Thallium exceeded its surface soil background reference concentrations in only 8% of upper-interval samples. Moreover, the 95% upper confidence interval of the site thallium sample mean is lower than the zone background reference concentration. Therefore, thallium's frequency and concentrations are not indicative of an acute thallium release at the site.
- All surface soil samples in which thallium exceeded its RBC and surface soil background reference concentration are located in the same area as antimony detections. Therefore, thallium contamination in these areas will be indirectly addressed as part of the larger antimony plume which is being addressed in this CMS.

where  
can I  
see?  
this?

Is this  
likely

term?

Where is the antimony discussion?

- Thallium's hazard at Combined SWMU 14 Hazard (0.1) is less than its Zone H background residential hazard (0.2).

**Vanadium** exceeded its RBC (55 mg/kg) at nine of 12 SWMU 14 upper-interval soil sample locations. However, none of the concentrations exceeded its surface soil background reference concentration (73 mg/kg). None of the lower-interval soil samples exceeded the subsurface soil background concentration for vanadium. Since vanadium detections do not exceed calculated background concentrations, it will not be addressed in this CMS.

### 3.2 Groundwater Contaminants of Concern

No groundwater COCs were identified in the RFI. However, the first round (July, 1998) shallow groundwater sample from well 014W006, installed in the former DANC excavation area, contained a vinyl chloride concentration (17.0 µg/L) that exceeded its RBC and MCL. However, vinyl chloride was not detected in second round (March, 1999) samples from 014GW006. No chlorinated VOCs were detected in wells 014-001 through -005 in four rounds of sampling, and no VOCs were detected in first round (February 1999) groundwater samples collected from well 014W007, which is downgradient of 014W006.

*\* Need to get another round of VOC data here in anticipation of*

Vinyl chloride is an anaerobic degradation product of 1,1,2,2-trichloroethane which is the main chemical component of the DANC contamination removed by the DET. The presence of vinyl chloride following the excavation suggests that the chlorinated hydrocarbon residue had been degraded in the biologically active vadose and saturated zones.

*Comment*

Based on the lack of groundwater contaminants in excess of MCLs or RBCs described above and the apparent natural degradation of chlorinated VOCs formerly present at the site, groundwater will not be further addressed in this CMS.

### **3.3 Remedial Goal Options**

#### **3.3.1 Combined SWMU 14 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.

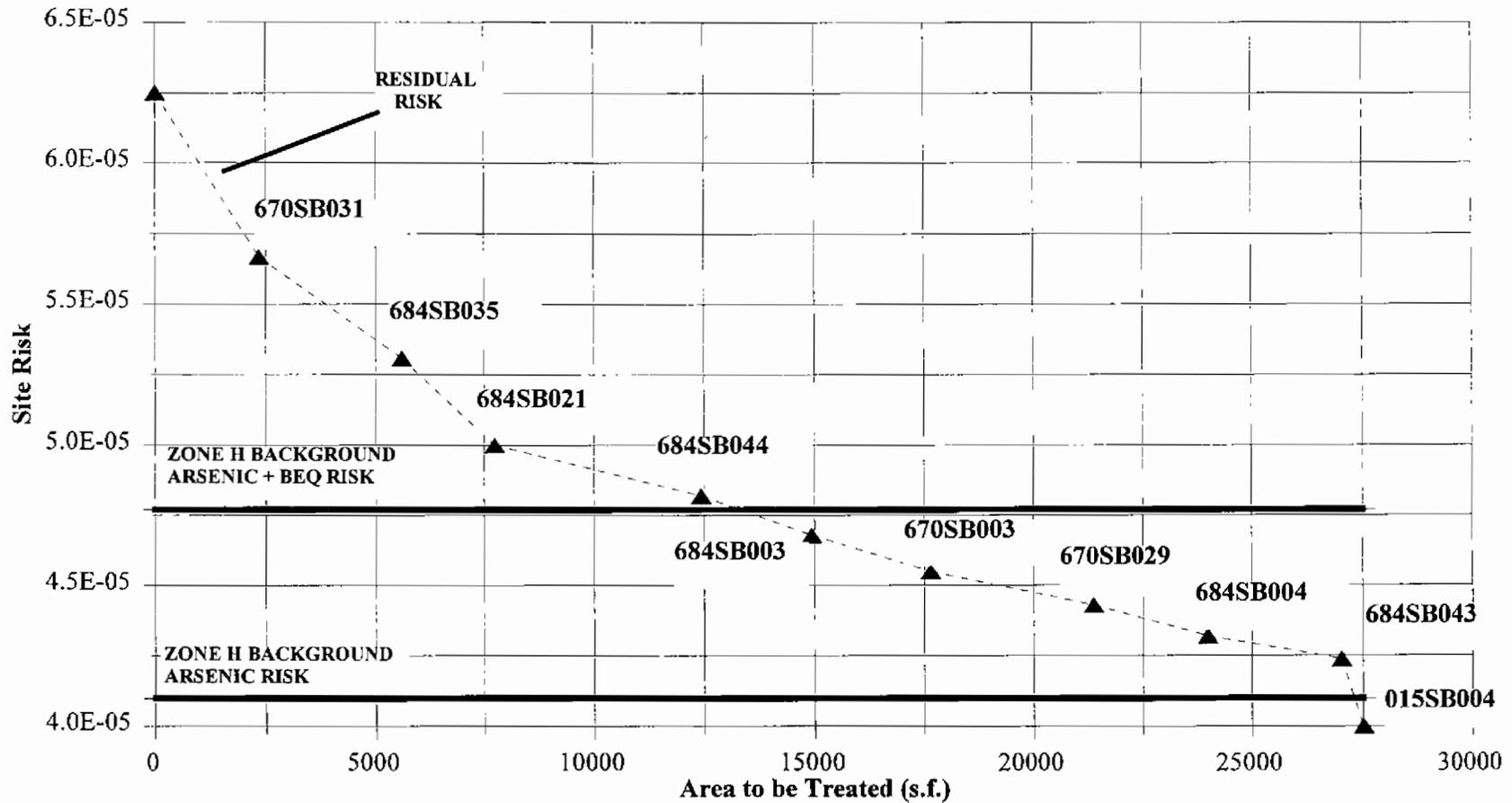
In addition to these RFI RGOs, alternate RGOs can be calculated by evaluating the incremental reduction in site risk as areas of greatest contamination are removed or otherwise remediated. Such calculations can be used to estimate the area and volume of soil requiring remediation in order to achieve 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 H 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 H background risk was calculated by applying the zone-specific background concentration of arsenic and BEQs to the risk and hazard formulas. Background arsenic concentrations (15.4 mg/kg) generate a Zone H background residential risk of 4.1E-05. Background BEQ concentrations (0.42 mg/kg) generate a Zone H background residential risk of 4.8E-05.

At Combined SWMU 14, residential point risks were ranked in terms of their relative contribution to overall site risk. Table 3-1 displays the greatest point contributors to residential risk at each site within Combined SWMU 14 excluding lead-contaminated points scheduled for removal by the DET. Figure 3-1 shows the reduction in residential site risk as the area associated with 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 H background risk.

*\*<sup>3-5</sup> OK, but isn't reduction of HQ equally relevant?*

**Figure 3-1 Combined SWMU 14  
Residential Risk Reduction Scenario**



Graph shows the effect of incremental point removals on overall residential site risk.

**Table 3-1  
 Combined SWMU 14 Residential Point Risk Reduction**

Point to be Removed	Estimated Area (ft <sup>2</sup> )	Cumulative Area (ft <sup>2</sup> )	Residential Point Risk	Total Site Risk Remaining After Point Removal
None	0	0	NA	6.3E-05
670SB031	2,338	2,338	9.0E-04	5.7E-05
684SB035	3,268	5,606	4.6E-04	5.3E-05
684SB021	2,142	7,747	4.4E-04	5.0E-05
684SB044	4,694	12,441	1.7E-04	4.8E-05
684SB003	2,496	14,937	1.6E-04	4.7E-05
670SB003	2,715	17,652	1.3E-04	4.6E-05
670SB029	3,732	21,384	1.2E-04	4.4E-05
684SB004	2,616	24,000	1.2E-04	4.3E-05
684SB043	3,024	27,023	7.1E-05	4.2E-05
015SB004	488	27,511	1.7E-04	4.0E-05

Note:

ft<sup>2</sup> — square feet

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.

*insert the background ARS of ARS + BEQ risks for demonstration when looking at the table.*

Table 3-2  
 Surface Soil Remedial Goal Options (mg/kg)

Compound	Point Hazard-Based RGOs				Point Risk-Based RGOs				Background Concentration
	0.1	1	3	Alt.	1E-06	1E-05	1E-04	Alt.	
<b>Residential Reuse Scenario</b>									
Antimony	2.92	29.2	88	NA <sup>1</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>1</sup>
Arsenic	2.19	21.9	66	15.4	0.383	3.83	38.3	15.4	15.4
Lead	NA <sup>4</sup>	NA <sup>4</sup>	NA <sup>4</sup>	400 <sup>3</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	400 <sup>2</sup>	118
BEQs <sup>6</sup>	NA <sup>4</sup>	NA <sup>4</sup>	NA <sup>4</sup>	NA <sup>4</sup>	0.060	0.6	6.0	0.42	0.42
<b>Industrial Reuse Scenario</b>									
Antimony	NA <sup>7</sup>	NA <sup>7</sup>	NA <sup>7</sup>	NA <sup>7</sup>	NA <sup>3</sup>	NA <sup>3</sup>	NA <sup>2</sup>	NA <sup>3</sup>	NA <sup>1</sup>
Arsenic	43.5	435	1,305	15.4	2.7	27.1	270.6	15.4	15.4
Lead	NA <sup>4</sup>	NA <sup>4</sup>	NA <sup>4</sup>	1,300 <sup>5</sup>	NA <sup>2</sup>	NA <sup>2</sup>	NA <sup>2</sup>	1,300 <sup>2</sup>	118
BEQs <sup>6</sup>	NA <sup>4</sup>	NA <sup>4</sup>	NA <sup>4</sup>	NA <sup>4</sup>	0.30	3.0	29.7	0.42	0.42

**Notes:**

- 1 — Combined SWMU 14 Site Hazard (0.9) for Antimony is less than the Background Zone H Hazard (1.1) for Antimony.
- 2 — Compound is not a recognized carcinogen and therefore does not contribute to risk.
- 3 — Background concentrations for this compound were not possible due to a lack of detections in background samples.
- 4 — Compound does not contribute to hazard.
- 5 — USEPA soil guidance concentration based on childhood exposure as predicted by IEUBK model.
- 6 — 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.
- 7 — No RGO needed because compound was not detected in quantities great enough to drive 0.1 hazard.
- NA — not applicable

Should we go ahead & bold what we want?

## **4.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES**

This section describes the initial steps toward remedy selection: identification and screening of applicable technologies. Once technologies are identified, they are reviewed based on site-specific conditions and waste constraints. Screening occurs when technologies are either eliminated from or retained for further consideration. From the technologies retained, alternatives for remedial action at SWMU 14 will be developed and further evaluated in Section 5.0.

### **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

### **In situ Physical/Chemical Treatment Technologies**

- **In situ and ex situ chemical oxidation** were screened from further consideration because they treat VOCs and SVOCs more effectively than inorganics and BEQs. Moreover, chemical oxidation is typically used to treat soils containing contaminants too concentrated or too toxic for bioremediation to be effective. For in situ oxidation, soils must be sufficiently permeable for the oxidant solution to reach the contamination and for reaction products to move away from the area. Furthermore, background metal 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 compounds dispersed over a large site such as Combined SWMU 14
  
- **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) and thermally enhanced SVE** were 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 a sufficient volume of 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. **Ex situ SVE** was screened from further consideration because it effectively treats VOCs and SVOCs, but not inorganics and BEQs.

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

#### **In situ Thermal Treatment Technologies**

- **In situ and ex situ aquathermolysis** were screened from further consideration because they do 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 a sufficient volume of 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.
- **In situ vitrification** was screened from further consideration because it may impact future use of the site. **Ex situ vitrification** was screened from further consideration because it is primarily used to treat radioactive contaminants.

#### **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 nonhalogenated VOCs and SVOCs — it does not effectively treat inorganics and BEQs.

#### **Ex situ Physical/Chemical Treatment Technologies**

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

### **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 for managing 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, Combined SWMU 14 BEQs concentrations are too low to supply sufficient British thermal units (Btus) to warrant this thermal technology — it would likely be cost prohibitive.
- **Open burn and detonation** were screened from further consideration because they are used primarily to treat munitions rather than inorganics and BEQs.

### **Other Treatment Technologies**

- none

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

### **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 since these compounds are often immobilized during the process, but not destroyed. 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 PAHs effectively, but institutional controls may be required and limit access to the site during remediation.

### **In situ Physical/Chemical Treatment Technologies**

- none

### **In situ Thermal Treatment Technologies**

- none

### **Ex situ Biological Treatment Technologies**

- none

### **Ex situ Physical/Chemical Treatment Technologies**

- **Chemical extraction** was screened from further consideration because it does not effectively treat BEQs (molecular weight = 252). Chemical extraction has been shown to be effective in treating soils containing inorganic and organic contaminants, but is generally least effective on very high molecular weight organics and very hydrophilic substances.
  
- **Physical separation** was screened from further consideration for several reasons:
  - Due to dispersed and relatively low concentrations of inorganic contamination at Combined SWMU 14, physical separation may not yield cost-effective quantities of recoverable metals.
  
  - Lead-shot contamination can be effectively treated with physical separation, however, these areas are scheduled to be removed by the DET during additional ISM activities before the implementation of corrective measures.
  
  - 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. Since the soil at Combined SWMU 14 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 reduction is minimal.

- **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 Combined SWMU 14. 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.

#### **Ex situ Thermal Treatment Technologies**

- none

#### **Other Treatment Technologies**

- none

Soil technologies retained for further consideration are listed below.

#### **Institutional Controls**

- Institutional controls

#### **Containment**

- Surface cap

#### **In situ Biological Treatment Technologies**

- Phytoremediation
- In situ landfarming

#### **In situ Physical/Chemical Treatment Technologies**

- none

**In situ Thermal Treatment Technologies**

- none

**Ex situ Biological Treatment Technologies**

- none

**Ex situ Physical/Chemical Treatment Technologies**

- none

**Ex situ Thermal Treatment Technologies**

- none

**Other Treatment Technologies**

- Excavation and offsite disposal

**4.2.2 Technology Screening Results for Groundwater Remediation**

Groundwater remedial technology identification and screening was not required during the CMS. Because the source was removed by the DET and based on the results of additional groundwater sampling performed during the CMS, Combined SWMU 14 shallow groundwater complies with all MCLs and does not require remedial action.

Table 4-1  
 Soil Technology Screening for Combined SWMU 14

Technology	Description	Site Constraints	Waste Constraints	Retained
<b>INSTITUTIONAL CONTROLS</b>				
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
<b>CONTAINMENT</b>				
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
<b>SOIL IN SITU BIOLOGICAL TREATMENT TECHNOLOGIES</b>				
Bioremediation	Naturally occurring microbes are stimulated by circulating water-based solutions through contaminated soils 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 (metals)
Bioventing	Air is either extracted from or injected into the unsaturated soils to increase oxygen concentrations 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, site (shallow water table) and waste constraint (metals)
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 soils contaminated with petroleum hydrocarbons and other compounds easily biodegraded under anaerobic conditions.	No, site (shallow water table) and waste constraint (metals)

**Table 4-1**  
**Soil Technology Screening for Combined SWMU 14**

Technology	Description	Site Constraints	Waste Constraints	Retained
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.	Yes
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 (metals)
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, site (shallow water table) and waste constraint (metals 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, site constraint

Table 4-1  
 Soil Technology Screening for Combined SWMU 14

Technology	Description	Site Constraints	Waste Constraints	Retained
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 sediments limit fracturing effectiveness and fractures will close in non-clayey soils. 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 constraint
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 constraint (shallow water table)
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 soils are 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 (shallow water table)
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. Soils should be fairly homogeneous and have high permeability, porosity, and uniform particle size distributions.	SVE applies to soils contaminated with VOCs and some SVOCs. The presence of NAPL in subsurface soil may affect the efficiency of SVE on organic compounds.	No, site (shallow water table) and waste constraint (metals and BEQs)
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 soils 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 soils may be treated with solidification/stabilization, some organics can delay or inhibit reactions necessary for solidification.	No, site constraint (future site use interference)

**Table 4-1**  
**Soil Technology Screening for Combined SWMU 14**

Technology	Description	Site Constraints	Waste Constraints	Retained
<b>SOIL IN SITU THERMAL TREATMENT TECHNOLOGIES</b>				
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 of 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, site (shallow water table) and waste constraint (metals and BEQs)
Thermally Enhanced Soil Vapor Extraction	Site soils are 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 (shallow water table) and waste constraint (metals and BEQs)
Vitrification	Electrical heating is used to melt contaminated soils, 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 constraint
<b>SOIL EX SITU BIOLOGICAL TREATMENT TECHNOLOGIES</b>				
Biopiles	Excavated soils are mixed with amendments, nutrients, and fillers and placed in aboveground enclosures. In an aerated static pile, excavated soils are 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 constraint (metals and BEQs)

**Table 4-1**  
**Soil Technology Screening for Combined SWMU 14**

Technology	Description	Site Constraints	Waste Constraints	Retained
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 constraint
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 constraint (metals 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 constraint
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 soils and clayey soils can create material handling problems.	Slurry-phase bioreactors are used primarily to treat nonhalogenated SVOCs and VOCs in excavated soils or dredged sediments. Slurry-phase bioreactors containing co-metabolites and specially adapted microorganisms can be used to treat halogenated VOCs and SVOCs, pesticides, and PCBs.	No, waste constraint (metals 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. Soils with higher clay content may reduce extraction efficiency and require longer contact times.	Acid extraction is suitable for treating soils contaminated by heavy metals.  Solvent extraction has been shown to be effective in treating soils containing primarily organic contaminants, but is generally least effective on very high molecular weight organics and very hydrophilic substances.	No, waste constraint (BEQs)
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Table 4-1  
 Soil Technology Screening for Combined SWMU 14

Technology	Description	Site Constraints	Waste Constraints	Retained
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 constraint
Dehalogenation	Reagents are added to soils 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 soils 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 constraint (metals 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, site constraint
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
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 soils will inhibit volatilization.	SVE applies to soils contaminated with VOCs and some SVOCs.	No, site constraint (shallow water table)

**Table 4-1**  
**Soil Technology Screening for Combined SWMU 14**

Technology	Description	Site Constraints	Waste Constraints	Retained
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 constrain (metals 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 bituminization, 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 soils may be treated with solidification/stabilization, some organics can delay or inhibit reactions necessary for solidification.	No, site constrain (future site use interfere)
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 constrain (metals and BEQs)
<b>SOIL EX SITU THERMAL TREATMENT TECHNOLOGIES</b>				
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 constrain (metals 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 constrain (metals)
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 constrain (metals and BEQs)

Table 4-1  
 Soil Technology Screening for Combined SWMU 14

Technology	Description	Site Constraints	Waste Constraints	Retained
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 constraint (metals and BEQs)
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 highest temperatures, but are not destroyed.	No, waste constraint (metals)
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 constraint
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 soils 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 constraint (low BEQs concentrations)
Vitrification	Electrical heating is used to melt contaminated soils, 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, site constraints

Table 4-1  
 Soil Technology Screening for Combined SWMU 14

Technology	Description	Site Constraints	Waste Constraints	Retained
<b>OTHER SOIL TREATMENT TECHNOLOGIES</b>				
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

Add  
 table  
 Summary  
 of alt. for  
 further  
 consideration

## **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 criteria to be eligible for selection. Evaluation of this criteria 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 the remedy. 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 time frame for each alternative to meet these standards will be estimated and included in this discussion.

### **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. Any proposed source control measure will include a discussion on estimated effectiveness based on site conditions and history of the specific technology.

#### **5.1.4 Compliance with Applicable Waste Management Standards**

Corrective action remedies must comply with applicable waste management standards. Each alternative must satisfy this criteria to be eligible for selection. This criteria is used to evaluate whether each alternative will meet all the 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 of 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 of the remedial action.
- Risks to workers during implementation of the remedial action.
- 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 remedy effectiveness monitoring, including an evaluation of the risks of exposure should monitoring be 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 and 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 containment, in situ and ex situ treatment, and excavation and disposal. Depending on remedial objectives and property reuse considerations, each 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: Phytoremediation
  
- Alternative 3: In situ Landfarming
  
- Alternative 4: Low-Permeability Surface Cap

- Alternative 5: Excavation to Residential Zone H Background Inorganic Site Risk with Offsite Disposal
  
- Alternative 6: Excavation and Offsite Disposal of All Areas Exceeding Zone H Background Concentrations

### **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 achieve a site wide residential risk of  $6.3E-05$  above background. *UW*

Implementation of no further remedial action is a viable remedial alternative because residual residential site wide risk is within the USEPA acceptable range ( $1.0E-04$  to  $1.0E-06$ ) following the DET ISM described in Section 2.3. Furthermore, the DET is scheduled to complete another ISM in 1999 — excavation and disposal of lead shot-contaminated soil from SWMU 14 and from the berm at the southern end of the Combined SWMU 14. *what about H(67) 3*

#### **5.2.1.1 No Further Remedial Action: Primary Criteria**

##### **Overall Protection of Human Health and the Environment**

No further remedial action provides no additional protection of human health and the environment. This alternative assumes that future use would be residential. Under the no further remedial action scenario, arsenic-, antimony-, and BEQs-contaminated soil would remain onsite. No institutional controls are included in this alternative.

### **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. However, as is, the residential site risk (6.3E-05) is within USEPA's acceptable range of 1.0E-04 to 1.0E-06.

*UHQ*

### **Source Control**

This alternative does not address source control. Contaminated soil would remain above remedial objectives.

### **Compliance with Applicable Waste Management Standards**

No waste will 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 of Alternative 1 is minimal. Soil volumes and concentrations would remain unchanged and this alternative does not reduce the magnitude of current site risk

#### **Reduction of 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 this alternative.

### **Implementability**

The no further remedial action 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: 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 Combined SWMU 14:

- *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, a 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 the root system of a plant and moved to the aboveground parts — the stems and leaves — where they can easily be 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 is able to 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 rhizospheric 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 in the planting scheme design including plant spacing, fertilization frequency, soil amendments, and water requirements.

During remedial activities, one or more of the following institutional controls would be installed as part of this alternative:

- Site access controls: fences, signs, gates, and additional site personnel
- Public awareness
- Long-term monitoring of general site conditions
- Land-use restrictions
- Excavation warnings and soil-use restrictions

### **5.2.2.1 Phytoremediation: Primary Criteria**

#### **Overall 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 during implementation, would eliminate risk to potential future residents or 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, 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 one of the least aggressive remedial technology and would likely require the most time to attain proposed cleanup standards. Once design plans are approved, this alternative would be expected to take several years to satisfy remedial objectives.

## **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 remedial objectives which are protective of future residential and industrial site users. Transportation of harvested materials offsite may 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 be performed for verification. No location-specific regulations would be triggered by this alternative.

### **5.2.2.2 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 this 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 initial, small-scale field tests.

#### **Reduction of Toxicity, Mobility, or Volume**

This alternative would provide effective toxicity, mobility, or volume reduction 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, or 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 Combined SWMU 14. Areas to be remediated are readily accessible. Contaminants are generally in the top 1 to 3 feet of soil, which contributes to phytoremediation 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 during implementation because soil would still represent an exposure threat until the contamination above remedial goals was phytoremediated.

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 more than 10 years to reduce COC concentrations to background levels. Table 5-1 summarizes its advantages and limitations.

### **Costs**

Costs associated with phytoremediation are presented in Table 5-2; however, current estimates costs for phytoremediation vary widely. Phytoremediation capital costs would be \$315,400, annual O&M costs would be \$30,000, and long-term monitoring costs would be \$22,000 per year. As appropriate, the long-term monitoring program can be modified with regulatory approval. The total cost for phytoremediation over a 30 year period would be \$1,031,020.

**Table 5-1**  
**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, 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 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 5-2**  
**Phytoremediation with Institutional Controls Costs**

Action	Quantity	Cost per Unit	Total Cost
<i>Capital Costs</i>			
Laboratory/pilot/field studies	LS	\$80,000	\$80,000
Mobilization/demobilization	LS	\$5,000	\$5,000
Planting	7 acres	\$10,000/acre	\$70,000
Soil cover and amendments	7 acres	\$7,500	\$52,500
Institutional controls	LS	\$10,000	\$10,000
Engineering/oversight	LS	20%	\$43,500
Contingency/miscellaneous	LS	25%	\$54,400
<b>Subtotal</b>			<b>\$315,400</b>

**Table 5-2**  
**Phytoremediation with Institutional Controls Costs**

Action	Quantity	Cost per Unit	Total Cost
<b>Operations and Maintenance Costs</b>			
Horticulture (plant health)	7 acres	\$1,000/acre	\$7,000
Pruning	7 acres	\$1,000/acre	\$7,000
Harvesting	7 acres	\$2,000/acre	\$14,000
Inspection	LS	\$2,000	\$2,000
<b>Subtotal</b>			<b>\$30,000</b>
<b>Present worth value at 6% discount rate over 30 years</b>			<b>\$413,000</b>
<b>Phytoremediation Long-term Monitoring Annual Program</b>			
Soil sampling (field work)	50 hrs	\$130/hr	\$6,500
Soil analysis	20 samples per year	\$200/sample	\$4,000
Evaluation	50 hrs	\$94/hr	\$4,700
Reporting/engineering	LS	20% cost	\$3,000
Misc. equipment, supplies, travel	LS	25% cost	\$3,800
<b>Subtotal</b>			<b>\$22,000</b>
<b>Present worth value subtotal at 6% for 30 years</b>			<b>\$302,800</b>
<b>Total</b>			<b>\$1,031,200</b>

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

*How is this effective for inorganics? Shouldn't this weakness be acknowledged to screen out this alternative?*

### 5.2.3 Alternative 3: In situ Landfarming

In situ landfarming is a demonstrated, active treatment process which uses soil's assimilative capacity to degrade, immobilize and transform COCs. Periodic disking or tilling will maintain appropriate oxygen levels in the soil while nutrient (phosphorus and nitrogen) and enhanced/engineered bacteria addition can supplement the process and improve degradation rates. Under certain conditions, landfarming has proven itself to be an effective and economical remedial technology.

During remedial activities, one or more of the following institutional controls would be installed as part of this alternative:

- Site access controls: fences, signs, gates, and additional site personnel
- Public awareness
- Long-term monitoring of general site conditions
- Land-use restrictions
- Excavation warnings and soil-use restrictions

### 5.2.3.1 In situ Landfarming: Primary Criteria

#### Overall Protection of Human Health and the Environment

In situ landfarming protects human health and the environment by slowly degrading, transforming, or immobilizing contaminants in the soil that contribute to site risk. This alternative, coupled with appropriate institutional controls during implementation, would eliminate risk to potential future residents or site workers and the environment due to dermal and gastrointestinal contact and drastically reduce the potential for contaminant migration.

Short-term risks from inhalation and dermal contact during implementation (due to tilling and disking) may be moderate, but could be controlled using common engineering techniques and appropriate PPE. This alternative would comply with applicable waste management standards and remedial objectives.

Finally, public acceptance of bioremediation can be very high, in part because of the "farm-like" aesthetic.

#### Attainment of Cleanup Standards

This alternative would attain media cleanup standards as established by the project team. In situ landfarming would likely require several months to a few years to attain proposed cleanup standards.

IMMOBILIZES  
of :: HQ STILL  
A PROBLEM?

## Source Control

This alternative would provide effective source control by slowly degrading, transforming, or immobilizing contaminants in the soil that contribute to site risk. 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

In situ landfarming meets remedial objectives that protects future industrial site workers. Since the waste will remain onsite and in place, no U.S. Department of Transportation regulations nor land-disposal restrictions would be triggered during remedial activities. Furthermore, no location-specific regulations would be triggered by this alternative.

### 5.2.3.2 In situ Landfarming: Secondary Criteria

#### Long-term Reliability and Effectiveness

In situ landfarming has proven itself to be an effective and economical remediation technology for the treatment of a wide range of hydrocarbons, including BEQs (PAHs). Inorganics, although not degraded, are immobilized during the biological transformation of organic compounds. Contaminants would be degraded to nontoxic elemental compounds through biodegradation. Future risk due to exposure to surface soil would be reduced by landfarming.

How is this demonstrated to ultimately reach NFA HQ?

#### Reduction of Toxicity, Mobility, or Volume

This alternative would provide effective toxicity, mobility, or volume reduction by slowly degrading, transforming, or immobilizing contaminants in the soil that contribute to site risk. Toxicity is reduced by biological processes that degrade the contaminants to less toxic forms. These biological processes would also immobilize inorganic compounds in the treatment zone (upper 1 to 2 feet). However, soil tilling and disking, while providing oxygen, may volatilize a minor fraction of the organic contamination even though heavy BEQs would likely resist

volatilization. Volume reduction, though likely to be minimal, would occur due to contaminant degradation or volatilization. With appropriate monitoring and maintenance, the toxicity, mobility, or volume reduction processes would be irreversible.

### **Short-Term Effectiveness**

Implementation of in situ landfarming would have some short-term effects on site workers due primarily to soil tilling and disking. Short-term risks from inhalation and dermal contact during implementation may be moderate but could be controlled using common engineering techniques and appropriate PPE. Adverse impacts to the surrounding environment are not anticipated during treatment activities; engineering and institutional controls would be applied to manage storm water runoff and erosion. Once design plans are approved, this alternative would be expected to take several years to satisfy remedial objectives.

### **Implementability**

In situ landfarming is technically and administratively feasible at Combined SWMU 14. Areas to be remediated are readily accessible. Contaminants are generally in the top 1 to 3 feet of soil which contributes to landfarming success. Overall, this alternative is easy to implement, maintain, and monitor. Only farming equipment and tanks/accessories to distribute the nutrients would be required to implement this technology. Confirmatory sampling would be required to monitor the performance of the process. No future remedial actions would be required after this alternative is completed.

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 landfarming 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 nutrient/fertilizer and (possible) bacteria addition. Agricultural analyses are required to complete the treatability study.
- Preliminary field testing at the site to monitor results and refine design parameters.
- Full-scale remediation

**Costs**

Costs associated with in situ land farming are presented in Table 5-3; however, current cost estimate for land farming may vary. In situ landfarming capital costs would be \$123,300, annual O&M costs would be \$43,500 including long-term monitoring. As appropriate, the long-term monitoring program can be modified with regulatory approval. The total cost for in situ landfarming over 30 years would be \$722,100. The monitoring period is negotiable — costs were evaluated over 30 years for consistency.

**Table 5-3  
 In situ Landfarming with Institutional Controls Costs**

Action	Quantity	Cost	Total Cost
<i>Capital Costs</i>			
Laboratory/pilot/field studies	LS	\$50,000	\$50,000
Mobilization/demobilization	LS	\$5,000	\$5,000
Treatment area preparation — storm water controls — site grading	LS	\$10,000	\$10,000
Irrigation system and piping	LS	\$10,000	\$10,000
Institutional controls	LS	\$10,000	\$10,000
Engineering/oversight	LS	20%	\$17,000
Contingency/miscellaneous	LS	25%	\$21,300
<b>Subtotal</b>			<b>\$123,300</b>

**Table 5-3**  
**In situ Landfarming with Institutional Controls Costs**

Action	Quantity	Cost	Total Cost
<b>Annual Operations and Maintenance Costs</b>			
Tilling	2 days/week	\$100/day	\$10,000
Moisture control and site monitoring	2 day/week	\$100/day	\$10,000
Sampling	50 samples	\$200/sample	\$10,000
Engineering/oversight	LS	20%	\$6,000
Contingency	LS	25%	\$7,500
<b>Subtotal</b>			<b>\$43,500</b>
<b>Present worth value at 6% discount rate over 30 years</b>			<b>\$598,800</b>
<b>Total</b>			<b>\$722,100</b>

*Note:*

LS — lump sum

#### 5.2.4 Alternative 4: Low-Permeability Surface Cap

This alternative uses a physical barrier to cover contaminated soil to eliminate the potential for dermal and gastrointestinal contact. It is not intended to prevent leaching (i.e., it is not a RCRA cap). Land use would be restricted to using institutional controls to minimize uncontrolled exposure. The estimated placement of the low-permeability surface cap is shown on Figure 5-1.

The area to be covered is approximately seven acres, approximately 70% of the site, and represents the area of the site in which contaminants exceed their remedial objectives. The actual location and size of the cover would be selected after the confirmation samples were collected and future land-use requirements better defined.

Cover construction would consist of two alternatives, depending on future site use: (1) a 24-inch thick, low permeability soil layer with a vegetative cover and (2) a combination cover: 60% soil cover and 40% 8-inch asphalt concrete pavement, coupled with a drainage system to divert runoff from the asphalt concrete cover surface. The soil cover would be sloped to manage storm water



runoff and prevent erosion. The combination cover would be designed to comply with future site needs.

For either cap system, confirmation sampling would complement current soil data to help delineate the extent of soil in which contaminant concentrations exceed the remedial objectives. This would ensure that all contaminated soil exceeding remedial objectives is covered.

One or more of the following institutional controls would be installed as part of this alternative:

- Site access controls: fences, signs, gates, and additional site personnel
- Public awareness
- Long-term monitoring of general site conditions
- Land-use restrictions
- Excavation warnings and soil-use restrictions

#### **5.2.4.1 Low-Permeability Surface Cap: Primary Criteria**

##### **Overall Protection of Human Health and the Environment**

The cover(s) would eliminate the threat of dermal and gastrointestinal contact for current and future site workers. Contaminated soil would be left onsite indefinitely; however, the cover would be maintained to ensure adequate protection. This alternative would protect human health and the environment by physically eliminating receptor pathways and controlling access through institutional controls. Cover construction and maintenance would be easily implemented and current site controls (site security, access control, and fencing) and additional institutional controls would be adequate to ensure minimal disturbance of the cover. Short-term risks from inhalation and dermal contact during implementation would be minimal, and could be controlled using common engineering techniques and PPE.

### **Attainment of Cleanup Standards**

Surface capping would attain media cleanup standards as established by the project team by eliminating dermal and gastrointestinal contact. As a result, risk-based cleanup standards would be achieved. This alternative would minimize the threat to human health and the environment by eliminating potential migration and exposure pathways.

### **Source Control**

This alternative would provide effective source control by eliminating further releases that might threaten human health and the environment by limiting rainwater infiltration and preventing direct contact to the contaminants. Furthermore, institutional controls would drastically reduce the likelihood of additional risks to future site workers or residents.

### **Compliance with Applicable Waste Management Standards**

The cover would isolate or eliminate contaminants exceeding remedial objectives in environmental media, but not manage solid or hazardous waste. The potential for contact with soil in which contaminants exceed remedial objectives is eliminated by removing the primary pathways. Site grading would need to comply with federal, state, and local air emissions and storm water control regulations.

#### **5.2.4.2 Low-Permeability Surface Cap: Secondary Criteria**

##### **Long-term Reliability and Effectiveness**

A cover would effectively reduce site worker contact with the contaminated soil. However, institutional controls and routine O&M would be required to ensure that any exposure to human and environmental receptors is within protective levels.

Soil and combination covers are generally reliable containment controls. If the cover failed, site workers could be exposed; however, repairs could be made to re-establish the cover's integrity. Future liability may be incurred because the waste is not destroyed.

### **Reduction of Toxicity, Mobility, or Volume**

Capping does not remove, treat, or remediate the contaminated soil; it provides containment only. The soil and combination covers are considered reversible — since the contaminants exceeding remedial objectives remain onsite, they may be exposed if the cover fails due to poor maintenance. This alternative would not reduce toxicity, mobility, or volume.

### **Short-term Effectiveness**

Adverse impacts to the surrounding environment are not anticipated during cover construction; engineering controls would be applied to manage storm water runoff. Once design plans are approved, actual cover construction would be expected to take a relatively short period of time (less than 6 months). During construction of either cover, there would be a potential risk of dermal or gastrointestinal contact and inhalation of particulate emissions; however, this risk would be reduced by using proper material handling practices and appropriate PPE.

It is anticipated that the time frame until remedial objectives are satisfied would be relatively brief. Consequently, worker exposure to the contaminants would be minimal.

### **Implementability**

A soil or combination cover with institutional controls is technically and administratively feasible. This alternative could be readily applied at the site since the proposed areas to be covered are easily accessible to site workers. Thus, implementation of this alternative would merely involve emplacement of the cover, implementation of institutional controls, and establishment of maintenance requirements. Future monitoring and maintenance would involve periodic cover

inspections and damage or degradation repair (if required); however, repairs would be easily implemented. The cover(s) would not require any extraordinary services or materials.

The cover location and material selection is not intended to interfere with future site use. The cover could be designed to serve as a beneficial part of future industrial site operations.

**Cost**

Costs associated with surface capping are presented in Tables 5-4 (soil cover) and 5-5 (asphalt concrete and soil combination cover). The total cost for a 24-inch thick low permeability soil layer with a vegetative cover, including institutional controls and long-term monitoring, would be \$568,500. Alternatively, the total cost for a combination soil/asphalt concrete cover, including application of institutional controls and long-term monitoring, would be \$1,045,700. O&M costs for these covers are \$6,000/year and \$7,000/year, respectively. Long-term monitoring would be required to maintain the effectiveness and integrity of the surface cover. The monitoring period is negotiable — costs were evaluated over 30 years for consistency.

**Table 5-4  
 Soil Cover with Institutional Controls Cost**

Action	Quantity	Cost per Unit	Total Cost
<i>Capital Costs</i>			
Mobilization/demobilization	LS	\$5,000	\$5,000
Grading/site preparation	5,000 yd <sup>3</sup>	\$1.50/yd <sup>3</sup>	\$7,500
24-inch soil cover	20,000 yd <sup>3</sup>	\$15.00/yd <sup>3</sup>	\$300,000
Vegetative cover	7 acres	\$1,800/acre	\$12,600
Institutional controls	LS	\$10,000	\$10,000
Engineering/oversight	LS	20%	\$67,000
Contingency/miscellaneous	LS	25%	\$83,800
<b>Subtotal</b>			<b>\$485,900</b>

**Table 5-4**  
**Soil Cover with Institutional Controls Cost**

Action	Quantity	Cost per Unit	Total Cost
<i>Operation and Maintenance Cost</i>			
Maintain cover (30 years)	LS	\$5,000	\$5,000
Inspection and reporting	LS	\$1,000	\$1,000
<b>Subtotal</b>			<b>\$6,000</b>
<b>Present worth value at 6% discount rate over 30 years</b>			<b>\$82,600</b>
<b>Total</b>			<b>\$568,500</b>

**Table 5-5**  
**Soil and Asphalt Concrete Combination Cover with Institutional Controls Costs**

Action	Quantity	Cost per Unit	Total Cost
<i>Capital Costs</i>			
Mobilization/demobilization	LS	\$5,000	\$5,000
Grading/site preparation	5,000 yd <sup>3</sup>	\$1.50/yd <sup>3</sup>	\$7,500
Drainage system	LS	\$25,000	\$25,000
Asphalt concrete surface (8 inches)	120,000 ft <sup>2</sup>	\$3.50/ft <sup>2</sup>	\$420,000
24-inch soil cover	12,000 yd <sup>3</sup>	\$15.00/yd <sup>3</sup>	\$180,000
Vegetative cover	4 acres	\$1,800 / acre	\$7,200
Institutional controls	LS	\$10,000	\$10,000
Engineering/oversight	LS	20%	\$130,900
Contingency/miscellaneous	LS	25%	\$163,700
<b>Subtotal</b>			<b>\$949,300</b>
<i>Operation and Maintenance Cost</i>			
Maintain drainage and cover (30 years)	LS	\$6,000	\$6,000
Inspection and reporting	LS	\$1,000	\$1,000
<b>Subtotal</b>			<b>\$7,000</b>
<b>Present worth value at 6% discount rate over 30 years</b>			<b>\$96,400</b>
<b>Total</b>			<b>\$1,045,700</b>

**5.2.5 Alternative 5: Excavation to Residential Zone H Background Inorganic Site Risk with Offsite Disposal**

Rather than treating each individual sample point above Zone H background concentrations, total site risk at SWMU 14 can be reduced to Zone H background levels by excavating or otherwise treating only the areas of greatest contamination at a site. Under this alternative, approximately 28,000 ft<sup>2</sup> of contaminated soil would be excavated to a depth of about 1 foot and disposed of offsite at a non-hazardous waste landfill. According to the site risk reduction analysis developed and discussed in Section 3.3, this alternative would result in a residual residential site risk of 4.0E-05, which is slightly less than the residential Zone H background inorganic risk of 4.1E-05.

LHQ?

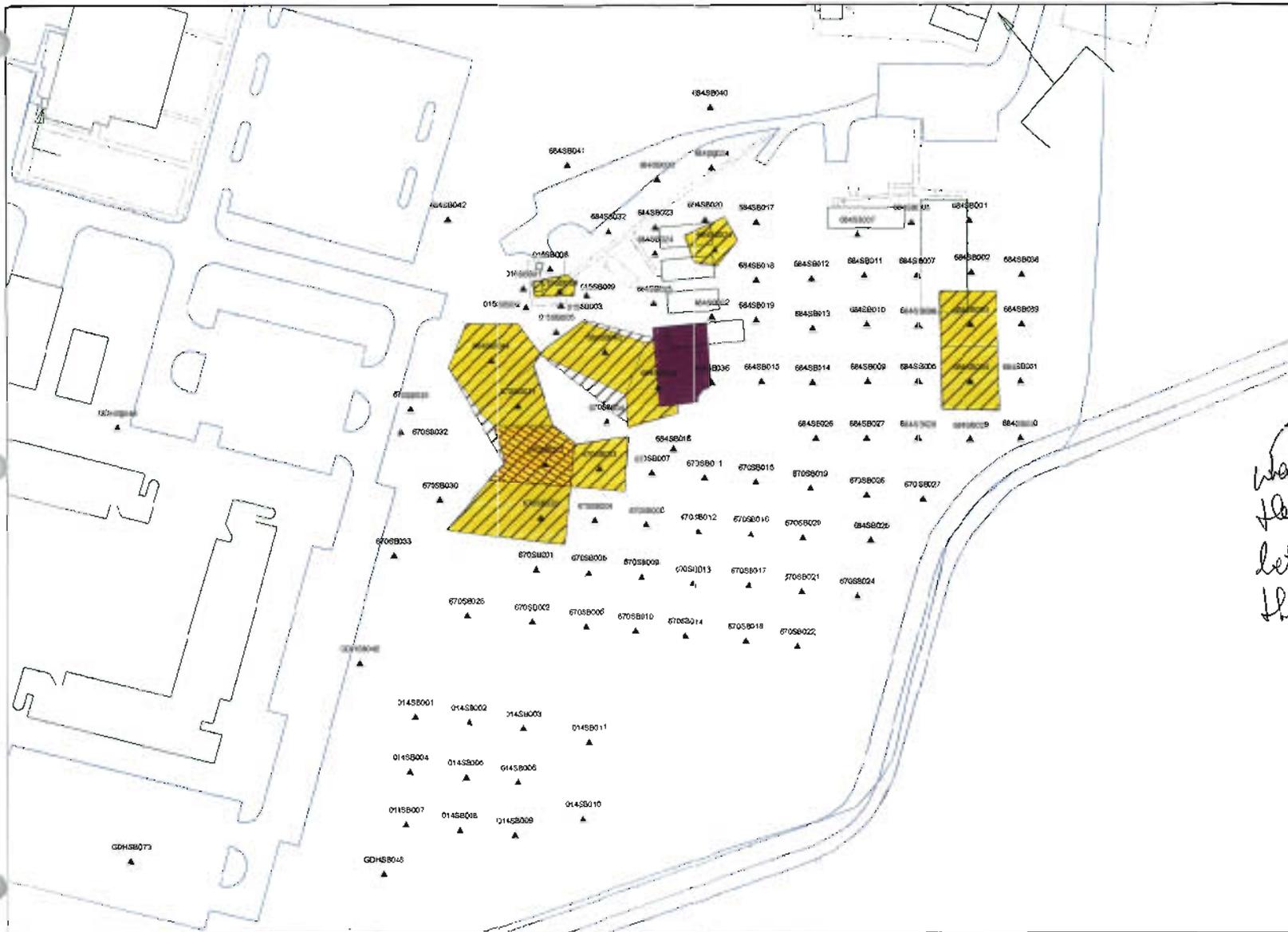
To achieve a site-wide residual residential Zone H arsenic background risk, approximately 1,000 yd<sup>3</sup> of soil would require removal, disposal, and replacement with clean backfill (Figure 5-2). Excavated soil would be placed in discrete stockpiles for sampling and TCLP analysis in order to classify the soil as either hazardous or nonhazardous and disposed of accordingly. Based on the rule of thumb that TCLP results will be less than or equal to 20 times less the total soil concentration of a contaminant and the fact that none of the three TCLP samples collected for TCLP analysis by the DET exhibited toxicity characteristics, all excavated soil is expected to be non-hazardous.

**5.2.5.1 Excavation to Residential Zone H Background Inorganic Site Risk with Offsite Disposal: Primary Criteria**

**Overall Protection of Human Health and the Environment**

Excavation to Zone H residential background risk and offsite disposal protects human health and the environment by removing contaminated soil that contributes to site risk greater than background. This alternative would limit risk to future site residents and the environment due to dermal and gastrointestinal contact to no greater level than is already present in non-contaminated areas of Zone H as a whole.

LHQ?



50 0 50 100 Feet

**LEGEND**

- ▲ Sample Points w/ ID
- ▭ BUILDING
- ▭ BOUNDARY
- ▭ FENCE
- ▭ ROAD
- ▭ SIDE-WALKS
- ▭ Already Excavated by DET and Replaced with Clean Soil
- ▭ Excavation Areas
- ▭ Scheduled for DET Removal
- ▭ Areas Requiring Excavation

\* All excavation areas are based on Risk-Threaten Polygons

*What is the difference between here and why?*



COMBINED SWMU 14  
CMS REPORT  
CHARLESTON NAVAL COMPLEX  
Charleston, SC

Figure 5.2  
Alternative 5 Excavation Locations

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. Contaminated soil would be excavated at select locations until confirmation samples satisfy site-wide risk reduction remedial objectives. This alternative is the most aggressive remedial technology and would likely require the least time to attain project team cleanup standards.

#### **Source Control**

This alternative would effectively control the source by eliminating contaminated media which contributes to site risk greater than calculated background levels.

#### **Compliance with Applicable Waste Management Standards**

This alternative would meet site-wide remedial objectives protective of potential future receptors. 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 is non-hazardous (three TCLP samples were collected and analyzed by the DET; none of the samples exhibited toxicity characteristics based on the TCLP results), TCLP analysis would be performed for verification. No location-specific regulations would be triggered by this alternative.

**5.2.5.2 Excavation to Residential Zone H Background Inorganic Site Risk with Offsite Disposal: Secondary Criteria  
Long-term Reliability and Effectiveness**

This alternative would reduce the quantity of soil in which contaminant concentrations exceed site-wide risk reduction remedial objectives. A residual site wide residential risk below Zone H inorganic background risk 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, future liability might be incurred because the waste is not destroyed.

**Reduction of Toxicity, Mobility, or Volume**

Excavation would eliminate the source area and therefore, eliminate contaminants affecting site-wide 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 analysis of the waste). 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, or 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 which specifies PPE, respiratory protection, etc. It is anticipated that the time frame until remedial objectives are satisfied would be relatively brief (less than three months). Consequently, worker exposure to the contaminants would be minimal.

### **Implementability**

Excavation with offsite disposal is technically and administratively feasible at Combined SWMU 14. 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 relatively small (approximately 1,000 yd<sup>3</sup> maximum) 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.

This alternative would not require any extraordinary services or materials. The Bee's Ferry Road Landfill in Charleston, South Carolina is a Class D facility, which 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.

### **Costs**

Costs associated with this alternative are presented in Table 5-6. The total cost for excavation and disposal to a nonhazardous, Subtitle D landfill would be \$111,000 — alternatively, the total cost for excavation and disposal to a hazardous, Subtitle C landfill would be \$403,500. If the excavated soil were distributed between the nonhazardous and hazardous landfills based on TCLP characterization, the actual total cost would fall between these two extremes. There are no O&M costs associated with this alternative.

**Table 5-6**  
**Excavation to Residential Zone H Background Inorganic Site Risk with Offsite Disposal Costs**

Action	Quantity	Cost per Unit	Total Cost
<b><i>Removal Action</i></b>			
Excavation	1,000 yd <sup>3</sup>	\$20/yd <sup>3</sup>	\$20,000
Confirmation/TCLP samples	50 samples	\$100/sample	\$5,000
Backfill	1,000 yd <sup>3</sup>	\$15/yd <sup>3</sup>	\$15,000
Engineering/oversight	LS	20% cost	\$8,000
Contingency/miscellaneous	LS	25% cost	\$10,000
<b>Subtotal</b>			<b>\$58,000</b>
<b><i>Subtitle D Disposal Facility</i></b>			
Transportation	1,000 yd <sup>3</sup>	\$8/yd <sup>3</sup>	\$8,000
Soil disposal	1,500 tons	\$30/ton	\$45,000
<b>Subtotal</b>			<b>\$53,000</b>
<b>Total (Subtitle D)</b>			<b>\$111,000</b>
<b><i>Subtitle C Disposal Facility</i></b>			
Transportation	1,000 yd <sup>3</sup>	\$8/yd <sup>3</sup>	\$8,000
Soil disposal	1,500 tons	\$225/ton	\$337,500
<b>Subtotal</b>			<b>\$345,500</b>
<b>Total (Subtitle C)</b>			<b>\$403,500</b>

*Note:*  
 LS — lump sum

### 5.2.6 Alternative 6: Excavation and Offsite Disposal of All Areas Exceeding Zone H Background Concentrations

All soil in which contaminants exceed calculated background reference concentrations would be excavated down to one foot below ground surface and disposed of in an offsite landfill. Antimony concentrations exceeding 0.1 residential hazard and lead concentrations exceeding 400 mg/kg would be excavated as well.

To achieve calculated background conditions for all Combined SWMU 14 COCs, approximately 4,600 yd<sup>3</sup> of soil would require removal/disposal. Sample points requiring removal are summarized in Table 5-7. Since contaminated soil would be addressed on a point-risk basis, more soil would require excavation and disposal (4,600 yd<sup>3</sup> vs 1,000 yd<sup>3</sup>) than the site risk remedial scenario presented in Section 5.2.5 (Alternative 5). 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.

**Table 5-7**  
**Excavation and Offsite Disposal of All Areas Exceeding Zone H Background Concentrations**  
**Sample Points Requiring Removal**

Sample Point	Estimated Associated Area (ft <sup>2</sup> ) <sup>a</sup>	Contaminants
<b>SWMU 14<sup>b</sup></b>		
None	N/A	N/A
<b>SWMU 15</b>		
3	762	BEQs <sup>c</sup>
4	488	Arsenic <sup>d</sup> , BEQs
6	1,481	BEQs
<b>AOC 670</b>		
3	2,715	BEQs
4	2,454	BEQs
5	2,499	BEQs
8	2,438	BEQs
9	2,493	Antimony <sup>e</sup>
11	2,724	Antimony
12 <sup>b</sup>	2,486	BEQs, Antimony, Arsenic, Lead
13	2,509	Antimony
16	2,435	Antimony
23 <sup>b</sup>	2,580	Antimony, Arsenic, Lead
26 <sup>b</sup>	2,613	BEQs, Lead
29	3,732	BEQs
30	7,056	BEQs
31	2,338	BEQs
32	5,000	BEQs, Arsenic
34	2,942	BEQs

**Table 5-7**  
**Excavation and Offsite Disposal of All Areas Exceeding Zone H Background Concentrations**  
**Sample Points Requiring Removal**

Sample Point	Estimated Associated Area (ft <sup>2</sup> ) <sup>a</sup>	Contaminants
<b>AOC 684</b>		
1	5,000	BEQs
2	2,407	BEQs
3	2,496	BEQs
4	2,616	BEQs
9	2,564	Antimony
12	2,966	Antimony
13	2,577	Antimony
14	2,604	Antimony
15	3,413	BEQs, Antimony
17	5,861	Antimony
18	2,274	Antimony
20	1,882	BEQs
21	2,142	BEQs
23	1,612	BEQs
24	2,052	BEQs
26	3,066	BEQs
27	2,592	BEQs
35	3,268	BEQs
36	3,468	BEQs
40	5,000	BEQs
43	3,024	BEQs
44	4,694	BEQs

**Notes:**

- a — Associated areas developed using Thiessen polygons.
- b — Contamination addressed during a DET ISM.
- c — BEQ concentration greater than its calculated background concentration, 424 µg/kg.
- d — Arsenic concentrations greater than its calculated background concentration, 15.6 mg/kg.
- e — Antimony concentration that exceeds its 0.1 residential hazard; no background concentration was calculated.

After the contaminated soil is removed, clean backfill would be placed in the excavated areas and graded. Excavation locations are shown on Figure 5-3.



**5.2.6.1 Excavation and Offsite Disposal of All Areas Exceeding Zone H Background Concentrations: Primary Criteria**

**Overall 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 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.

**Attainment of Cleanup Standards**

Excavation would attain media cleanup standards as established by the project team. 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 potential residential or industrial site users. 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 non-hazardous, TCLP analysis would be performed for verification. No location-specific regulations would be triggered by this alternative.

#### **5.2.6.2 Excavation and Offsite Disposal of All Areas Exceeding Zone H Background Concentrations: 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, future liability might be incurred because 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, or 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

the time frame until remedial objectives are satisfied would be relatively brief (less than three months). Consequently, worker exposure to the contaminants would be minimal.

### **Implementability**

Excavation with offsite disposal is technically and administratively feasible at Combined SWMU 14. 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 4,600 yd<sup>3</sup>) 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, which 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.

### **Costs**

Costs associated with excavation and offsite disposal are presented in Table 5-8. The total cost for excavation and disposal to a nonhazardous, subtitle D landfill would be \$499,000. Alternatively, the total cost for excavation and disposal to a hazardous, Subtitle C landfill would be \$1,844,500. 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 5-8**  
**Excavation and Offsite Disposal of All Areas Exceeding Zone H Background Concentrations Costs**

Action	Quantity	Cost per Unit	Total Cost
<b><i>Removal Action</i></b>			
Excavation	4,600 yd <sup>3</sup>	\$20/yd <sup>3</sup>	\$92,000
Confirmation/TCLP samples	150 samples	\$100/sample	\$15,000
Backfill	4,600 yd <sup>3</sup>	\$15/yd <sup>3</sup>	\$69,000
Engineering/oversight	LS	20% cost	\$35,200
Contingency/miscellaneous	LS	25% cost	\$44,000
<b>Subtotal</b>			<b>\$255,200</b>
<b><i>Subtitle D Disposal Facility</i></b>			
Transportation	4,600 yd <sup>3</sup>	\$8/yd <sup>3</sup>	\$36,800
Soil disposal	6,900 tons	\$30/ton	\$207,000
<b>Subtotal</b>			<b>\$243,800</b>
<b>Total (SubtitleD)</b>			<b>\$499,000</b>
<b><i>Subtitle C Disposal Facility</i></b>			
Transportation	4,600 yd <sup>3</sup>	\$8/yd <sup>3</sup>	\$36,800
Soil disposal	6,900 tons	\$225/ton	\$1,552,500
<b>Subtotal</b>			<b>\$1,589,300</b>
<b>Total (Subtitle C)</b>			<b>\$1,844,500</b>

### 5.3 Development and Evaluation of Groundwater Remedial Alternatives

Development and evaluation of groundwater remedial alternatives was not required during the CMS. Because the source was removed by the DET and based on the results of additional groundwater sampling performed during the CMS, Combined SWMU 14 shallow groundwater is in compliance with all MCLs and requires no further remedial action.

### 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. The focus should help determine which options are cost-effective and which remedy uses permanent solutions and treatment to the maximum extent practicable.

#### **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. All the alternatives evaluated in Section 5.3 are *technically feasible, implementable, and have been developed and used at other sites*. All alternatives generally protect human health and the environment except no further remedial actions, which provides no additional protection. State and community acceptance are determined in the same manner for each alternative. The key criteria that distinguish the soil alternatives focus are long-term reliability and effectiveness, reduction of mobility, toxicity, or volume, short-term effectiveness, implementability, and cost.

##### **5.4.1.1 Primary Criteria**

All alternatives considered for selection must comply with the primary criteria: protection of human health and the environment, attainment of cleanup standards, source control, and compliance with applicable waste management standards.

#### **Overall 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 of human health and the environment.

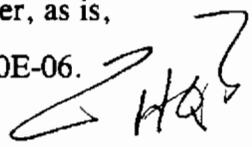
Alternatives 2 and 3, phytoremediation and in situ landfarming, protect human health and the environment by slowly removing, transforming, or immobilizing contaminants that contribute to site risk. Coupled with minor institutional controls, these alternatives eliminate dermal contact and ingestion pathways over time.

Alternative 4, the low-permeability surface cap, protects human health and the environment through containment and land-use restrictions and prevents completion of dermal and gastrointestinal pathways.

Alternatives 5 and 6, both excavation alternatives, protect human and health and the environment through removal of affected soil media. Alternative 5, excavation to residential Zone H background inorganic site risk with offsite disposal aims to efficiently reduce site risk and achieve remedial objectives by maximizing contaminant removal and minimizing soil removal. Alternatively, alternative 6, excavation and offsite disposal of all areas exceeding Zone H background concentrations aims to remove point risk to remedial objectives.

#### **Attainment of Cleanup Standards**

Alternative 1 does not comply with the risk-based goals developed in Section 3. However, as is, the residential site risk (6.3E-05) is within USEPA's acceptable range of 1.0E-04 to 1.0E-06.



Alternatives 2 and 3 comply with remedial objectives; however, these technologies would require months or years to attain cleanup standards.

Alternative 4 complies with remedial objectives for protection of human health and the environment because the risk pathway is eliminated by capping the contaminated soil. However, the contaminated soil would remain onsite.

Alternatives 5 and 6 comply with remedial objectives by removing the affected soil. Alternative 5 reduces site risk by removing the most contaminated areas. Alternatively, Alternative 6 addresses point risk by eliminating all points (and their associated areas) that exceed remedial objectives.

### **Source Control**

Alternative 1 does not address source control. Contaminated soil would remain above remedial objectives selected by the project team.

Alternatives 2 and 3 would provide effective source control by slowly removing, transforming, or immobilizing contaminants in the soil that contribute to site risk. For Alternative 2, phytoremediation, disposal of resulting affected plant material would eliminate the contaminants from the site.

Alternative 4 does not remove the source. However, this alternative would provide effective source control by limiting further exposure that might threaten human health or the environment. However, the contaminated soil would remain onsite.

Alternative 5 would provide effective source control by eliminating media which contributes to site risk greater than calculated background levels. Alternative 6 would effectively control the source by eliminating contaminated media exceeding calculated background concentrations for each of the COCs.

### **Compliance with Applicable Waste Management Standards**

No waste would be managed under Alternative 1. Therefore, waste management standards do not apply.

Alternative 2, phytoremediation, meets remedial objectives. Transportation and land disposal restrictions might be triggered if contaminated harvested materials required offsite disposal.

Alternative 3, in situ landfarming, meets remedial objectives. No waste would be managed under this alternative; therefore, waste management standards do not apply.

The cover implemented as Alternative 4 would isolate or eliminate contaminants exceeding remedial objectives in environmental media, but not manage solid or hazardous waste. Site grading would need to comply with federal, state, and local air emissions and storm water control regulations.

Alternatives 5 and 6 meet specific medial objectives. Excavation activities on-site 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. Although it is anticipated that excavated soil is non-hazardous, TCLP analysis would be performed for verification to determine proper disposal options.

#### **5.4.1.2 Secondary Criteria**

Five secondary criteria typically highlight the major differences between the alternatives: long-term reliability and effectiveness, reduction of toxicity, mobility, or volume, short-term effectiveness, implementability, and cost.

### **Long-term Reliability and Effectiveness**

Long-term reliability and effectiveness of Alternative 1 is minimal. Soil volumes and concentrations would remain unchanged and this alternative does not reduce the magnitude of current site risk.

Alternative 2 is limited to research and limited field testing. However, only institutional controls would be required to prevent exposure to human and environmental receptors during the application of phytoremediation.

In situ landfarming, Alternative 3, has proven itself to be an effective and economical remediation technology. Contaminants would be degraded to nontoxic elemental compounds through biodegradation. Future risk due to exposure to surface soil would be reduced by landfarming.

A cover would effectively reduce site worker contact with the contaminated soil during Alternative 4. However, institutional controls and routine O&M would be required to ensure that any exposure to human and environmental receptors is within protective levels.

Alternative 5 would reduce the quantity of soil in which contaminant concentrations exceed site-wide risk reduction remedial objectives. Alternative 6 would reduce the quantity of soil in which contaminant concentrations exceed calculated background concentrations. As such, background residual risk on a point-by-point basis would remain following the completion of this remedial alternative.

### **Reduction of Toxicity, Mobility, or Volume**

Alternative 1 does not reduce contaminant toxicity, mobility, or volume.

Alternatives 2 and 3 effectively reduce toxicity, mobility, or volume reduction 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.

Alternative 4, capping, does not remove, treat, or remediate the contaminated soil; it provides containment only. The soil and combination covers are considered reversible since the contaminants exceeding remedial objectives remain onsite. Regular maintenance is required to ensure that the integrity of the cover is sustained.

Alternatives 5 and 6, excavation and offsite disposal eliminates the contaminants that affect site remedial objectives. However, the waste's overall toxicity, mobility, or volume would not be reduced with this alternative since the contaminated soil would merely be transferred to another location (Subtitle C or D landfill).

### **Short-Term Effectiveness**

No short-term effects are associated with Alternative 1.

Alternatives 2, 3, 4, 5, and 6 include exposure to workers, which can be effectively controlled using engineering controls and appropriate PPE during planting, grading, tilling, capping, or excavating activities. Remedial time frames for Alternatives 2 and 3 are relatively long since they rely on biological and assimilative processes. However, worker exposure during O&M activities would be minimal. Remedial time frames for Alternatives 4, 5, and 6 are relatively short (likely less than three to four months).

### **Implementability**

All six alternatives can be implemented at Combined SWMU 14 and are technically and administratively feasible.

**Costs**

Capital (indirect and direct), O&M, and net present worth for all six alternatives are presented in Table 5-9. Alternatives range in cost from \$0 for no further remedial action to \$1,844,500 for excavation and offsite disposal at a Subtitle C landfill.

**Table 5-9  
 Soil Alternatives Cost Comparison**

Alternative	Capital Costs	Annual O&M	Net Present Worth
<b>1</b> No Further Remedial Action	none	none	\$0
<b>2</b> Phytoremediation	\$372,000	\$52,000	\$1,089,200
<b>3</b> In situ landfarming	\$181,300	\$43,500	\$780,100
<b>4a</b> Low-permeability soil cap	\$543,900	\$6,000	\$626,500
<b>4b</b> Low-permeability soil and asphalt concrete cap	\$1,007,300	\$7,000	\$1,103,000
<b>5a</b> Excavation to Residential Zone H Background Inorganic Site Risk with Offsite Disposal (Subtitle D)	\$111,000	none	\$111,000
<b>5b</b> Excavation to Residential Zone H Background Inorganic Site Risk with Offsite Disposal (Subtitle C)	\$403,500	none	\$403,500
<b>6a</b> Excavation and Offsite Disposal of All Areas Exceeding Zone H Background Concentrations (Subtitle D)	\$499,000	none	\$499,000
<b>6b</b> Excavation and Offsite Disposal of All Areas Exceeding Zone H Background Concentrations (Subtitle C)	\$1,844,500	none	\$1,844,500

**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 assigned a score for each of the primary and secondary criteria based on the comparative analysis of alternatives in Section 5.4. For primary criteria, the scoring methodology is presented as:

- 0 — criteria not met
- 1 — criteria may be met
- 2 — criteria met
- 3 — criteria exceeded

For secondary criteria, the scoring methodology is presented as:

- 0 — poor
- 1 — below average
- 2 — average
- 3 — above average

The primary criteria scores are multiplied by a larger weighting factor to emphasize their importance compared to the secondary criteria. A comment is included to justify each score and summarize the comparative analysis discussion in Section 5.4. Finally, the scores for each criteria are summed to develop an overall score for each alternative, which is used to rank the six remedial alternatives and provide a tool for selecting the final site remedy. The results are summarized in Table 5-10.

The recommended final site remedy is discussed in Section 6.

**Table 5-10a**  
**Summary of Evaluation of Soil Alternatives: No Further Remedial Action**

Evaluation Criteria	Weighting Factor <sup>1</sup>	Comments	Score <sup>2</sup>	Score x WF
<b>Primary Criteria</b>				
Protection of human health and the environment	2	Provides no additional protection of human health and the environment. However, residual residential site risk is within the USEPA acceptable range. <i>not HQ</i>	0	2
Attainment of cleanup standards	2	Does not comply with remedial objectives.	0	0
Source control	2	Does not address source control.	0	0
Compliance with applicable waste management standards	2	No waste is managed under this alternative. Therefore, waste management standards do not apply.	2	4
<b>Secondary Criteria</b>				
Long-term reliability and effectiveness	1	Long-term reliability and effectiveness of Alternative 1 is minimal.	1	1
Reduction in toxicity, mobility, or volume	1	Does not reduce toxicity, mobility, or volume of waste.	0	0
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	PW = \$0	3	3
<b>Ranking Score</b>				<b>16</b>

**Notes:**

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

**Table 5-10b**  
**Summary of Evaluation of Soil Alternatives: Phytoremediation**

Evaluation Criteria	Weighting Factor <sup>1</sup>	Comments	Score <sup>2</sup>	Score x WF
<b>Primary Criteria</b>				
Protection of human Health and Environment	2	Protects human health and the environment by slowly removing, transforming, or immobilizing contaminants. Coupled with institutional controls.	2	4
Attainment of cleanup standards	2	Complies with remedial objectives. Requires relatively lengthy treatment period.	<del>1</del>	4
Source control	2	Slowly removes or immobilizes source.	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
<b>Secondary Criteria</b>				
Long-term reliability and effectiveness	1	Limited to research and limited field testing.	1	1
Reduction in toxicity, mobility, or volume	1	Effective reduction of toxicity, mobility, or 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. Potentially one of the slowest alternatives to implement.	2	2
Cost	1	PW = \$1,089,200	1	1
<b>Ranking Score</b>				<b>24</b>

*Notes:*

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

**Table 5-10c**  
**Summary of Evaluation of Soil Alternatives: In situ Landfarming**

Evaluation Criteria	Weighting Factor <sup>1</sup>	Comments	Score <sup>2</sup>	Score x WF
<b>Primary Criteria</b>				
Protection of human health and environment	2	Protects human health and the environment by slowly removing, transforming, or immobilizing contaminants. Coupled with institutional controls.	2	4
Attainment of cleanup standards	2	Complies with remedial objectives. Requires relatively lengthy treatment period.	2	4
Source control	2	Slowly removes or immobilizes source.	2	4
Compliance with applicable waste management standards	2	Meets remedial objectives. No waste would be managed under this alternative. Therefore, waste management standards do not apply.	2	4
<b>Secondary Criteria</b>				
Long-term reliability and effectiveness	1	Effective and economical technology. Contaminants would be degraded to nontoxic elemental compounds through biodegradation.	2	2
Reduction in toxicity, mobility, or volume	1	Effective reduction of toxicity, mobility, or 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. Potentially one of the slowest alternatives to implement.	2	2
Cost	1	PW = \$780,100	2	2
<b>Ranking Score</b>				<b>26</b>

**Notes:**

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

**Table 5-10d**  
**Summary of Evaluation of Soil Alternatives: Low-permeability Surface Cap**

Evaluation Criteria	Weighting Factor <sup>1</sup>	Comments	Score <sup>2</sup>	Score x WF
<b>Primary Criteria</b>				
Protection of human health and environment	2	Protects human health and the environment through containment and land-use restrictions; exposure pathways eliminated.	2	4
Attainment of cleanup standards	2	Complies with remedial objectives for protection of human health and the environment. However, contaminated soil remains onsite.	1	2
Source control	2	Source not removed. However, the cap would provide effective source control by eliminating further releases.	2	4
Compliance with applicable waste management standards	2	Solid or hazardous waste would not be managed under this alternative. However, site grading activities must comply with air emissions and storm water regulations.	2	4
<b>Secondary Criteria</b>				
Long-term reliability and effectiveness	3	Institutional controls and routine O&M would be required to ensure long-term reliability of cap.	2	2
Reduction in toxicity, mobility, or volume	1	Does not reduce toxicity, mobility, or volume. Soil exceeding remedial objectives remains onsite.	0	0
Short-term effectiveness	3	Minimal worker exposure, which can be effectively controlled with engineering controls and PPE.	2	2
Implementability	1	Technically and administratively feasible. Soil and asphalt concrete cover is amenable to industrial reuse scenarios.	2	2
Cost	3	PW = \$626,500 (soil cover)	2	2
		PW = \$1,103,300 (soil and asphalt concrete cover)	1	1
<b>Ranking Score</b>			<b>21 or 22</b>	

**Notes:**

- PW — present worth
- 1 — Weighting Factor assigned by project team consensus
- 2 — Criteria-specific evaluation score:
 

<b>Primary:</b>	<b>Secondary:</b>
0 — criteria not met	0 — poor
1 — criteria may be met	1 — below average
2 — criteria met	2 — average
3 — criteria exceeded	3 — above average

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**Table 5-10e**  
**Summary of Evaluation of Soil Alternatives: Excavation to Residential Zone H Background Inorganic Site Risk with Offsite Disposal**

Evaluation Criteria	Weighting Factor <sup>1</sup>	Comments	Score <sup>2</sup>	Score x WF
<b>Primary Criteria</b>				
Protection of human health and environment	2	Removes soil to a restricted access area (landfill) where exposure pathways are minimal.	3	6
Attainment of cleanup standards	2	Complies with site risk reduction remedial objectives.	3	6
Source control	2	Effective source control by eliminating most contaminated media. Soil with acceptable residual risk would remain onsite.	2	4
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
<b>Secondary Criteria</b>				
Long-term reliability and effectiveness	1	Residual site risk would remain below calculated background site risk.	2	2
Reduction in toxicity, mobility, or 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. Potentially most rapid alternative.	3	3
Cost	1	PW = \$111,000 (nonhazardous soil) PW = \$403,500 (hazardous soil)	3 2	3 2
<b>Ranking Score</b>				<b>30 or 31</b>

**Notes:**

- PW — present worth
- 1 — Weighting factor assigned by project team consensus
- 2 — Criteria-specific evaluation score:
 

<b>Primary:</b>	<b>Secondary:</b>
0 — criteria not met	0 — poor
1 — criteria may be met	1 — below average
2 — criteria met	2 — average
3 — criteria exceeded	3 — above average

**Table 5-10f**  
**Summary of Evaluation of Soil Alternatives: Excavation and Offsite Disposal of All Areas Exceeding Zone H Background Concentrations**

Evaluation Criteria	Weighing Factor <sup>1</sup>	Comments	Score <sup>2</sup>	Score x WF
<b>Primary Criteria</b>				
Protection of human health and environment	2	Removes soil to a restricted access area (landfill) where exposure pathways are minimal.	3	6
Attainment of cleanup standards	2	Complies with point-risk reduction remedial objectives.	3	6
Source control	2	Effective source control by eliminating most contaminated media. All 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
<b>Secondary Criteria</b>				
Long-term reliability and effectiveness	1	Background residual risk would remain on a point-by-point basis.	2	2
Reduction in toxicity, mobility, or 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. Will require 4,400 yd <sup>3</sup> clean fill.	2	2
Cost	1	PW = \$499,000 (nonhazardous soil) PW = \$1,844,500 (hazardous soil)	2 0	2 0
<b>Ranking Score</b>				<b>29 to 31</b>

**Notes:**

- PW — present worth
- 1 — Weighting factor assigned by project team consensus
- 2 — Criteria-specific evaluation score:
 

<b>Primary:</b>	<b>Secondary:</b>
0 — criteria not met	0 — poor
1 — criteria may be met	1 — below average
2 — criteria met	2 — average
3 — criteria exceeded	3 — above average

\*  
 Add Summary table w/ scores next page

## 6.0 RECOMMENDATIONS

Recommendations for the soil and groundwater remedial alternatives are outlined here. Selection of the final alternatives was selected 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, ~~no further remedial action~~ is the recommended remedial alternative for Combined SWMU 14. This alternative was selected for several key reasons:

- Residual residential site risk would be  $6.3E-05$  (inorganic compound background residential risk of COCs at Combined SWMU 14 is  $4.1E-05$ ) — residual risk is in USEPA's acceptable residential risk range ( $1.0E-06$  to  $1.0E-04$ )
- It would be the least expensive alternative (\$0).
- The DET has performed an ISM at the Combined SWMU 14 (empty DANC container and affected soil removal as well as construction debris removal) and is scheduled to remove lead-contaminated soil from SWMU 14 and the berm in the southern portion of the site in summer 1999. Therefore, residential site risk will be further reduced.
- No O&M would be required — no remaining liabilities.
- It allows for unrestricted reuse and redevelopment of the site — a Navy preference.

How?   
lowest scores

What about HQ exceedences?  
also DHEC will not buy it

If site risk reduction is required by the project team, then **excavation to residential Zone H background inorganic site risk with offsite disposal** is the recommended remedial alternative for Combined SWMU 14. 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 4.0E-05 — all points with a point risk exceeding 1.0E-04 would be removed.
- It would be the least expensive alternative, other than no further remedial action, for managing nonhazardous soil (\$111,000).
- 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 will be removed from the site.
- It allows for unrestricted reuse and redevelopment of the site — a Navy preference.

## **6.2 Groundwater Remedial Alternative**

Based on the rationale and decision factors in the previous sections, there is no groundwater contamination which requires remedial action.

## **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, no interaction is required 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: (1) to initiate and sustain community involvement and (2) 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 presentations for informal community groups whenever possible.
- 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 updated 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:

- Updating and publicizing the information repository.
- Publicizing the environmental point of contact.
- Continuing 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 regularly scheduled and publicized forum for interfacing with community members on the progress of the environmental program, including the 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

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United States Environmental Protection Agency (USEPA). (May 1994) *RCRA Corrective Action Plan (Final)*, Office of Waste Programs Enforcement Office of Solid Waste.

**9.0 SIGNATORY REQUIREMENT**

Condition I.E. of the Hazardous and Solid Waste Amendments (HSWA) portion of 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 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 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 fine and imprisonment for knowing violations.*

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

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Date