CORRECTIVE MEASURES STUDY WORK PLAN SOLID WASTE MANAGEMENT UNIT 17 (SWMU 17) ZONE H CNC CHARLESTON SC

5/1/2001

NAVFAC SOUTHERN

CORRECTIVE MEASURES STUDY WORK PLAN

Solid Waste Management Unit 17, Zone H

Charleston Naval Complex
North Charleston, South Carolina

SUBMITTED TO
U.S. Navy Southern Division
Naval Facilities Engineering Command

CH2M-Jones

May 2001

Revision 1
Contract N62467-99-C-0960

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
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5090/11
Code 18713
14 May 01

Mr. John Litton, P.E.
Director, Division of Hazardous and Infectious Waste Management
Bureau of Land and Waste Management
South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201

Subj: SUBMITTAL OF CORRECTIVE MEASURES STUDY WORK PLAN FOR SOILD WASTE MANAGEMENT UNIT 17

Dear Mr. Litton:

The purpose of this letter is to submit the Corrective Measures Study Work Plan (Revision 1) for Solid Waste Management Unit (SWMU) 17, Zone H located at the Charleston Naval Complex. The work plan is submitted to fulfill the requirements of condition IV.E.2 of the RCRA Part B permit issued to the Navy by the South Carolina Department of Health and Environmental Control and the U.S. Environmental Protection Agency (EPA).

The Charleston Naval Complex BRAC Cleanup Team discussed this document and the proposed rationale action. CH2M Hill has distributed the document under separate cover letter. Appropriate certification is provided under that correspondence. We request that the Department and the EPA review this document and provide comments or approval whichever is appropriate.

If you should have any questions, please contact, Matthew Humphrey or myself at (843) 743-9985 and (843) 820-5551 respectively.

Sincerely,

ROBERT A. HARRELL, JR., P.E.
Environmental Engineer
BRAC Division

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CH2MHILL

May 10, 2001

John Litton, P.E., Director
Division of Hazardous and Infectious Wastes
South Carolina Department of Health and
Environmental Control
Bureau of Land and Waste Management
2600 Bull Street
Columbia, SC 29201

Re: Corrective Measures Study Work Plan for Solid Waste Management Unit (SWMU) 17, Zone H

Dear Mr. Litton:

Enclosed please find four copies of the Corrective Measures Study Work Plan for SWMU 17, in Zone H of the Charleston Naval Complex (CNC). This report has been prepared pursuant to agreements by the CNC BRAC Cleanup Team for completing the RCRA Corrective Action process.

Please contact me if you have any questions or comments.

Sincerely,

CH2M HILL

Dean Williamson, P.E.

cc: Tony Hunt/Navy, w/att
Rob Harrell/Navy, w/att
Mihir Mehta/SCDHEC
Gary Foster/CH2M HILL, w/att

CORRECTIVE MEASURES STUDY WORK PLAN

Solid Waste Management Unit 17, Zone H

Charleston Naval Complex
North Charleston, South Carolina

SUBMITTED TO
U.S. Navy Southern Division
Naval Facilities Engineering Command

PREPARED BY
CH2M-Jones

May 2001

Revision 1
Contract N62467-99-C-0960
158814.ZH.PR.09

Certification Page for Corrective Measures Study Work Plan for SWMU 17, Zone H, Revision 1

I, Dean Williamson, certify that this report has been prepared under my direct supervision. The data and information are, to the best of my knowledge, accurate and correct, and the report has been prepared in accordance with current standards of practice for engineering.

South Carolina

Temporary Permit No. T2000342

Dean Williamson, P.E.

5/4/2001

Date

SOUTH CAROLINA
CH2M HILL, INC.
No. C00201
CERTIFICATE OF AUTHORIZATION

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A Selected figures from the RFI Addendum.

B Responses to SCDHEC and EPA Comments

C Calculations of Site-Specific DAFs at SWMU 17

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Acronyms and Abbreviations

μg/kg	microgram per kilogram
μg/L	microgram per liter
AST	above-ground storage tank
BEQ	Benzo(a)pyrene equivalents
CA	corrective action
CFR	Code of Federal Regulations
CMS	corrective measures study
CNC	Charleston Naval Complex
COC	chemical of concern
COPC	chemical of potential concern
DAF	dilution attenuation factor
DNAPL	dense nonaqueous phase liquid
DPT	direct push technology
EPA	U.S. Environmental Protection Agency
FBM	Fleet Ballistic Missile
ft bgs	feet below ground surface
ft/day	feet per day
HI	hazard index
LNAPL	light nonaqueous phase liquid
m/m	meter per meter
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MCS	media cleanup standard
mg/kg	milligram per kilogram
m/yr	meters per year
NAPL	nonaqueous phase liquid
NAVBASE	Naval Base
NAVFACENGCOM	Southern Division Naval Facilities Engineering Command
ORC™	oxygen release compound

Acronyms and Abbreviations, Continued

PAH	polycyclic aromatic hydrocarbon
PCA	tetrachloroethane
PCB	polychlorinated biphenyl
ppb	parts per billion
PRG	Preliminary Remediation Goal
RAO	remedial action objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RGO	remedial goal option
SCDHEC	South Carolina Department of Health and Environmental Control
SSL	soil screening level
SVE	soil vapor extraction
SVOC	semi-volatile organic compound
SWMU	Solid Waste Management Unit
TEQs	TCDD (dioxin isomer) equivalents
TV	transformer vault
USBP	U.S. Border Patrol
USGS	U.S. Geological Survey
UST	underground storage tank
VOC	volatile organic compound

SECTION 1.0

Introduction

1.0 Introduction

In 1993, Naval Base (NAVBASE) Charleston was added to the list of bases scheduled for closure as part of the Defense Base Realignment and Closure Act, which regulates closure and transition of property to the community. The Charleston Naval Complex (CNC) was formed as a result of the dis-establishment of the Charleston Naval Shipyard and NAVBASE on April 1, 1996.

CNC corrective action (CA) activities are being conducted under the Resource Conservation and Recovery Act (RCRA). The South Carolina Department of Health and Environmental Control (SCDHEC) is the lead agency for CA activities at the site. All RCRA CA activities are performed in accordance with the Final Permit (Permit No. SC0 170 022 560). In April 2000, CH2M-Jones was awarded a contract to provide environmental investigation and remediation services at CNC. This Corrective Measures Study (CMS) Work Plan has been prepared by CH2M-Jones to describe the plan to identify and evaluate the potential remedial alternatives for the soil and groundwater at Solid Waste Management Unit (SWMU) 17 in Zone H at the CNC .

1.1 Regulatory Background

CH2M-Jones has prepared this CMS Work Plan on behalf of the Southern Division Naval Facilities Engineering Command (NAVFACENGCOM) to comply with the RCRA Hazardous and Solid Waste Amendments Permit requirements for closure of the CNC. A RCRA Facility Investigation (RFI), a baseline risk assessment, and an RFI Addendum prepared by EnSafe Inc. (EnSafe) have been completed for SWMU 17 and submitted to SCDHEC for review. SCDHEC comments on the RFI Addendum are currently being resolved and addressed. An RFI work plan addendum is being developed for collection of additional soil and groundwater samples to complete the delineation of the extent of contamination (and to address the majority of SCDHEC's comments). However, the overall nature and extent of contamination has been generally well-established for the majority of the site. In response to SCDHEC's comments on Revision 0 of this Work Plan, selected figures from EnSafe's RFI Addendum that illustrate the SWMU boundary, extent of contamination, direction of groundwater flow, and geology are included in this document as Appendix A and referenced in the text. Comments provided by SCDHEC and the U.S.

Environmental Protection Agency (EPA) on Revision 0 of this Work Plan, and the CH2M-Jones response to those comments, are included in this Work Plan as Appendix B.

The next step in the RCRA CA program for SWMU 17 is the CMS process, which consists of this CMS Work Plan, the CMS report, and implementation of the selected corrective measure alternative. This CMS Work Plan discusses the remedial action objectives and media cleanup standards to be used for protecting human health at SWMU 17.

1.2 Site Background and History

SWMU 17, shown in Figure 2.5.2A of Appendix A, is located at Building FBM 61 within Zone H at the CNC. FBM 61 is the former Fleet Ballistic Missile Training Center that was used by the Navy from 1962 until June 1996. It is leased by the U.S. Border Patrol (USBP) and is used as a law enforcement training facility.

The zoning for SWMU 17, as applied by the City of North Charleston, is B-2, which is a zoning type that allows for various commercial business activities but does not provide for long-term or permanent residential use. The CNC Reuse Plan designates the future land use of this area for government offices and a training campus. The USBP's use of this area for law enforcement training is compatible with the zoning and future land use provided for in the Reuse Plan.

There are four known sources of contamination at SWMU 17. These four source areas, designated as A through D, are described below and shown in Figure 1-1.

A: In June 1987, a leak occurred in a boiler fuel oil line that runs underneath a storage addition on the north side of FBM 61. Approximately 14,355 gallons of #5 diesel fuel oil leaked, of which approximately 7,300 gallons were recovered.

B: In September 1997, a 250-gallon steel underground storage tank (UST) was removed because holes in the tank had allowed #2 diesel fuel oil to leak into the ground. This UST was located next to transformer vault (TV) 1.

C: In 1984, a line pole capacitor ruptured and spilled polychlorinated biphenyl (PCB) oils at the northern end of the paved courtyard. The Navy cleaned up the PCB oils.

D: Soil samples collected in 1982 confirmed the presence of PCB-containing soils beneath the drains at TV1. There is no information as to whether samples were collected from the soils near TV2, which is a second TV at the site. PCBs were also detected in oily soil samples collected during the cleanup of source A, above. Both PCB-filled transformers were removed in the early 1990s.

In addition to the four known sources described above, the possibility was presented in the EnSafe RFI Addendum that another UST exists beneath the floor of FBM 61 (EnSafe, 2000). Mr. Frank Lauver, who has been the Facility Maintenance Manager since 1982, confirmed the existence of a UST in the northeast corner of the building. While there was never any evidence of leaks while the tank was in use, it was emptied in 1995 and abandoned in place. The tank is currently surrounded by concrete on three sides (including the bottom of the tank) and was inspected in 1999. There was no evidence of staining on the concrete.

1.3 Summary of Site Investigation Activities to Date

Site investigation activities have occurred in five separate phases since 1994. Table 1-1 briefly summarizes these activities. Soil sample collection and groundwater monitoring well installation methods are detailed in *the Final Investigation Report for Zone H, Naval Base Charleston* (EnSafe/Allen & Hoshall, 1996).

A total of 36 surface soil samples were collected from the top foot of the soil interval in 1994-1995, and 33 subsurface soil samples were collected in 1994 and 1995 at a depth of approximately 3 to 5 feet below ground surface (ft bgs). Generally, these samples were analyzed for the full suite of analytes (volatile organic compounds [VOCs], semi-volatile organic compounds [SVOCs], pesticides, PCBs, metals, and cyanide). Tables 2.5.12 and 2.5.13 in the RFI Addendum list the analyses performed for each of the samples collected (EnSafe, 2000).

Six surface, 10 subsurface, and 16 saturated soil samples were also collected in 1999 using direct push technology (DPT). The saturated zone samples were collected to provide a comparison to groundwater samples in areas of the site with light non-aqueous phase liquids (LNAPL) and dense non-aqueous phase liquids (DNAPL). Saturated soil samples were analyzed for VOCs, SVOCs, pesticides, PCBs, metals, and cyanide. Figure 1-2 shows surface and subsurface soil sample locations.

A total of 10 shallow groundwater monitoring wells were installed in 1994 and 1998 to a typical depth of about 15 ft bgs. In 1998, one deep monitoring well was installed to a depth of 44 ft bgs at SWMU 17. In 1999, 27 temporary wells were installed to a depth of approximately 15 ft bgs using DPT. These wells were installed to investigate other potential sources of contamination at SWMU 17 and to better delineate the extent of specific contaminants in groundwater. Figure 1-3 shows groundwater monitoring wells and DPT locations.

Soil samples collected from SWMU 17 borings indicate that the site geology consists of unconsolidated coastal sediments. Four cross-sections of the site were provided in the RFI Addendum, illustrating the interbedded nature of these sediments, which consist of silty sands and marsh clays. These figures are included in Appendix A (see Figures 2.5.5A and 2.5.5B). The water table is approximately 5 ft bgs at SWMU 17, and the aquifer materials consist of interbedded sands and clays that range from 5 to 15 feet in thickness. Beneath this aquifer lies an organic clayey silt (Qm1) that appears to be laterally continuous at SWMU 17 since it is detected in the bottom portions of all of the groundwater wells installed at the site. This clay unit is approximately 15 feet thick in the one well that fully penetrated it, and may provide an effective barrier in preventing shallow groundwater contamination from reaching the deeper aquifer that lies beneath the clay. Groundwater elevations are shown in Figure 2.5.7A, Appendix A.

As described earlier, surface soil samples, subsurface soil samples, and groundwater samples were collected at the site and analyzed for VOCs, SVOCs, PCBs/pesticides, and metals. The RFI Addendum contains 53 figures showing the lateral extent of these chemicals across the site and 10 tables listing the concentrations of the chemicals detected in the samples (EnSafe, 2000). Figures 2.5.4A, 2.5.4B, 2.5.4C, and 2.5.4D (see Appendix A) illustrate the extent of contamination for selected chemicals in each impacted medium. Figures 2.5.8A and 2.5.8C (also presented in Appendix A) have been included herein to show the extent of LNAPLs and DNAPLs in the subsurface. Because of minor data gaps at the conclusion of this multi-event sampling program, limited additional sampling is needed to address the full extent of the contamination in the soil and groundwater. These samples will be collected as an RFI Addendum activity and addressed separately from this document. At the current time, enough is known about the nature and extent of contamination to initiate the CMS process. The early stages of the CMS process can be conducted concurrently with the activities related to the additional sampling event.

To develop a list of chemicals of potential concern (COPCs), concentrations of chemicals in soil and groundwater samples were compared to site background concentrations, risk-based concentrations (RBCs), soil screening levels (SSLs) or maximum contaminant levels (MCLs), as appropriate (EnSafe, 2000). RBCs for surface soils were developed by EnSafe and are documented in the RFI Addendum (EnSafe, 2000); SSLs for subsurface soils and RBCs for groundwater are based on EPA Region IX Preliminary Remediation Goals (PRGs) (EPA, 2000) and are listed in Table 2.5.36 in the RFI Addendum. MCLs are the federal drinking water standards that were promulgated by EPA (Title 40 of the Code of Federal Regulations Part 264 (40 CFR 264). Figures 1-4 through 1-6 illustrate the extent of contamination in surface soil, subsurface soil, and groundwater, relative to SSLs and RBCs. For these figures, the chemical that has the greatest lateral extent across the site has been selected for each media. Accordingly, Aroclor-1260 is shown for soils, and chlorobenzene is shown for groundwater. Additional figures are presented in Section 2.0 to better illustrate the extent of contamination in each of the impacted medium at the site.

After the COPCs were identified by the screening process described above, a risk assessment for SWMU 17 was conducted by EnSafe. The risk assessment identified a preliminary set of chemicals of concern (COCs) that significantly contribute to a pathway in a use scenario for a specific receptor. Section 2.0 describes the results of the risk assessment and the final set of COCs that were identified for SWMU 17.

1.4 Summary of Conclusions from RFI Addendum

The RFI Addendum (EnSafe, 2000) included the following summary of the general origins and extent of key contaminants, which serves as an overall conceptual site model regarding sources of contamination and current status:

> *PCB and diesel fuel oil from activities in and around FBM 61 have entered soil and groundwater at the site. PCB contamination is the result of transformer fluid leaks in the paved courtyard area on the north side of the building. Aroclor-1260 is the main PCB contaminant exceeding screening levels in soil. Chlorinated benzenes are also present as contaminants associated with the leaking transformer dielectric fluid. Leaking transformer fluids pooled on the surface or in pavement subgrade materials northwest of what is now the storage area, and migrated vertically until accumulating in the saturated zone as a DNAPL in the area immediately surrounding well 017002. The DNAPL found at well 017002 is persistent but not great in thickness (0.10 ft, 01/00). The DNAPL accumulation appears static but is a continuing source of dissolved phase constituents such as the chlorinated benzene compounds. Although there have been some PCB detections in groundwater, chlorobenzene is the most widespread contaminant in groundwater related to the dielectric fluid and has migrated north and south of the building area.*
>
> *Diesel fuel leaking from UST FBM 61-1 and the buried boiler fuel pipeline likely contributed to the spread of PCB contaminants in soil. Residual diesel fuel from*

the pipeline leak is present as LNAPL in the storage addition area. LNAPLs at FBM 61 have not migrated from the source area and are relatively immobile under existing site groundwater gradients. However, the LNAPLs continue to be a source of dissolved phase constituents. Soluble phase fuel constituents are present in shallow groundwater beneath the paved courtyard and storage addition, and in the area around the pipeline between the storage addition and the boiler fuel storage AST [above-ground storage tank]. Moderate pumping of the temporary wells during development and sampling created a noticeable increase in LNAPL measured in SWMU 17 wells. This implies that the LNAPLs may be induced to move by low pumping of the aquifer.

The low permeability clayey sediments of Qm1 effectively isolate the basal sand (Qs1) of the surficial aquifer beneath SWMU 17 which has not been impacted by contaminants in near surface soils and shallow groundwater.

1.5 CMS Work Plan Organization

This CMS Work Plan consists of the following five sections, including this introduction:

1.0 Introduction — Presents the purpose of the Work Plan and background information necessary to understand the CMS objectives. Accordingly, this section includes a general site description and a description of the nature and extent of contamination in soils and groundwater at SWMU 17.

2.0 Risk Assessment Results and COC Identification — Discusses the risk assessment performed for SWMU 17 and direct and indirect exposure scenarios identified as needing further evaluation.

3.0 Corrective Measures Study Approach —Presents the results of the baseline risk assessment, describes the remedial action objectives, and proposes media cleanup standards for the site.

4.0 Project Management Plan — Describes the overall project management approach, including roles and responsibilities, communication plan, project schedule, and project deliverables.

5.0 References —Includes any documents cited in the previous four sections.

Appendix A presents the selected figures from the RFI Addendum.
Appendix B presents SCDHEC and EPA comments on CMS Work Plan Revision 0.
Appendix C presents the calculations of site-specific DAFs at SWMU 17.

Appendix D presents the Johnson and Ettinger Model Parameters and Simulation Output.

All tables and figures are found at the end of their respective sections.

TABLE 1-1
Summary of Site Investigation Activities at SWMU 17, Zone H
CMS Work Plan, SWMU 17, Zone H, Charleston Naval Complex

Date	Soils	Groundwater
1994	34 surface soil samples (0-1 ft bgs)	Wells 017001 to 017004 installed
	32 subsurface soil samples (3-5 ft bgs)	Wells 017005 and 017006 installed later to determine northern extent of groundwater contamination
June 1997	6 soil borings in paved courtyard to investigate oil/water separators (performed as part of Zone L RFI)	
June 1998	--	Wells 017007 – 017010 installed; Deep well 01702D installed to investigate full stratigraphic section
1999 Addendum activities	6 surface soil samples	27 temporary wells
	10 subsurface soil samples (DPT)	
	16 saturated soil samples (collected below the water table using DPT)	

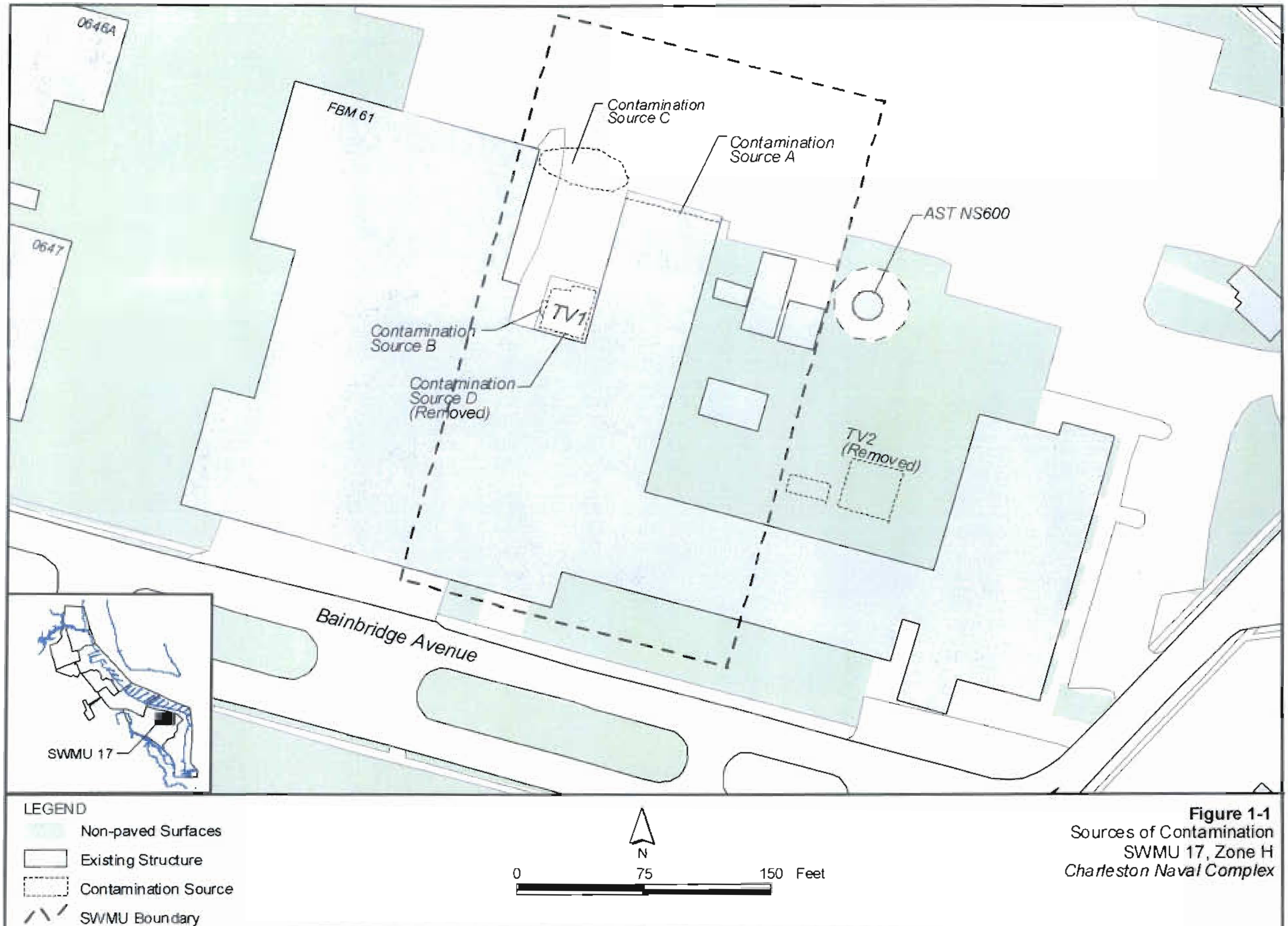

Figure 1-1
Sources of Contamination
SWMU 17, Zone H
Charleston Naval Complex

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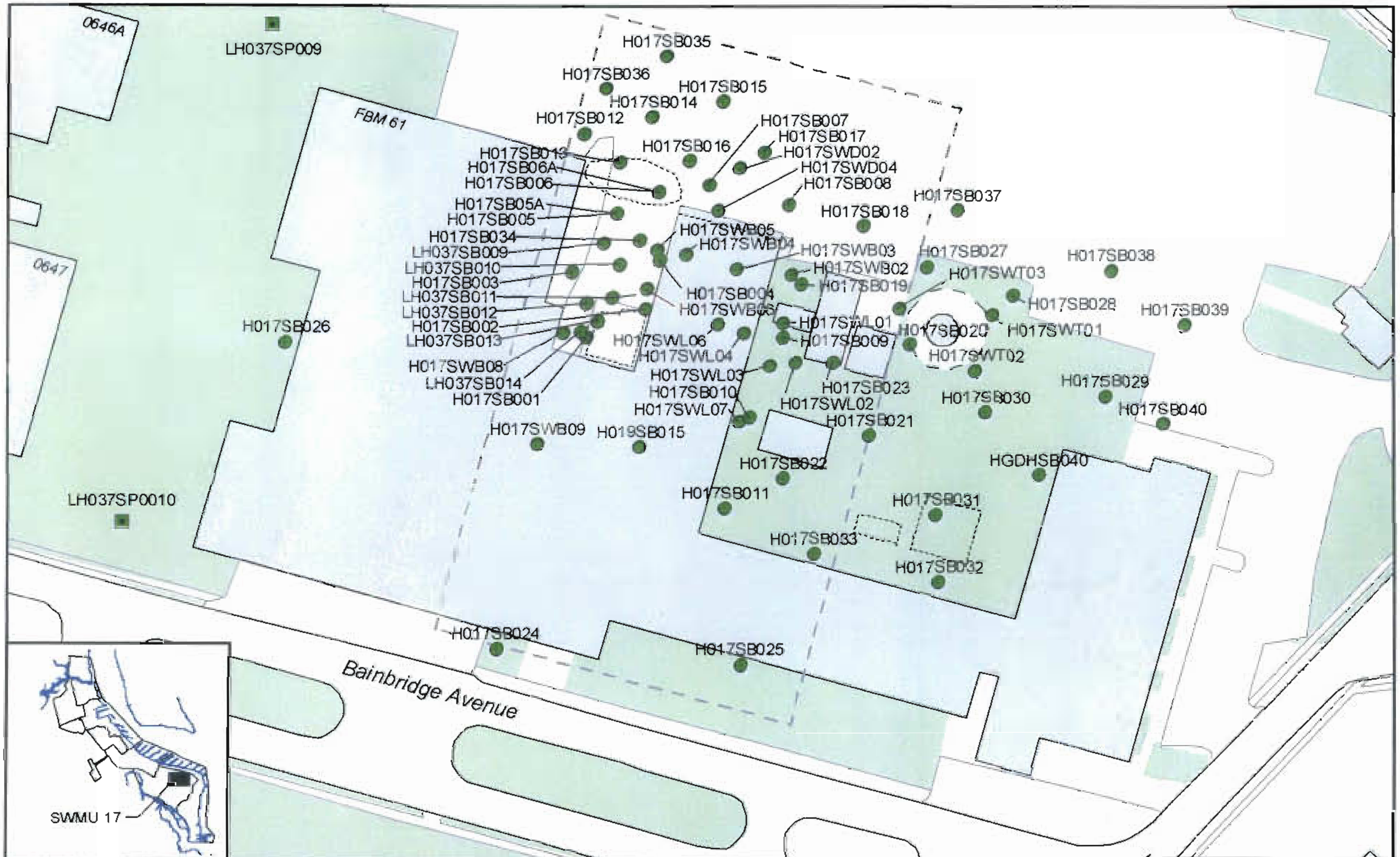

LEGEND
- Soil Boring
- Surface Soil
- Soil Probe
- SWMU Boundary

N

0 75 150 Feet

Figure 1-2
Soil Sample
Location Map
SWMU 17, Zone H
Charleston Naval Complex

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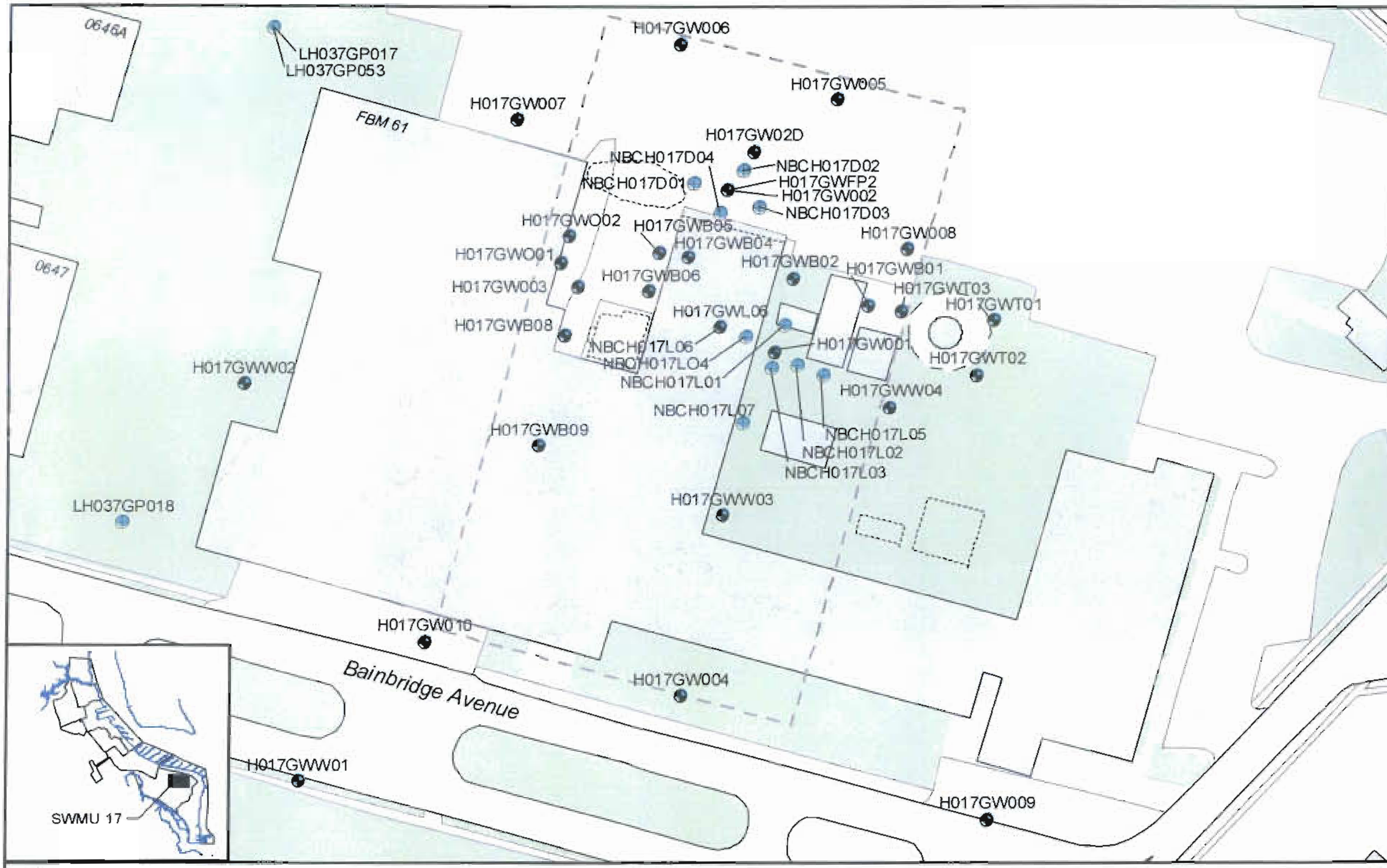


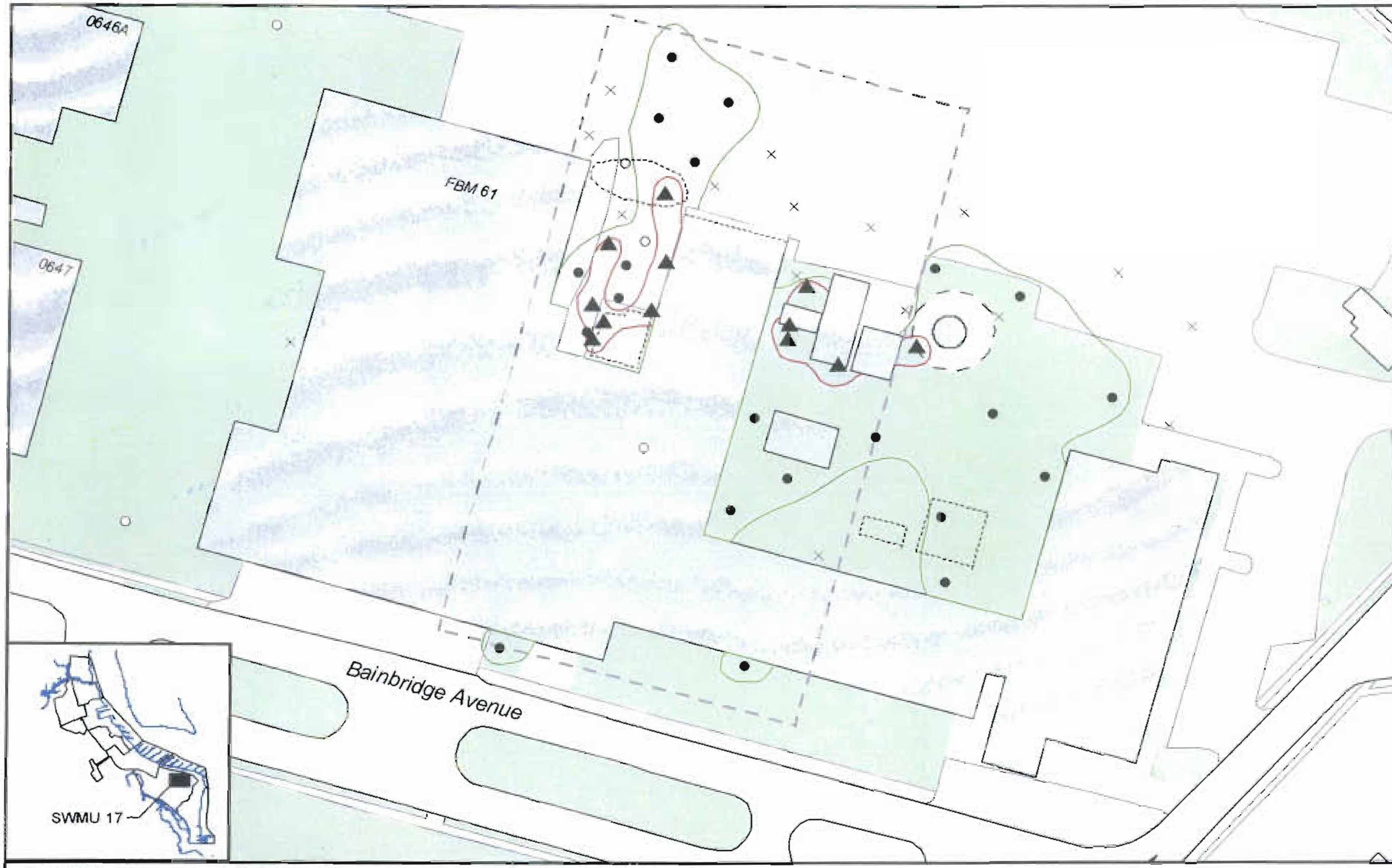
LEGEND
- Groundwater Probe
- Groundwater Well
- SWMU Boundary

N

0 75 150 Feet

Figure 1-3
Groundwater Sample
Location Map
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cms_swmu17_cms.apr, Date: 2 May 2001 16:45, User: ASPOSATO



LEGEND:
- ○ Not Sampled
- X ND
- ● <= 0.999 (mg/kg)
- ▲ >= 1.0 (mg/kg)
- SWMU Boundary

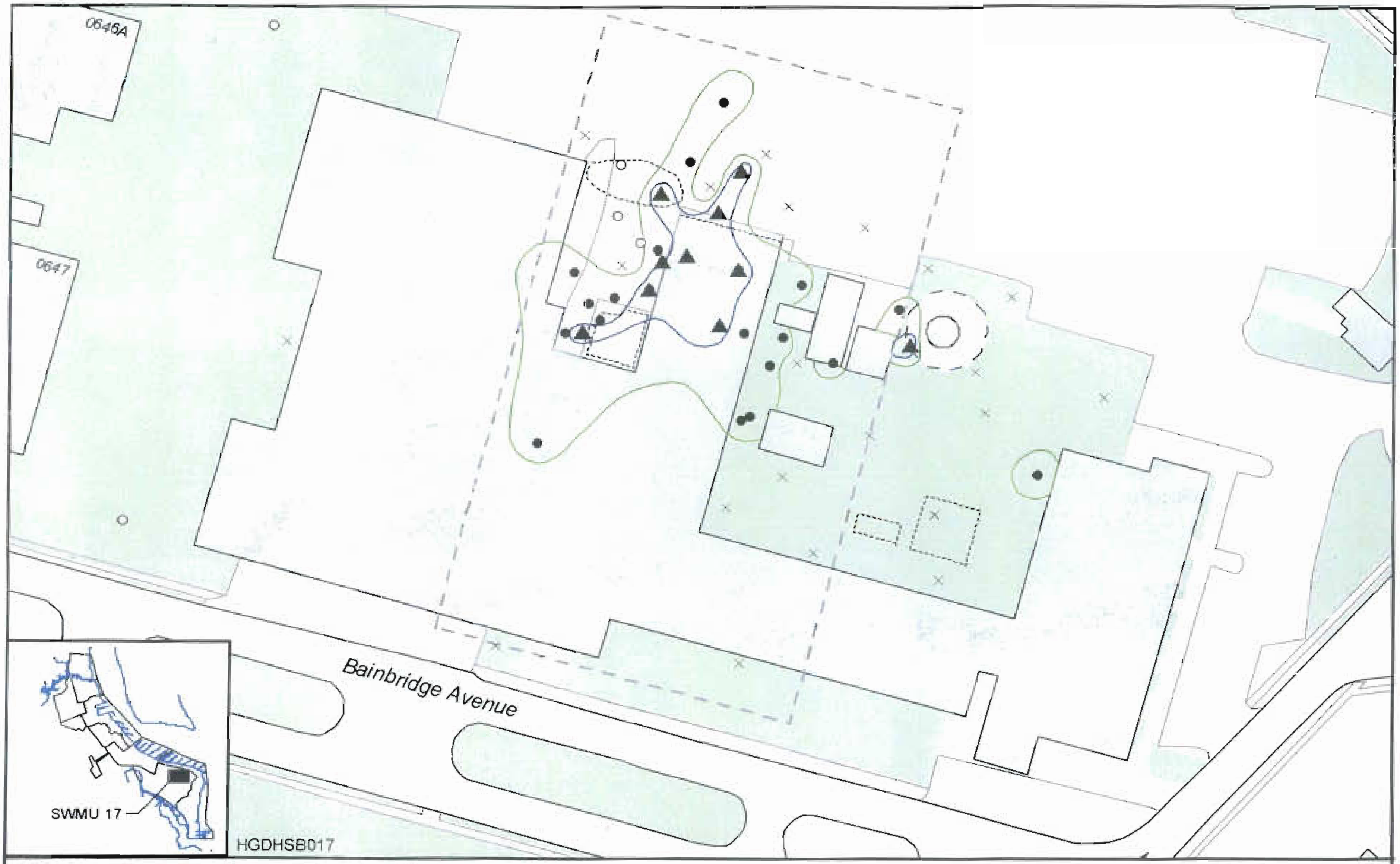
NOTE: RBC = 1.0 mg/kg.
- ND
- 1.0 mg/kg

N

0 75 150 Feet

Figure 1-4
Extent of Aroclor-1260
in Surface Soils
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\c\c_swmu17_cms.apr, Date: 3 May 2001 13:42, User: ASPOSATO



LEGEND:
- ○ Not Sampled
- X ND
- ● <= 0.999 (mg/kg)
- ▲ >= 1.0 (mg/kg)
- SWMU Boundary

NOTE: SSL = 15.7 mg/kg.
- ND
- SSL

N

0 75 150 Feet

Figure 1-5
Extent of Aroclor-1260
in Subsurface Soils
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\crc_swmu17_cms.apr, Date: 3 May 2001 13:54, User: ASPOSATO

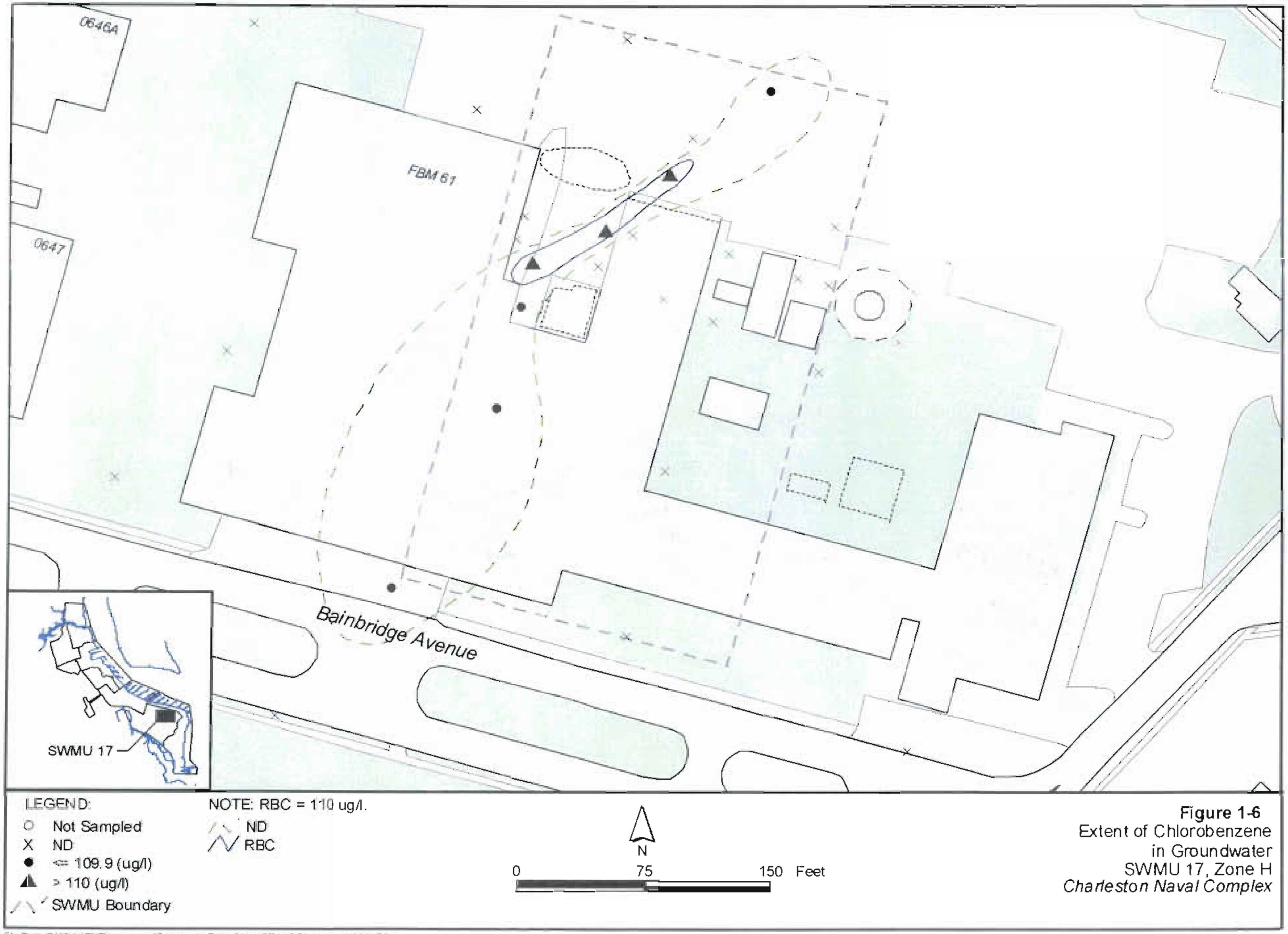


Figure 1-6
Extent of Chlorobenzene in Groundwater
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\1\gis\CNC\crc_swmu17_cms.apr, Date: 3 May 2001 13:51, User: ASPOSATO

SECTION 2.0

Risk Assessment Results and COC Identification

2.0 Risk Assessment Results and COC Identification

This section discusses the risk assessment performed for SWMU 17 and documented in the Zone H RFI Addendum (EnSafe, 2000), and direct and indirect exposure scenarios identified as needing further evaluation in this CMS. This section also presents the preliminary COCs identified in the RFI and a COC refinement process to select a final set of COCs per medium for the CMS. In addition, proposed remedial action objectives (RAOs), media cleanup standards (MCSs) and remedial goal options (RGOs) are presented for use in the alternatives evaluation in the CMS.

A risk assessment for SWMU 17 was performed and documented in the Zone H RFI Addendum (see Volume II of IV, Sections 2.5 to 4.0) for COPCs identified in the preliminary screening process. According to the RFI and risk assessment, environmental media at SWMU 17 that have been excessively impacted include surface and subsurface soils and groundwater. Potential offsite impacts were evaluated as part of the fate and transport analysis; it was concluded that offsite sediment or surface water impacts are not occurring at the present time and are not anticipated to occur in the future. There are no sediments or surface water associated with this SWMU; therefore, these media do not need to be remediated or considered in the CMS.

Preliminary COCs that were identified in the RFI for soils and groundwater are further refined in the following sections to selected final COCs for the SWMU 17 CMS.

2.1 Surface Soil COC Evaluation

Table 2-1 presents a risk assessment summary for surface soils for both unrestricted and industrial land use. Below are conclusions from the risk assessment regarding these COCs.

- Aroclor-1260 and benzo(a)pyrene equivalents (BEQs) were identified as COCs for a residential scenario, while Aroclor-1260 is the only COC identified for a general worker scenario. No COCs were identified for noncarcinogenic effects.

- For Aroclor-1260, the unrestricted scenario risk (1E-06) RBC was exceeded in 12 of the 39 sampling locations, and in one industrial worker scenario.

(1E-05) RBC value was exceeded in 6 of 39 locations for general workers; the highest concentration of 180 milligrams per kilogram (mg/kg) occurred at 017SB020, which is located near the secondary containment wall around AST NS600. It was noted in the RFI Addendum that, if this single high value is removed from the data set, the exposure point concentration, which is the likely concentration for a receptor exposure, decreases from 11.9 mg/kg to 4.0 mg/kg, indicating that this location is a significant "hot spot."

- For BEQs, the highest concentration of 0.28 mg/kg was detected at 017SB002, next to the newer extension of building FBM 61, within the asphalt-paved area. The detected BEQs are above the unrestricted use risk level (1E-06) RBC value of 0.088 mg/kg, but all are below an industrial scenario (1E-05) RBC of 0.78 mg/kg. The maximum detected BEQ concentrations within SWMU 17 are well below the CNC basewide reference value of 1.304 mg/kg for surface soils.
- The action level for tetrachlorodibenzo-p-dioxin (dioxin isomer) equivalents (TEQs) is 1 microgram per kilogram (μg/kg). None of the detected TEQs were above this criterion, although they were above residential and industrial RBCs.

2.1.1 Surface Soil Risk Results and Uncertainty

Surface soil risks for workers are within 1 to 100 in a million-risk range, and the hazard index (HI) was below 1.0. Risks to a future resident are at the upper limit for the acceptable risk range, while HIs are below 1.0. The calculated risks resulted primarily from the inhalation of dust. Typically, the inhalation pathway contributes to significantly less dose/risk than the ingestion and dermal pathways. Because of the assumptions used in the risk assessment, the inhalation pathway risks to a worker were higher (reported at 2 x 10-5). The ingestion and dermal pathway risks were 6 x 10-6 and 1 x 10-6, respectively, indicating that risks to a future industrial worker from these pathways is well within the acceptable risk limits. Residential scenario risks from inhalation were at 4 x 10-5, compared to ingestion pathway risks at 5 x 10-5 and dermal pathway risks at 1 x10-5. Thus the cumulative risks from the ingestion and dermal pathway to a resident are likely to be 5 x 10-5, which is within EPA's acceptable risk range, although it is above the SCDHEC's point of departure risk of 1 in a million for a future resident. However, HIs were below a value of 1.0. The risks will be further discussed by COC below.

BEQs — The RFI evaluated this group of compounds following EPA Region IV guidance for surface soil direct exposures. The maximum detected concentration for polycyclic aromatic hydrocarbons (PAHs) of 0.28 mg/kg in surface soil is well below the typical detection limit value of 0.33, as well as the established CNC reference or background level (1.304 mg/kg).

The overall cumulative risk contribution from BEQs is also low. Therefore, BEQs are not recommended for further evaluation as a COC in the remedial alternatives analysis of this CMS.

TEQs — TEQs have an established action level of 1 part per billion (ppb) at CNC. None of the detected TEQs reported exceeded these limits. Although no site-specific anthropogenic background levels for TEQs were established for CNC, they are known to occur in the background of the urban environment (ATSDR, 1997). Therefore, TEQs are not recommended for further evaluation as a COC in the remedial alternatives analysis of this CMS.

PCBs — Aroclor-1260 was reported in surface soil at concentrations ranging between 0.036 to 180 mg/kg concentration, contributing a risk of 2 x 10-5 for industrial land use, and 7 x 10-5 for unrestricted land use. Because Aroclor-1260 appears to be site-related and is a contributor to the cumulative risk, it will be carried through the remedial alternatives analysis as a COC. The statistical exposure point concentrations can be used to determine if residual concentrations meet the target MCSs.

2.1.2 Summary of Surface Soil COCs

Based on the RFI and risk assessment as well as the preceding discussion, Aroclor-1260 is the only surface soil COC that needs further evaluation for remediation in the CMS to protect human health and the environment at SWMU 17.

2.2 Subsurface Soil COC Evaluation

Subsurface soils are not a direct exposure concern under normal industrial operation conditions or residential use. However, subsurface contaminants may indirectly influence other media through migration over time. Therefore, they were evaluated for the potential to migrate downward to shallow groundwater and the potential to volatilize into air.

2.2.1 Subsurface Soil Leachability to Groundwater

Based on the fate and transport evaluations conducted during the RFI, the chemicals listed in Tables 2-2A and 2-2B were identified as COPCs since they exceeded the default EPA soil SSLs for leachability to groundwater, with a dilution attenuation factor of 1.0 (DAF=1) (see Section 2.5.6 of RFI Addendum, EnSafe, 2000). Most of the contaminated subsurface soils are located under the newer extension of Building FBM 61 and asphalt pavement, although some of the contaminated subsurface soils are in the unpaved area and areas with fractured pavement. Site-specific SSLs are calculated for each of the COPCs to determine if the soil concentrations will serve as continuing source of groundwater contamination at SWMU 17.

2.2.2 Site-Specific DAF Calculation

In the RFI, a generic, highly conservative DAF of 1 was used in the SSL calculation. Therefore, a site-specific DAF value was estimated in a manner that is consistent with EPA SSL guidance. Calculation spreadsheets that describe the assumptions made to calculate site-specific DAFs are included in Appendix C. Tables 2-2A and 2-2B present SSLs that were estimated assuming current land use (industrial) with contamination being present underneath the building and asphalt paved areas, and hypothetical future unrestricted land use where buildings and pavement are removed and contamination is free to leach to groundwater.

The two most sensitive input parameters for the DAF calculation are the hydraulic conductivity (K) and hydraulic gradient (I). Based on the results of a study performed by the U.S. Geological Survey (USGS) that involved computer model simulations of groundwater flow, CNC hydraulic conductivities range from 3 to 8 feet per day (ft/day). A hydraulic conductivity of 4 ft/day is appropriate for SWMU 17, based on the model results and was used in the DAF calculations. The value used for the hydraulic gradient was 0.01 meter per meter (m/m) and is considered to be an average value for the site. For industrial land use, about 25 percent of the area is assumed to be unpaved or otherwise available for leaching/percolation. This assumption is considered to be appropriate yet conservative, since much of the subsurface contamination is underneath the asphalt-paved parking lot and underneath the newer extension of building FBM 61. Thus, leachability is limited for these subsurface soils and is likely to be less than the assumed 25 percent. In contrast, the unrestricted land use scenario assumed that there is no paved area or buildings on top of soil contamination to prevent leaching. The site-specific DAF calculated for SWMU 17 for industrial land use is 63.8, and the site-specific DAF for hypothetical unrestricted land use is 17.4.

The comparison of the maximum detected subsurface soil concentrations and the SSLs estimated using both DAFs resulted in identical COC selection for the industrial and hypothetical unrestricted scenarios. Thus, the COCs are the same for both industrial and unrestricted land uses, based on the leachability evaluations.

2.2.3 Chemicals Above SSLs but Not in Groundwater Above Criteria

Several chemicals in Table 2-2 that were detected in subsurface soil above the SSL (based on a DAF=1) were not detected in groundwater at the site. These chemicals are discussed in the following paragraphs.

PAHs — Individual PAH constituents were compared to their chemical-specific SSL values. These relatively insoluble PAHs are not expected to pose a leaching hazard or to become dissolved in the groundwater. PAHs are largely associated with the presence of LNAPL on top of shallow groundwater, and in subsurface soils within the 'smear zone' of the fluctuating water table. Removal of LNAPL will be specifically addressed during the evaluation of remedial alternatives, and it is anticipated that PAHs in the subsurface soil located above the LNAPL may be reduced in concentration as part of this effort. Because of their low solubilities, these chemicals were not detected in groundwater at SWMU 17. Consequently, the three PAHs listed in Tables 2-2A and 2-2B — (benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene) — are not proposed as COCs.

Methylnaphthalene and Ethylbenzene — These two chemicals were reported in subsurface soil samples within and near the LNAPL-containing area. Subsurface soil concentrations for these chemicals were also below the site-specific SSLs. Therefore, methylnaphthalene and ethylbenzene are not proposed as COCs for subsurface soil.

Hexachlorobenzene — This chlorinated aromatic hydrocarbon is relatively immobile and has not been detected in groundwater. It was detected in only 2 of the 34 soil samples (see Figure 2.5.27 of the RFI Addendum, EnSafe, 2000). Because it is limited in area of occurrence and is not above the site-specific SSLs, hexachlorobenzene is not proposed as a COC for subsurface soil.

Styrene — Styrene was detected in only 1 of the 20 subsurface soil samples, and the detected concentration was below the site-specific SSLs. It was not detected in any groundwater samples. Therefore, styrene is not proposed as a COC for subsurface soil.

1,1,2,2-Tetrachloroethane (PCA) — 1,1,2,2-PCA was reported in only one subsurface soil sample at 3.8 mg/kg, above its industrial and residential SSL values. However, it was not detected in groundwater in the vicinity. Considering the time that has likely passed since the subsurface release, this highly soluble chemical would have reached groundwater if it were present in significant volume and higher than the SSL. Because of the infrequency of detection and because it is not present in the groundwater, 1,1,2,2-PCA is not proposed as a COC for subsurface soil.

2.2.4 Summary of Subsurface Soil COCs for Protection of Groundwater

Based on the discussion above, the following COCs are proposed for subsurface soil to protect groundwater from the leaching of contaminants from soil:

- Aroclor-1260
- Benzene
- Chlorobenzene
- 1,3-dichlorobenzene
- 1,4-dichlorobenzene
- 1,2,4-trichlorobenzene

2.2.5 Evaluation of Potential Subsurface Soil Releases to Air

Because several of the subsurface soil COPCs are volatile, they could migrate from the subsurface environment into ambient air and into the indoor air of buildings above or adjacent to the contaminated area. A screening evaluation for such potential was conducted by comparing maximum and average detected subsurface soil concentrations with SSLs for air releases from two state environmental agencies. These maximum and mean concentrations were compared with industrial land use-based SSL-air values (see Table 2-3 for summary). Of the VOCs and SVOCs detected in the subsurface soils, only chlorobenzene and benzene exceed their SSL-air values.

Based on guidance provided by the EPA, the Johnson and Ettinger (1991) model was also used to predict indoor air concentrations resulting from the volatilization of contaminants from soil. Values assigned to the model input parameters are described in Appendix D. The results are the same as those obtained from the SSL-air comparison described above, and indicate that only benzene and chlorobenzene are COCs for the air migration pathway at SWMU 17. The results are included in Table 2-3, and output of the Johnson and Ettinger model simulations is included in Appendix D. Appendix D also shows the results of the comparison of residential SSL-air values with the maximum and average detected subsurface soil concentrations (the comparison with residential SSLs also indicates that chlorobenzene and benzene are the only COCs for the air migration pathway at SWMU 17).

2.2.6 Summary of Subsurface Soil COCs

Based on the previous discussion, the following COCs are proposed for subsurface soil to protect groundwater from the leaching of contaminants from soil and to protect industrial workers from exposure to COCs that may volatilize into air:

- Aroclor-1260
- Benzene
- Chlorobenzene
- 1,3-dichlorobenzene
- 1,4-dichlorobenzene
- 1,2,4-trichlorobenzene

As part of the subsurface soil and groundwater remedial planning and corrective measure alternatives, LNAPL, DNAPL, and associated saturated soil at the site will also be addressed as COCs.

2.3 Groundwater COC Evaluation

Table 2-4 presents the groundwater COPCs with a significant level of occurrence, which contributed most to the overall risk from assumed ingestion of groundwater. For noncarcinogenic effects, these include 1,3-dichlorobenzene and chlorobenzene; for carcinogenic effects, only Aroclor-1260 is included. The DNAPL/LNAPL detected in groundwater will be addressed in the CMS. These COPCs are discussed further in this section.

To assess the potential for indoor air migration, the maximum detected groundwater concentrations were compared to groundwater RBCs for air emissions. These criteria were selected from State of Connecticut Department of Environmental Protection guidance tables (Appendix E to Sections 22a-133k-1 through 22a-133k, of Regulation of Connecticut State Agencies Volatilization Criteria for Groundwater). The results indicate that the groundwater concentrations are below these criteria for all COPCs except Aroclor-1260; thus, the remainder of the COPCs do not appear to be of concern for migration from groundwater to air.

Groundwater concentrations were compared with MCLs and RBCs, assuming potable use. Because the groundwater is classified as GB-2, comparing site groundwater concentrations against MCLs and RBCs is a protective evaluation of the water quality.

2.3.1 Uncertainty Discussion

Although benzidine was included as a COPC for the risk assessment, it was detected in only 1 out of 17 samples. It was detected in the first sampling event in well 017GW005, but was not detected in two subsequent re-sampling events of that well. Therefore, it is reported as an incomplete exposure and migration pathway in the fate and transport section of the RFI Addendum (Section 2.5.6.2, EnSafe, 2000). Based on a review of the site data, it appears that this chemical is not present at the site; therefore, benzidine is not selected as a COC for the CMS.

2.3.2 Summary of Groundwater COCs for CMS

Based on the previous discussions, the following are COCs for the CMS at SWMU 17:

- Aroclor-1260
- Benzene
- Chlorobenzene
- 2-chlorophenol
- 1,3-dichlorobenzene
- 1,4-dichlorobenzene
- Naphthalene
- 1,2,4-trichlorobenzene

2.4 Remedial Action Objectives

RAOs are medium-specific goals that the remedial actions are designed to accomplish in order to protect human health and the environment by preventing or reducing exposures under current and future land use conditions. The following RAOs have been identified for the media at SWMU 17.

- Surface Soils — Protection of Onsite Industrial Workers: The RAOs for surface soils are to prevent ingestion, direct dermal contact, or exposure by inhalation of contamination via vapors or soil particulates with unacceptable carcinogenic or non-carcinogenic risk.

- Subsurface Soils — Protection of Groundwater and Indoor Air Quality: The RAOs for subsurface soils are to prevent migration of contamination from soil into groundwater in excess of drinking water standards or tap water RBCs, and to control volatile emissions of contaminants into buildings such that indoor air concentrations do not pose an unacceptable risk to onsite industrial workers.
- Groundwater — Protection and Restoration of Beneficial Use: The RAOs for groundwater are to prevent ingestion and direct/dermal contact with groundwater having unacceptable carcinogenic or non-carcinogenic risk, and to restore the aquifer to beneficial use.

2.5 Remedial Goal Options and Proposed Media Cleanup Standards

Throughout the process of remediating a hazardous waste site, a risk manager uses a progression of increasingly acceptable site-specific media levels in considering remedial alternatives. Remedial goal options (RGOs) and media cleanup standards (MCSs) under RCRA are developed at the end of the risk assessment in the RFI/RI/State programs.

RGOs can be based on a variety of criteria, such as specific incremental cancer risk levels (e.g., 1E-04, 1E-05, or 1E-06), HI levels (e.g., 0.1, 1.0, 3.0), or site background concentrations. For a particular RGO, specific MCSs can be determined as target concentration values. Achieving these MCSs is accepted as demonstrating that RGOs and RAOs have been achieved. Achieving these goals should promote the protection of human health and the environment, while achieving compliance with applicable state and federal standards.

Preliminary MCSs and RGOs were selected from EPA Region IX PRG tables (EPA, 2000), established drinking water MCLs, and other available guidance for COCs. The exposure media of concern for SWMU 17 are surface and subsurface soils and groundwater. Because SMWU 17 is located within a highly developed area of the CNC, and there are no surface water bodies in the immediate vicinity of the site, ecological exposures were not considered necessary for evaluation.

As previously indicated, a variety of criteria can be used to develop target options such as incremental carcinogenic risks of 10E-06, 10E-05, and 10E-04; target HIs of 0.1, 1, and 3; or background concentrations. It is also important to specify the assumed land use and exposure conditions in the RGOs.

2.5.1 Surface Soil MCSs/RGOs

Aroclor-1260 was the only COC identified for surface soil. Table 2-5 presents RGOs and MCSs for the associated target risk level for Aroclor-1260. Although residential use is not planned for this site, for purposes of comparison Table 2-5 presents RGOs for residential use. Figure 2-1 illustrates the extent of Aroclor-1260 in surface soils at concentrations greater than 1 mg/kg. During the CMS, the feasibility of achieving an MCS of 1 mg/kg or 10 mg/kg for Aroclor-1260 in surface soil will be evaluated. Either of these values may be an acceptable MCS.

The statistical averages of the exposed surface soil left in place after implementation of the corrective measures will be within the proposed target cleanup levels (i.e., MCSs). For exposure point concentrations in the residual risk estimations, these are the UCL 95% concentrations above the mean. The unpaved portion of the site is approximately one-half acre in size and will be used as a single exposure unit. Statistical averages will be estimated for the Aroclor-1260 targets for all site data, replacing clean soils with the analytical results from these soils. Details on this statistical approach will be discussed in CMS Report.

2.5.2 Subsurface Soil MCSs

Compounds identified as COCs in subsurface soil were based on leachability to groundwater, with two COCs identified on the basis of exceeding SSL-air values. The target concentrations based on releases to air are much higher than those based on the leachability to groundwater. Therefore, the lower of these two values, the SSL for protection against leachability to groundwater, was included as the MCS in Table 2-6. Table 2-6 includes the MSCs/RGOs as the target subsurface soil concentrations estimated on the basis of a site-specific DAF of 17.4 for the future residential scenario and 63.8 for the industrial scenario for the alternatives analysis in the CMS.

Figures 2-2 and 2-3 illustrate the extent of the COCs in subsurface soils at concentrations greater than their unrestricted and industrial MCSs, respectively. The MCSs will be met in the site subsurface average concentrations, as SSLs are estimated based on the averages.

2.5.3 Groundwater MCSs

The groundwater has MCLs and maximum contaminant level goals (MCLGs) applied to public water supply wells, which are typically completed in deeper aquifers. Contamination at SWMU 17 is detected mostly in the shallow groundwater (2 to 5 ft bgs). The groundwater flow gradients are relatively flat, indicating limited offsite migration potential. Therefore, the applicability of MCLs should be evaluated as part of the risk management decision. Table 2-7 provides a preliminary list of groundwater MCSs.

Figure 2-4 illustrates the extent of the COCs listed in Table 2-7 that exceed MCSs. Figure 2-5 provides a composite view of the site area where groundwater and subsurface soils exceed MCSs. This will be the area targeted by the subsurface and groundwater treatment technologies in the CMS; free products will be removed.

2.6 Potential CMS Field Investigation

Once MCSs have been determined for each COC, corrective measure technologies will be identified in the CMS. The technologies will be evaluated on the basis of various criteria, including effectiveness in attaining the MCSs, and cost. Preferred technologies will be advanced to the pilot test or design phase. To reduce the uncertainty associated with the performance, implementation, and cost of certain technologies, it may be necessary to collect additional data on contaminant extent, soil properties, or NAPL properties. Additional data or pilot testing may also be required for the design. The types of data that may be needed are uncertain at this time but will be determined when corrective measure technologies are identified and are in the process of evaluation.

TABLE 2-1
Summary of Surface Soil Risks for SWMU 17
CMS Work Plan, SWMU 17, Zone H, Charleston Naval Complex

Preliminary COC from RFI	Maximum Concentration (mg/kg)	Incremental Lifetime Cancer Risk		Final COC for CMS Work Plan?	
		Industrial Land Use	Residential Land Use	Industrial	Residential
PCB Aroclor-1260	180	2 x 10-05	7 x 10-05	Yes	Yes
Dioxins (TEQs)[a]	0.00012	7 x 10-06	3 x 10-05	No	No
BEQs[b]	0.28	1 x 10-06	3 x 10-06	No	No
Total Risk		3 x 10-05	1 x 10-04		

HIs were less than 1.0 for all scenarios.
The majority of the risks are from inhalation of dust pathway.

a. Detected dioxins (maximum = 0.12 parts per billion [ppb]) were below the SCDHEC and EPA action level of 1 ppb. In addition, background TEQs are not established for CNC although TEQs are ubiquitous in urban soils.

b. BEQs were below background levels and below typical detection limits (e.g., 0.33 mg/kg).

NC not a carcinogen

TABLE 2-2A
Summary of Subsurface Soil COPCs and COCs Based on Groundwater Protection Under an Unrestricted Land Use Scenario
CMS Work Plan, SWMU 17, Zone H, Charleston Naval Complex

COPCs from RFI (>SSL at DAF=1)	Detected Concentration Range (mg/kg)	SSLs (at DAF=1)	Site-Specific SSLs[a] (at DAF=17.4) (mg/kg)	Detected in Groundwater at >RBC/MCL	COC (>SSL at DAF=17.4 and Detected in Groundwater)
Aroclor-1260	0.035-6200	1[b]	15.7	Yes	Yes
Benzene	0.042-7.2	0.002	0.026	Yes	Yes
Benzo(a)anthracene	0.026-3.1	0.08	1.7	No	No
Benzo(a)pyrene	0.021-1.6	0.4	6.98	No	No
Benzo(b)fluoranthene	0.023-0.79	0.2	4.4	No	No
Chlorobenzene	0.0035-790	0.07	0.87	Yes	Yes
Ethylbenzene	2.6-5.3	0.7	11.4	No	No
1,2-dichlorobenzene	0.22-1.8	0.9	14.8	No	No
1,3-dichlorobenzene[c]	0.167-22	0.1	1.7	Yes	Yes
1,4-dichlorobenzene	0.315-40	0.1	1.7	Yes	Yes
1,2-dichloroethene, total	0.26-0.27	0.02	0.35	No	No
Hexachlorobenzene	0.285-1.3	0.1	1.74	No	No
Naphthalene	0.043-26	4	73.2	No	No
Styrene	0.59	0.2	3.5	No	No
1,2,4-trichlorobenzene	0.1-410	0.3	4.37	Yes	Yes
1,1,2,2-tetrachloroethane	3.8	0.0002	0.003	No	No

a. The leachability criteria or soil screening levels are selected from EPA Region IX PRG tables (EPA 2000), with a site-specific DAF calculated at 17.4 (see Appendix C).

b. Aroclor-1260 is assigned a PRG of 1 mg/kg.

c. 1,4 dichlorobenzene SSL value is used for 1,3-dichlorobenzene.

TABLE 2-2B
Summary of Subsurface Soil COPCs and COCs Based on Groundwater Protection Under an Industrial Land Use Scenario
CMS Work Plan, SWMU 17, Zone H, Charleston Naval Complex

COPCs from RFI (>SSL at DAF=1)	Detected Concentration Range (mg/kg)	SSLs (at DAF=1)	Site-Specific SSLs[a] (at DAF=63.8) (mg/kg)	Detected in Groundwater at >RBC/MCL	COC (>SSL at DAF=63.8 and Detected in Groundwater)
Aroclor-1260	0.035-6200	1[b]	57.4	Yes	Yes
Benzene	0.042-7.2	0.002	0.095	Yes	Yes
Benzo(a)anthracene	0.026-3.1	0.08	6.43	No	No
Benzo(a)pyrene	0.021-1.6	0.4	25.5	No	No
Benzo(b)fluoranthene	0.023-0.79	0.2	16.07	No	No
Chlorobenzene	0.0035-790	0.07	3.1	Yes	Yes
Ethylbenzene	2.6-5.3	0.7	41.5	No	No
1,2-dichlorobenzene	0.22-1.8	0.9	54.1	No	No
1,3-dichlorobenzene[c]	0.167-22	0.1	6.4	Yes	Yes
1,4-dichlorobenzene	0.315-40	0.1	6.4	Yes	Yes
1,2-dichloroethene, total	0.26-0.27	0.02	1.3	No	No
Hexachlorobenzene	0.285-1.3	0.1	6.4	No	No
Naphthalene	0.043-26	4	268.4	No	No
Styrene	0.59	0.2	12.76	No	No
1,2,4-trichlorobenzene	0.1-410	0.3	15.8	Yes	Yes
1,1,2,2-tetrachloroethane	3.8	0.0002	0.009	No	No

a. The leachability criteria or soil screening levels are selected from EPA Region IX PRG tables (EPA 2000), with a site-specific DAF calculated at 63.8 (see Appendix C).

b. Aroclor-1260 is assigned a PRG of 1 mg/kg.

c. 1,4 dichlorobenzene SSL value is used for 1,3-dichlorobenzene.

TABLE 2-3
SWMU 17 Subsurface Soil COC - Evaluation of Potential for Air Emissions from Subsurface Soil COPCs
CMS Work Plan, SWMU 17, Zone H, Charleston Naval Complex

	Concentration		RBC (SSL-Air) - Industrial		SSL-Air	
COPC	**Maximum (mg/kg)**	**Average (mg/kg)**	**Virginia (mg/kg)**	**Connecticut (mg/kg)**	**J-E Model, Tier 2 (mg/kg)**	**Industrial – Air COC?**
Benzene	7.2	2	1.1	113	0.18	Yes
Chlorobenzene	790	159	14	106	58.2	Yes
1,2-dichloroethene (total)	0.270	0.265	NA	22[a]	24.5	No
1,2-dichlorobenzene	1.8	1.6	330	818	658	No
1,3 dichlorobenzene	22	10	NA	818	NA	No
1,4 dichlorobenzene	40	11	1,200	3,270	311	No
1,2,4-trichlorobenzene	410	93	980	NA	3532	No
Ethylbenzene	5.3	3.6	610	5,672	437	No
Styrene	0.59	0.59	1,500	28	1,628	No
1,1,2,2-tetrachloroethane	3.8	NA	0.77	1	0.6	No[b]
Tetrachloroethene	1	NA	14	27	1.85	No
Toluene	5.5	3.2	180	2,615	509	No
Xylene (total)	21	18.5	NA	1,702	509	No

a. Value is from Michigan Department of Environmental Quality (MI-DEQ) Part 201, June 2000- for cis- and trans-DCE.

b. 1122-PCA was detected in only one sample.

Virginia - Virginia Voluntary Remediation Regulations (9VAC 20-160-0)

Connecticut - State of Connecticut Department of Environmental Protection guidance tables (Appendix E to Sections 22a-133k-1 through 22a-133k, of Regulation of Connecticut State Agencies Volatilization Criteria for Groundwater).

TABLE 2-4
Summary of COPCs and COCs for Groundwater at SWMU 17
CMS Work Plan, SWMU 17, Zone H, Charleston Naval Complex

Groundwater COPC	Maximum Groundwater Concentration (µg/L)	Detected in Groundwater Frequently, Recently?	RBC (µg/L)	MCL (µg/L)	GW RBC for Air (µg/L) (based on residential land use)	COC
Aroclor-1260	62	Yes	0.034	0.5	45	Yes
Benzidine	56	No	0.00029	NA	NA	No
Benzene	130	Yes	0.41	5	5,600	Yes
Chlorobenzene	6,900	Yes	110	NA	210,000	Yes
2-chlorophenol	180	Yes	30	NA	NA	Yes
1,2-dichloroethene	54	No	61	70 [a]	85,000	No
1,2-dichlorobenzene	280	Yes	370	600	160,000	No
1,3-dichlorobenzene	1,400	Yes	5.5	NA	NA	Yes
1,4-dichlorobenzene	2,700	Yes	0.5	75	16,000	Yes
Naphthalene	33	Yes	6.2	NA	31,000	Yes
1,2,4-trichlorobenzene	1,200	Yes	190	70	30,000	Yes

a. 1,2-DCE is assumed to be all cis-isomer.

TABLE 2-5
Remedial Goal Options - Surface Soil at SWMU 17
CMS Work Plan, SWMU 17, Zone H, Charleston Naval Complex

				Residential RGOs/MCSs Based on Carcinogenic Risks			Industrial RGOs/MCSs Based on Carcinogenic Risks		
	Minimum Detection	Maximum Detection	COC	1E-6	1E-5	1E-4	1E-6	1E-5	1E-4
COC	(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Aroclor-1260	0.036	180	Yes	0.2	2	20	1	10	100

TABLE 2-6
Subsurface Soil - MCSs/RGOs for SWMU 17
CMS Work Plan, SWMU 17, Zone H, Charleston Naval Complex

Chemical	Detected Concentration Range (mg/kg)	MCS – Industrial[a] (mg/kg)	MCS – Residential[a] (mg/kg)
Aroclor-1260	0.035-6,200	57.4	15.7
Benzene	0.002-7.2	0.095	0.026
Chlorobenzene	0.004-790	3.14	0.87
1,3-dichlorobenzene	0.058-22	6.38b	1.74[b]
1,4-dichlorobenzene	0.024-40	6.38	1.74
1,2,4-trichlorobenzene	0.32-410	15.84	4.37

a. All the criteria are leachability to groundwater-based SSLs. The SSLs are selected from EPA Region IX PRG tables, (EPA, 2000), with a site-specific DAF calculated as 63.8 for industrial land use and 17.4 for residential land use (see Appendix B).

b. 1,4 dichlorobenzene SSL value is used for 1,3-dichlorobenzene.

TABLE 2-7
Groundwater MCSs/RGOs for SWMU 17
CMS Work Plan, SWMU 17, Zone H, Charleston Naval Complex

						RGOs Based on Noncarcinogenic Risks		
	Minimum Concentration	Maximum Concentration	Proposed MCS	MCL	Explanation	HI=0.1	HI=1	HI=3
COC	(μg/L)	(μg/L)	(μg/L)	(μg/L)		(μg/L)	(μg/L)	(μg/L)
Aroclor-1260	2.3	520	0.5	0.5	MCL is proposed cleanup goal.	NA	NA	NA
Benzene	2	130	5	5	MCL is proposed cleanup goal.	NA	NA	NA
Chlorobenzene	.78	6,900	110	NA	Not a carcinogen; cleanup goal for HI=1 is 110 μg/L.	11	110	330
2-chlorophenol	5	18	30	NA	Not a carcinogen; cleanup goal for HI=1 is 30 μg/L.	3	30	90
1,3-dichlorobenzene	2	1,400	600	600#	MCL is proposed cleanup goal.	0.6	6	17
1,4-dichlorobenzene	1	2,700	75	75	MCL is proposed cleanup goal.	NA	NA	NA
Naphthalane	6	33	6.2	NA	Not a carcinogen; cleanup goal for HI=1 is 6.2 μg/L.	0.62	6.2	19
1,2,4-trichlorobenzene	1	1,400	70	70	MCL is proposed cleanup goal.	19	190	570

NA Not applicable (not a carcinogen)

Value for 1,3-dichlorobenzene is based on 1,2-dichlorobenzene.

LEGEND
- ○ Not Sampled
- X ND
- ● <= 0.999 (mg/kg)
- ▲ >= 1.0 (mg/kg)
- SWMU Boundary

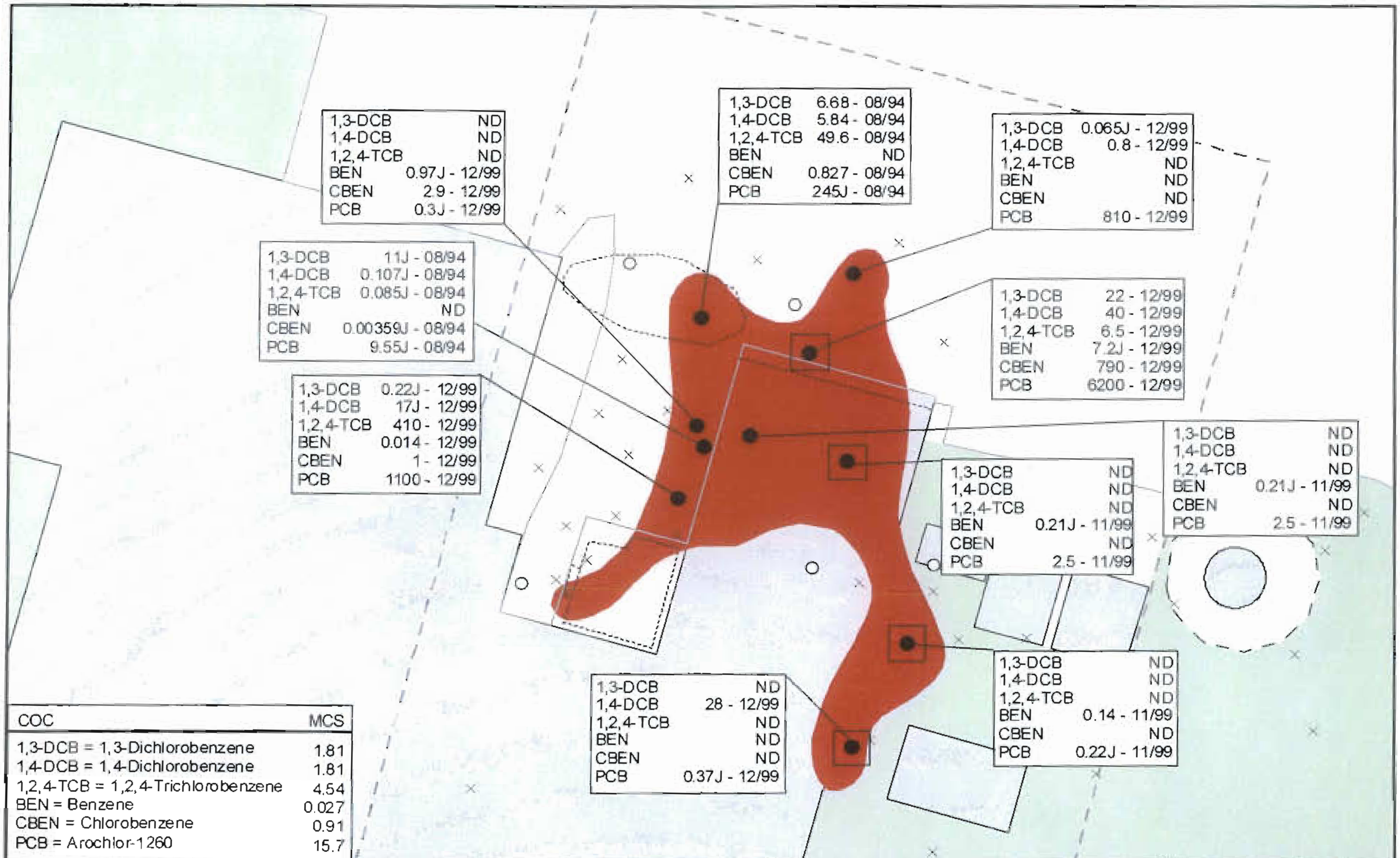
Area Exceeding MCS (1 mg/kg) for Future Unrestricted Land Use

N

0 75 150 Feet

Figure 2-1
Extent of Aroclor-1260
in Surface Soils for
Future Unrestricted Land Use
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\crc_swmu17_cms.apr, Date: 3 May 2001 13:54, User: ASPOSATO



LEGEND:

Subsurface Soil Sample Locations

- ● Concentration > MCS
- O Concentration < MCS
- X Not Detected
- Where NAPL Occurs
- Exceeds MCSs for Future Unrestricted Land Use

NOTES:

1. NAP - 18J - 11/97 = Chemical ID - Maximum Concentration, Qualifier - Date Sampled
2. Units in mg/kg

N

0 40 80 Feet

Figure 2-2
Locations of Subsurface Soil Samples
That Exceed MCSs for
Future Unrestricted Residential Land Use
SWMU 17, Zone H
Charleston Naval Complex

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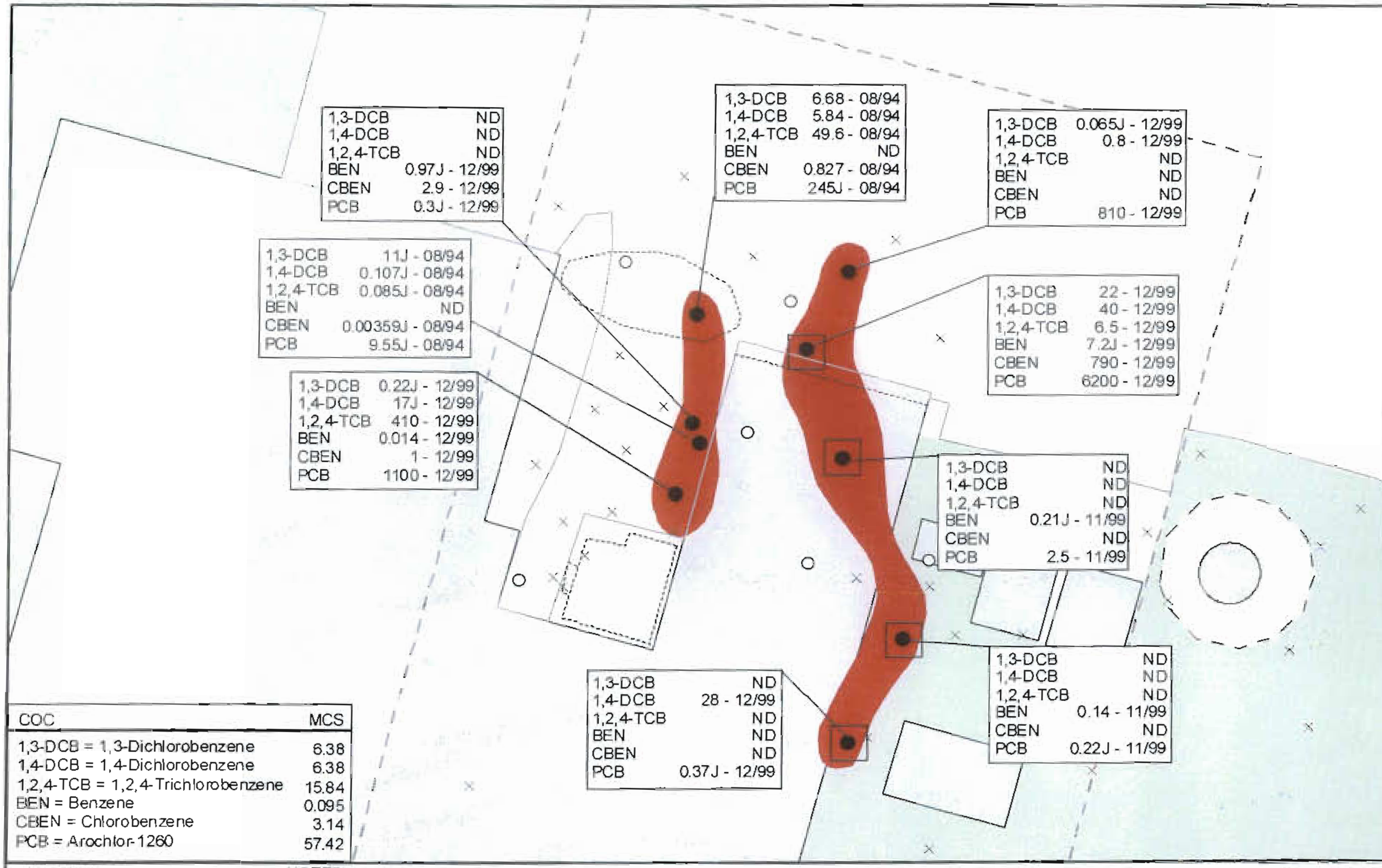


COC	MCS
1,3-DCB = 1,3-Dichlorobenzene	6.38
1,4-DCB = 1,4-Dichlorobenzene	6.38
1,2,4-TCB = 1,2,4-Trichlorobenzene	15.84
BEN = Benzene	0.095
CBEN = Chlorobenzene	3.14
PCB = Arochlor-1260	57.42

LEGEND:

Subsurface Soil Sample Locations

- ● Concentration > MCS
- ○ Concentration < MCS
- X Not Detected
- Where NAPL Occurs
- Exceeds MCSs for Future Unrestricted Land Use

NOTES:

1. NAP - 18J - 11/97 =
   Chemical ID - Maximum Concentration, Qualifier - Date Sampled
2. Units in mg/kg

N

0 40 80 Feet

Figure 2-3
Locations of Subsurface Soil Samples
That Exceed MCSs for
Future Industrial Land Use
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\crc_swmu17_cms.apr, Date: 3 May 2001 15:27, User: ASPOSATO

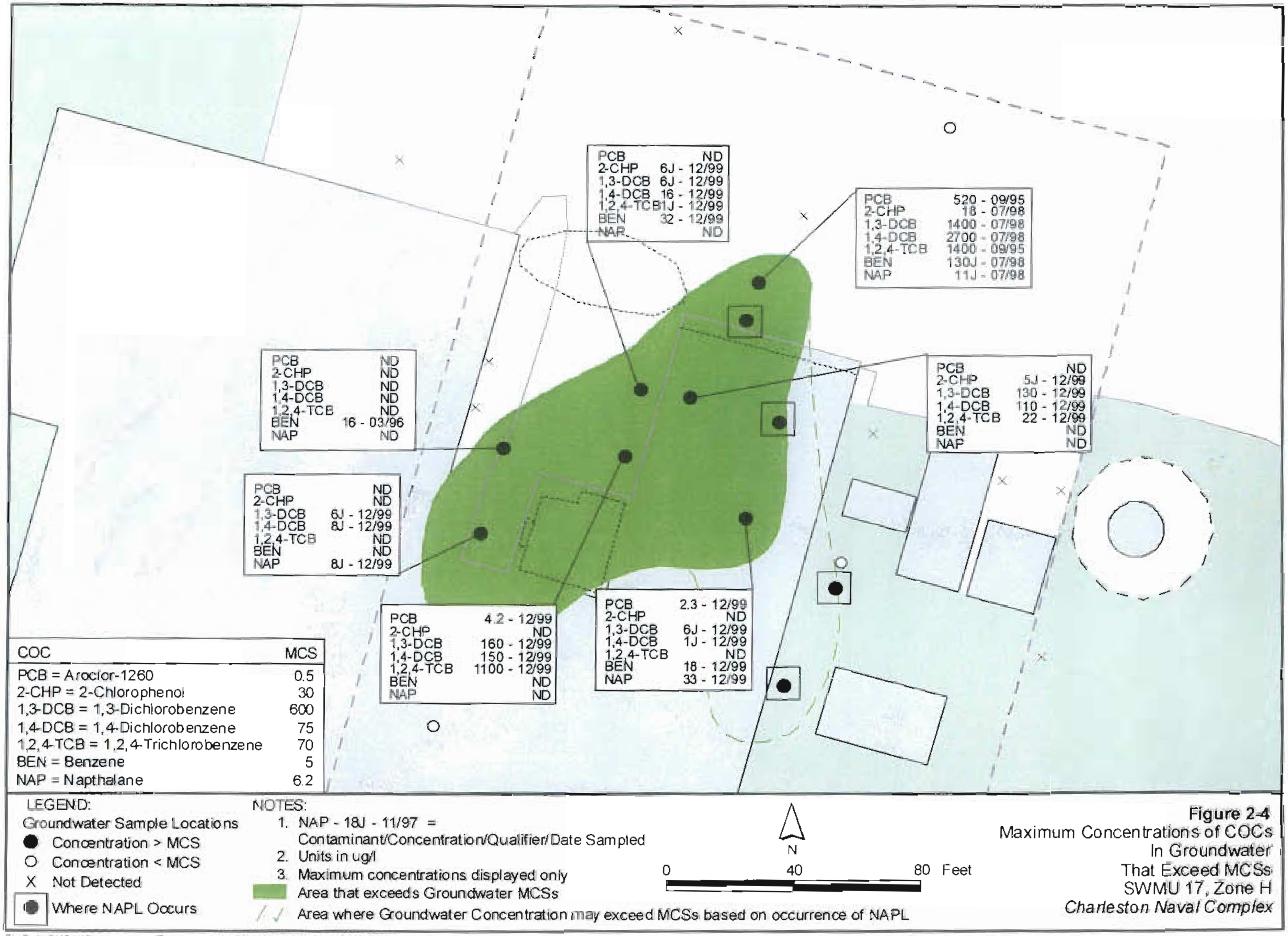


Figure 2-4
Maximum Concentrations of COCs In Groundwater That Exceed MCSs
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\18gis\CNC\cm_swmu17_cms.apr, Date: 3 May 2001 15:39, User: ASPOSATO

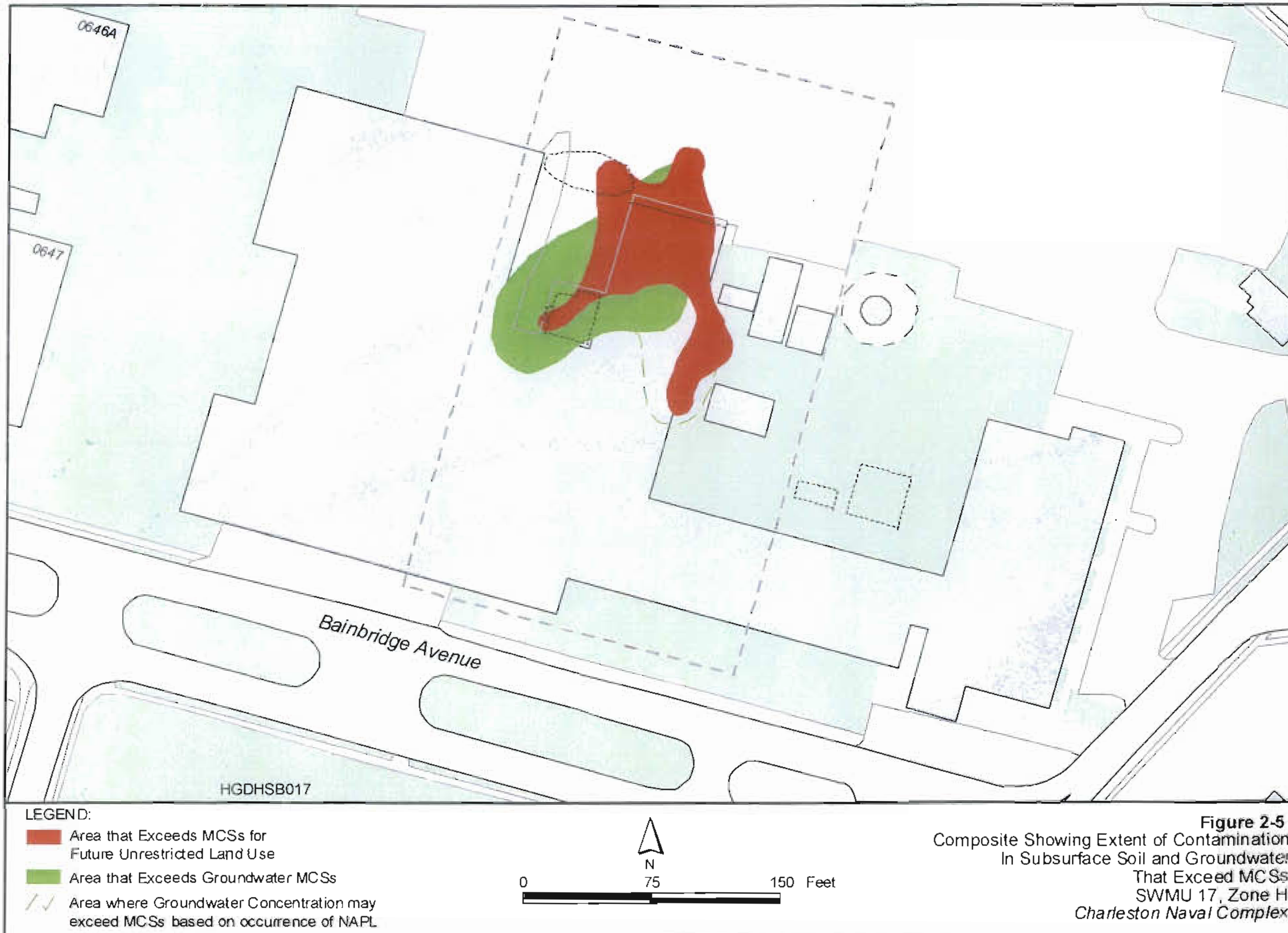


Figure 2-5
Composite Showing Extent of Contamination
In Subsurface Soil and Groundwater
That Exceed MCSs
SWMU 17, Zone H
Charleston Naval Complex

File Path: C:\1\gis\CNC\crc_swmu17_cms.apr, Date: 3 May 2001 15:41, User: ASPOSATO

SECTION 3.0

Corrective Measures Study Approach

3.0 Corrective Measures Study Approach

The CMS will consist of the following tasks that will be performed in the order presented below:

1. Corrective measure technologies will be identified to address the soil and groundwater contamination at the site.
2. Corrective measure technologies will be grouped together into alternatives, which will consist of one or more technologies that are well-suited to treat contamination in all media at the site.
3. Corrective measure alternatives will be screened using several criteria and decision factors.
4. A preferred corrective measure alternative will be selected.
5. The CMS and preferred corrective measure alternative will be documented in the CMS report.

The CMS report will consider the application of technologies under two land use scenarios. The first scenario is that of unrestricted future land use and the second scenario is that of industrial land use. Each scenario will trigger appropriate media cleanup standards that are protective of human health. The selection of the industrial land use scenario may involve the implementation of land use controls, and would therefore require the development of a land use control plan for the CNC.

The approach that will be used to identify and screen technologies and alternatives in the CMS is described in the following sections.

3.1 Identification of Corrective Measure Technologies

Corrective measure technologies, which have the potential to eliminate, control, and/or reduce unacceptable risk to human health or the environment to acceptable levels, will be identified and screened. A preliminary list of technologies, described below, was developed on the basis of the list of COCs and RGOs discussed in Section 2:

- Excavation — This technology involves excavation of surface and/or subsurface soils with appropriate disposal or treatment, and backfilling of the excavation.

- Soil Cap — This technology involves the installation of an impermeable or semi-permeable barrier on top of the surface soils to reduce the potential COC exposure to humans and to reduce additional leaching of contaminants from surface and subsurface soils to groundwater.
- Six-Phase Heating — This technology involves the placement of electrodes in the ground, with electrical current running between the electrodes to generate heat that results from the natural resistance of soil/groundwater. Contaminants with boiling points lower than the achievable temperature (100 degrees Celsius) are volatilized, collected in the vadose zone, and treated above ground.
- Soil Vapor Extraction (SVE) and Bioventing — This technology involves vapor extraction wells installed to strip the volatile compounds from the subsurface (vadose zone) soils and to provide oxygen to support biodegradation.
- Air-Sparging/SVE — This technology involves the injection of air below the water table to strip out volatile contaminants from the groundwater and saturated soils. SVE wells are used to collect the vapors, which are treated above ground. The process also transfers oxygen to the groundwater, which promotes biodegradation.
- Hydraulic Containment through Groundwater Extraction — This technology involves strategically placed groundwater extraction wells to provide hydraulic control so that the contamination does not migrate offsite.
- In situ Aerobic Biodegradation — This technology involves the injection of oxygen release compound (ORCTM) to enhance aerobic biodegradation. The ORC is injected with direct push methods. It slowly releases oxygen that promotes biodegradation.
- Monitored Natural Attenuation — This technology involves monitoring to evaluate naturally occurring processes, such as biodegradation, dispersion, adsorption, and dilution, that may be adequate to prevent the migration of contamination away from SWMU 17.
- Multi-Phase Extraction — This technology involves the simultaneous removal of NAPL, groundwater, and soil vapors from extraction wells. The groundwater table is lowered in the process, allowing SVE and bioventing to occur in what was formerly saturated soil.

- In Situ Oxidation — This technology involves the injection of oxidizing agents (hydrogen peroxide or potassium permanganate) to promote abiotic in situ oxidation of organic compounds in the groundwater, saturated soil, and unsaturated soil.
- Free Product Skimming — This technology involves the removal of free product (mobile NAPL) by using skimming pumps in extraction wells.
- Vacuum Enhanced NAPL Recovery — This technology involves the use of a vacuum truck to apply a vacuum to monitoring or recovery wells to enhance NAPL removal.
- Land Use Controls – This technology involves the implementation of various measures to control the exposure to COCs under an industrial land use scenario. It would require the basewide development of a land use control plan.

These and other technologies will be screened on the basis of their effectiveness, implementability, and cost.

3.2 Approach to Evaluating Corrective Measure Alternatives

Corrective measure technologies that pass the initial screening will be assembled into alternatives. According to the RCRA permit issued by SCDHEC (SCDHEC, 1998), the alternatives will be evaluated with the following five standards:

1. Protect human health and the environment.
2. Attain media cleanup standards (RGOs).
3. Control the source of releases to minimize future releases that may pose a threat to human health and the environment.
4. Comply with applicable standards for the management of wastes generated by remedial activities.
5. Other factors include (a) long-term reliability and effectiveness; (b) reduction in toxicity, mobility, or volume of wastes; (c) short-term effectiveness; (d) implementability; and (e) cost.

Each of the five standards is defined in more detail below:

1. **Protect human health and the environment.** The alternatives will be evaluated on the basis of their ability to protect human health and the environment. The ability of an alternative to achieve this standard may or may not be independent on its ability to

achieve the other standards. For example, an alternative may be protective of human health, but may not be able to attain the media cleanup standards if the media cleanup standards are not directly tied to protecting human health.

2. **Attain media cleanup standards (RGOs).** The alternatives will be evaluated on the basis of their ability to achieve RGOs. The RGOs were defined in Section 2.0 of this work plan. Since there is some uncertainty with this evaluation, this uncertainty will be qualitatively characterized. Another aspect of this standard is the time frame to achieve the RGOs. Estimates of the time frame for the alternatives to achieve RGOs will be provided.
3. **Control the source of releases.** This standard deals with the control of releases of contamination from the source (the area in which the contamination originated). There are four known sources of contamination at SWMU 17 that were the result of accidental releases of contaminants. This standard will apply to NAPL- and contaminated soils at the site, which if left unaddressed, may continue to act as sources of contaminants to groundwater.

4. **Comply with any applicable standards for management of wastes.** This standard deals with the management of wastes derived from implementing the alternatives; for example, groundwater from pump and treatment operations. Alternatives will be designed to comply with all standards for management of wastes. Consequently, this standard will not be explicitly included in the detailed evaluation presented in the CMS.

5. **Other factors.** Five other factors are to be considered if an alternative is found to meet the four standards described above. These other factors are as follows:

   5a. Long-term reliability and effectiveness

   Alternatives will be evaluated on the basis of their reliability, and the potential impact should the alternative fail. In other words, a qualitative assessment will be made as to the chance of the alternative's failing and the consequences of that failure. An assessment also will be made of the useful life of the technologies in the alternative.

   5b. Reduction in the toxicity, mobility, or volume of wastes

   Alternatives with technologies that reduce the toxicity, mobility, or volume of the contamination will be generally favored over those that do not. Consequently, a qualitative assessment of this factor will be performed for each alternative.

   5c. Short-term effectiveness

Alternatives will be evaluated on the basis of the risk they create during the implementation of the remedy. Factors that may be considered include fire, explosion, and exposure of workers to hazardous substances.

5d. Implementatiblity

The alternatives will be evaluated for thèir implementability by considering any difficulties associated with constructing the systems (such as the construction disturbances they may create), operation of the alternatives, and the availability of equipment and resources to implement the technologies comprising the alternatives.

5e. Cost

A net present value of each alternative will be developed. These cost estimates will be used for the relative evaluation of the alternatives, not to bid or budget the work. The estimates will be based on information available at the time of the CMS and on a conceptual design of the alternative. They will be "order-of-magnitude" estimates with a generally expected accuracy of -50 percent to +50 percent for the scope of action described for each alternative. The estimates will be categorized into capital costs and operations and maintenance costs for each alternative.

In addition to the criteria described above, the alternatives will be evaluated for the ability to achieve all contractual obligations of CH2M-Jones and the Navy.

3.3 Corrective Measures Study Report

The CMS report will be prepared to present the identification, development, and evaluation of potential corrective measures for SWMU 17. A proposed outline of the report, as shown in Table 3-1, provides an example of the report format and content organization.

TABLE 3-1
Example Outline of CMS Report
SWMU 17, Zone H, Charleston Naval Complex

Executive Summary

1.0 Introduction
- 1.1 Corrective Measures Study Purpose and Scope
- 1.2 Report Organization
- 1.3 Background Information
  - 1.3.1 Facility Description
  - 1.3.2 Site History and Background
    - 1.3.2.1 Geology and Hydrology
    - 1.3.2.2 Nature and Extent of Contamination
    - 1.3.2.3 Contaminant Fate and Transport
    - 1.3.2.4 Summary of Risk Assessment

Identification and Screening of Technologies
- 2.1 Remedial Goal Objectives
- 2.2 Identification and Screening of Technologies
  - 2.2.1 Identification and Initial Screening of Technologies
  - 2.2.2 Evaluation of Technologies
  - 2.2.3 Selection of Technologies
- 2.3 Summary

3.0 Development and Screening of Alternatives
- 3.1 Development of Preliminary Alternatives
  - 3.1.1 Alternative 1
  - 3.1.2 Alternative 2
  - 3.1.3 Alternative 3
- *<<Additional alternatives will be developed as found necessary>>*
- 3.2 Screening of Preliminary Alternatives
  - 3.2.1 Screening Criteria
  - 3.2.2 Alternative 1
  - 3.2.3 Alternative 2
  - 3.2.4 Alternative 3

<<Additional alternatives will be screened as found necessary>>

3.3 Summary of Screening Alternatives

4.0 Detailed Analysis of Alternatives

4.1 Approach

4.2 Evaluation Criteria

4.3 Description of Alternatives

4.3.1 Alternative 1

4.3.2 Alternative 2

4.3.3 Alternative 3

<<Additional alternatives will be described as found necessary>>

4.4 Detailed Analysis of Alternatives

4.4.1 Alternative 1

4.4.2 Alternative 2

4.4.3 Alternative 3

<<Additional alternatives will be analyzed as found necessary>>

4.5 Comparative Analysis of Alternatives

5.0 Recommended Remedial Alternative

6.0 References

Appendices

A Technology Specific Documentation

B Contaminant Fate and Transport Calculations (if needed)

C Corrective Measure Alternative Cost Estimates

<<Additional appendices will be added, if necessary>>

List of Tables

List of Figures

SECTION 4.0

Project Management Plan

4.0 Project Management Plan

This project management plan has been prepared to define the project organization, to identify key personnel and their responsibilities, and to establish reporting requirements and lines of communication for the performance of the CMS and the preparation of the CMS report for SWMU 17. The plan also includes the proposed project schedule and the project deliverables required during the CMS. The plan has been developed to maintain consistency in procedures and communications during execution of the CMS.

4.1 Project Organization and Responsibilities

The organizations that will participate in completing the CMS for SWMU 17 have specific functions according to their project responsibilities, as described below:

- Lead Regulatory Agency — SCDHEC, the lead regulatory agency, will assign a lead engineer and hydrogeologist for the review and completion of the CMS for the site.
- Support Regulatory Agency — EPA is the support regulatory agency with Dann Spariosu as EPA's point of contact for this project.
- Owner/Operator — The U.S. Navy is the Owner/Operator of the site, and Tony Hunt with the Navy is the primary contact for SCDHEC and EPA. The Navy is ultimately responsible for completing the CMS and implementing the agency-approved CA.
- Owner's Contractor — CH2M-Jones, the Navy's contractor, is responsible for completing this project for the Navy. Dean Williamson is the primary point of contact for the CH2M-Jones team, and will be assisted by Ms. Rebecca Carovillano, who will serve as the alternate point of contact and task leader for the CMS.

4.2 Project Schedule

The project schedule for completing the CMS for SWMU 17 is presented in this subsection. The schedule presented in Table 4-1 includes the following:

- CMS tasks and associated subtasks
- Anticipated start and end dates for each subtask
- Project milestones, including completion for each work item

The project schedule will be finalized on the basis of the input from the reviewers of this document. Table 4-1 presents the project schedule.

4.3 Project Deliverables

The project deliverables consist of the CMS report, which will be prepared in draft and final versions. The comments on the draft CMS report that are received from the Navy, EPA, and SCDHEC will be incorporated into the final CMS report.

TABLE 4-1
Project Schedule

Activity	Start Date	End Date
Comment Period for CMS Work Plan	1/8/2001	2/7/2001
Revisions to CMS Work Plan	2/8/2001	2/23/2001
Implementation of CMS Work Plan	2/23/2001	5/1/2001
Submission of Revision 0 CMS Report	5/25/2001	5/25/2001
Comment Period for CMS Report	5/25/2001	6/25/2001
Submission of Revision 1 CMS Report	6/25/2001	7/25/2001

SECTION 5.0

References

5.0 References

Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Chlorinated Dibenzo-p-Dioxins. Draft for Public Comment (update). September 1997.

EnSafe/Allen & Hoshall. *Final RCRA Facility Investigation Report for Zone H Naval Base Charleston*. Prepared for the Department of the Navy, Southern Division Naval Facilities Engineering Command: Charleston, SC. Contract N62467-89-D0318. July 1996.

EnSafe. *RCRA Facility Investigation Addendum*. NAVBASE Charleston. 2000.

Johnson and Ettinger. *http://www.epa.gov/oerrpage/superfund/programs/risk/airmodel/johnson_ettinger.htm*. 1991.

South Carolina Department of Health and Environmental Control (SCDHEC). RCRA Permit SC0 170 022 560. Charleston Naval Complex, Charleston, South Carolina. August 17, 1988.

U.S. Environmental Protection Agency. *http://www.epa.gov/region09/waste/sfund/prg*. November 1, 2000.

APPENDIX A

Selected Figures from RFI Addendum

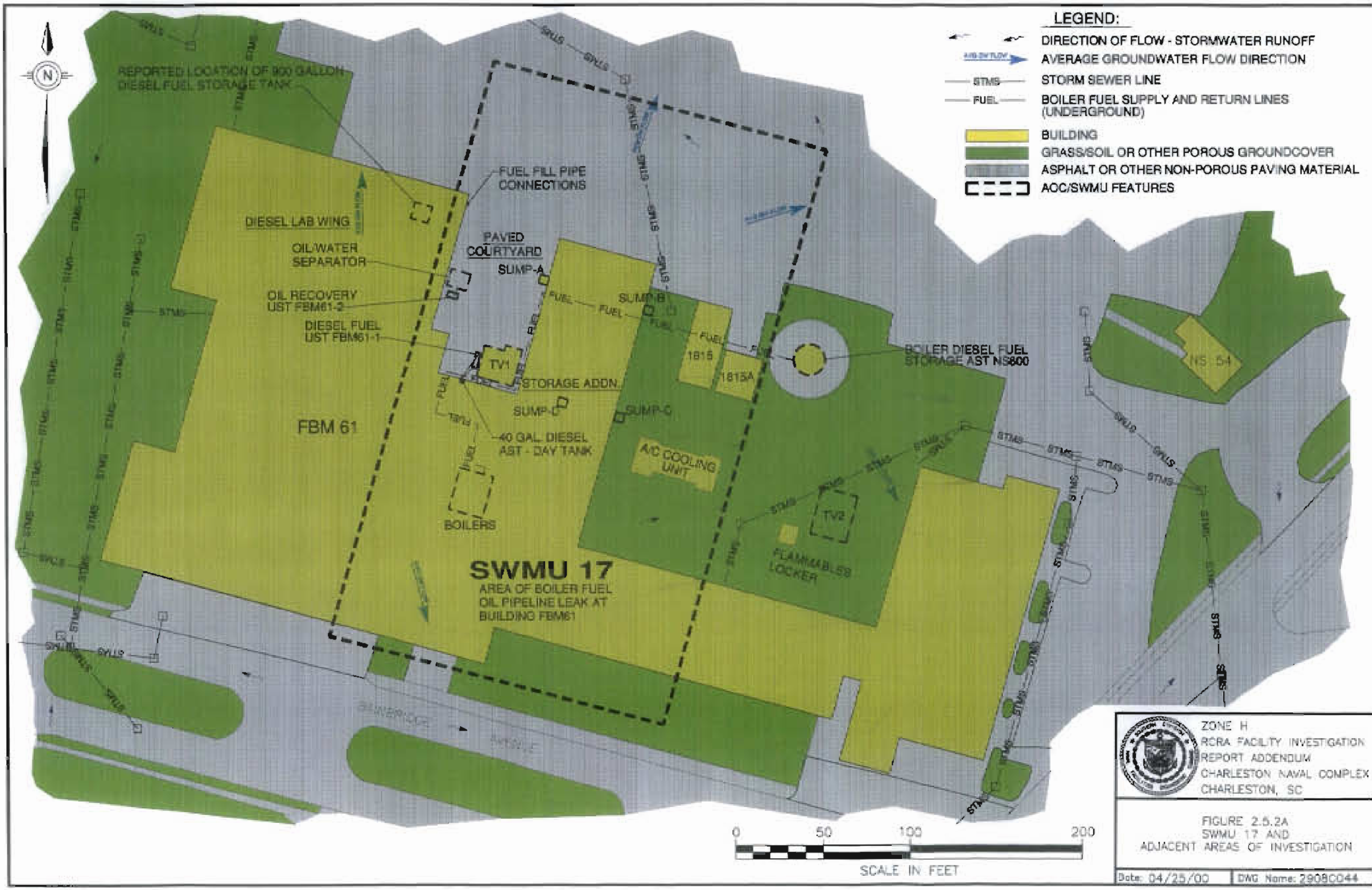
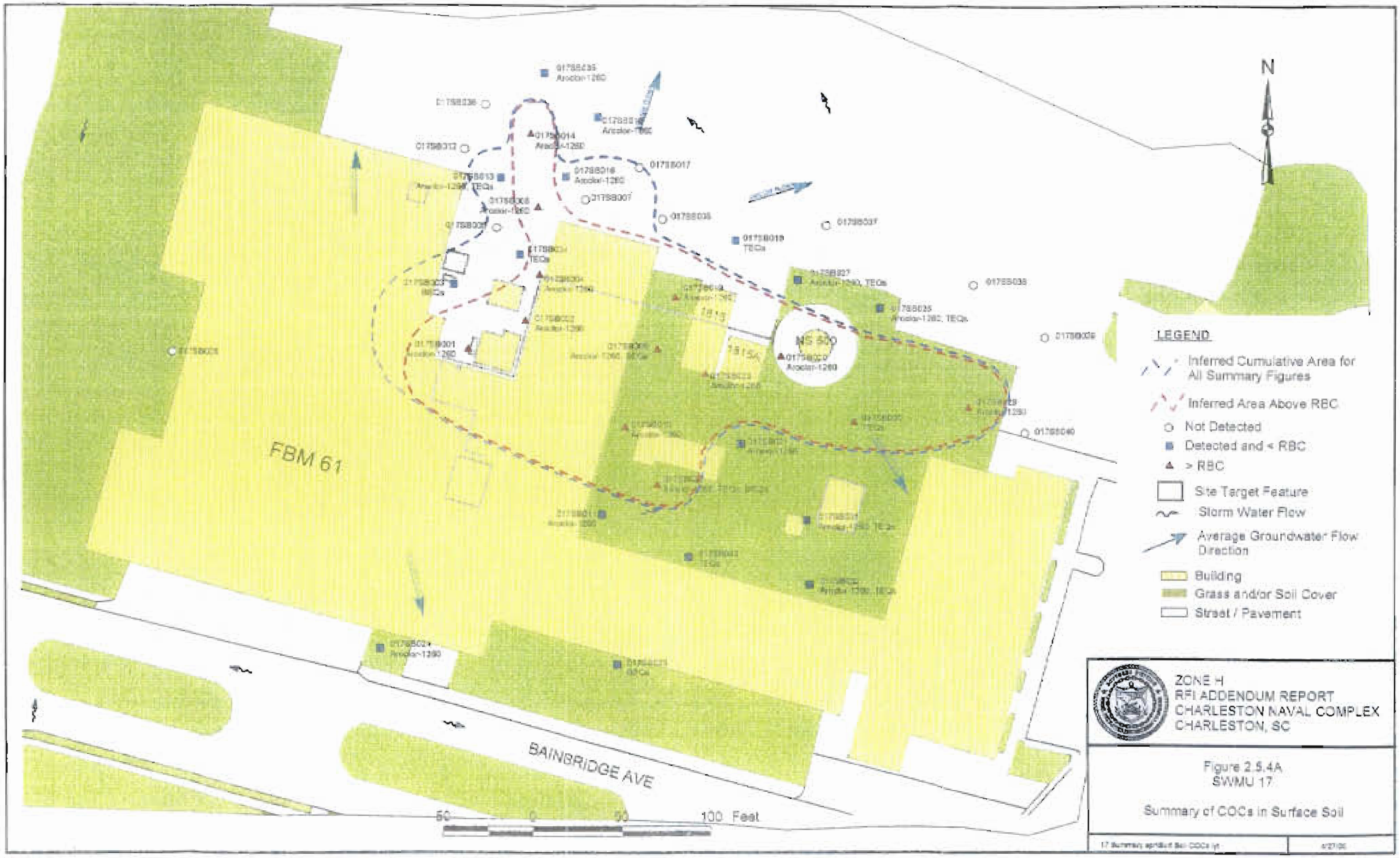
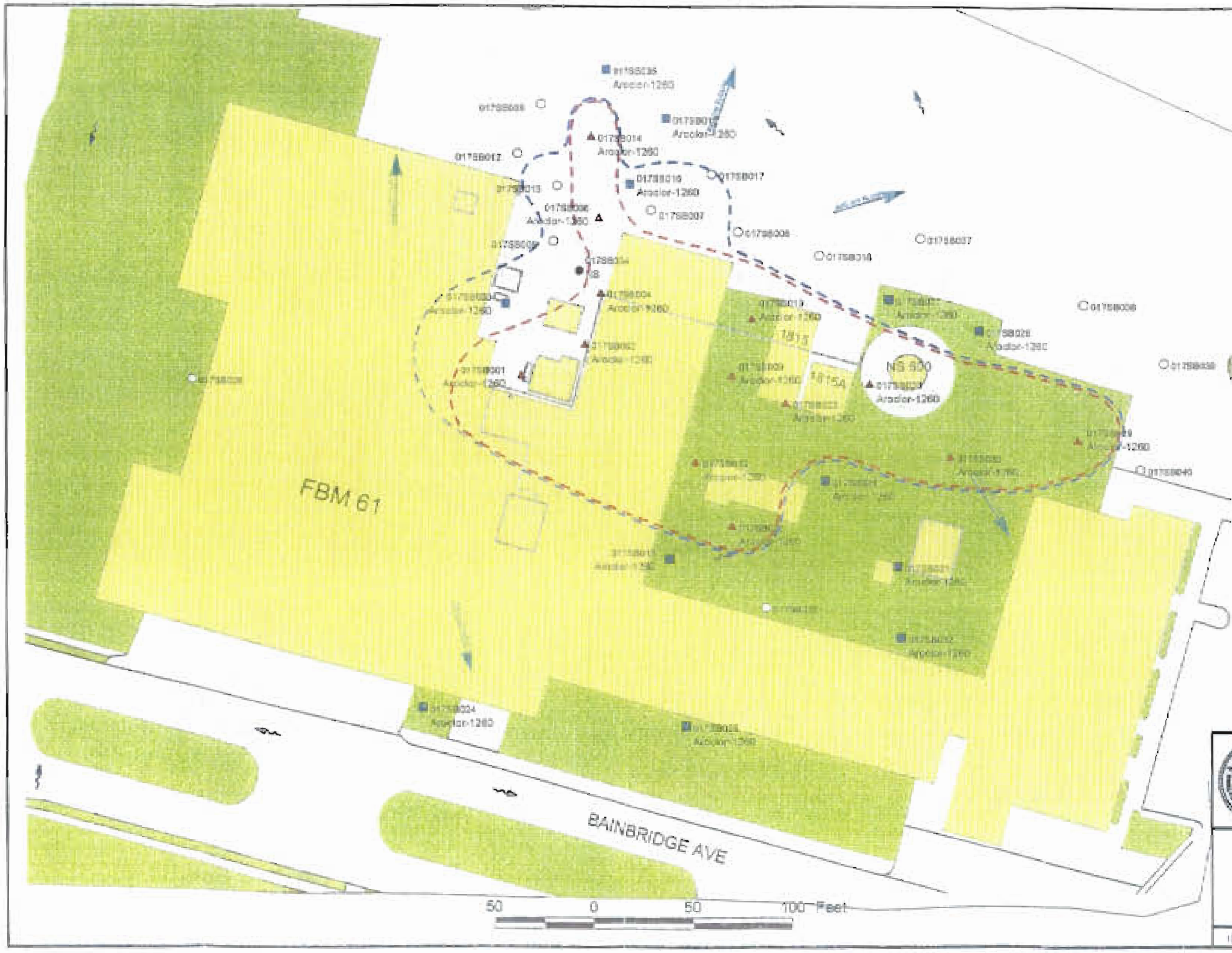


FIGURE 2.5.2A
SWMU 17 AND
ADJACENT AREAS OF INVESTIGATION



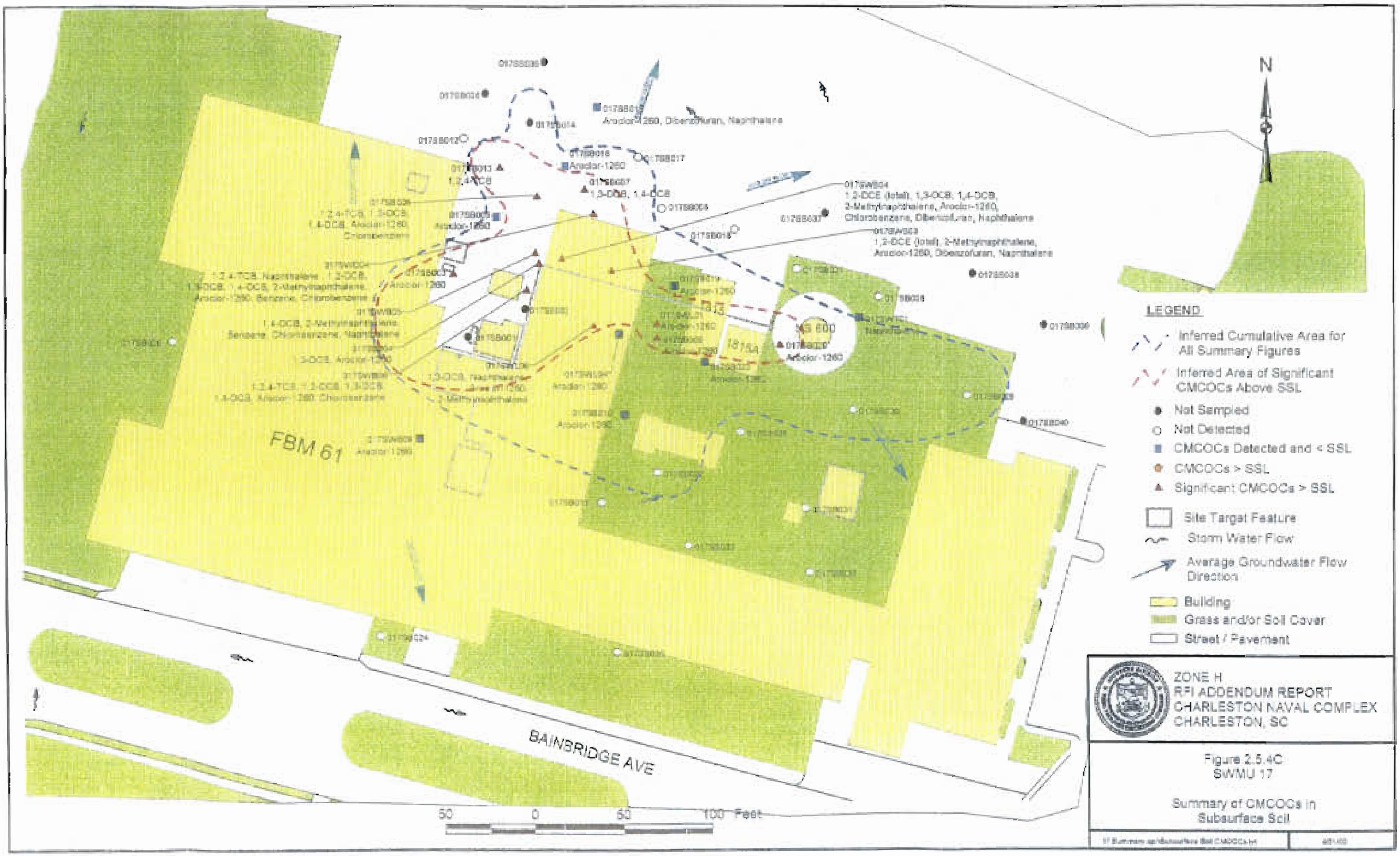
N
FBM 61
BAINBRIDGE AVE
NS 500
LEGEND
Inferred Cumulative Area for All Summary Figures
Inferred Area Above RBC
Not Detected
Detected and < RBC
> RBC
Site Target Feature
Storm Water Flow
Average Groundwater Flow Direction
Building
Grass and/or Soil Cover
Street / Pavement
50 0 50 100 Feet
ZONE H
RFI ADDENDUM REPORT
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC
Figure 2.5.4A
SWMU 17
Summary of COCs in Surface Soil



ZONE H
RFI ADDENDUM REPORT
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC

Figure 2.5.4B
SWMU 17

Summary of Soil-to-Groundwater CMCOCs
In Surface Soil


N
FBM 61
BAINBRIDGE AVE
50 0 50 100 Feet
LEGEND
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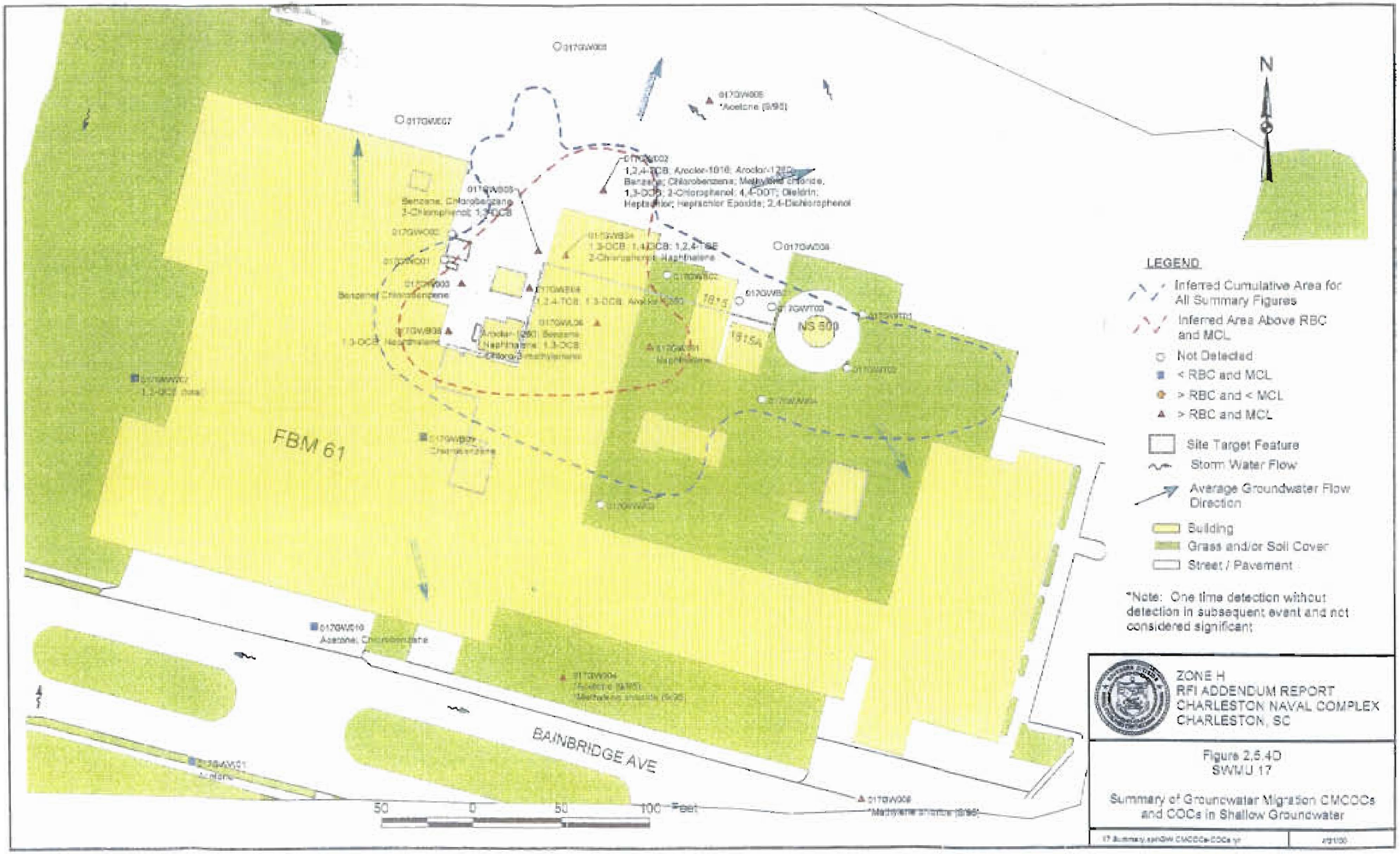
Inferred Area of Significant CMCOCs Above SSL
Not Sampled
Not Detected
CMCOCs Detected and < SSL
CMCOCs > SSL
Significant CMCOCs > SSL
Site Target Feature
Storm Water Flow
Average Groundwater Flow Direction
Building
Grass and/or Soil Cover
Street / Pavement
ZONE H
RFI ADDENDUM REPORT
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC
Figure 2.5.4C
SWMU 17
Summary of CMCOCs in Subsurface Soil



ZONE H
RFI ADDENDUM REPORT
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC

Figure 2.5.4D
SWMU 17

Summary of Groundwater Migration CMCOCs and COCs in Shallow Groundwater

LITHOSTRATIGRAPHIC UNITS

FILL UNITS

Unit	Description
Fc	FILL CLAY: INORGANIC CLAYS AND SILTS; MAY CONTAIN THIN SAND INTERVALS.
Fs	FILL SAND: TYPICALLY A VERY-FINE GRAINED ORANGE SAND.

QUATERNARY AGE UNITS

Unit	Description
Qm_4	THE MOST RECENTLY DEPOSITED DARK GREY TO BLACK, ORGANIC RICH CLAYEY SILT (MARSH CLAY).
Qm_3	A DARK GREY TO BLACK, ORGANIC RICH, CLAYEY SILT (MARSH CLAY) THAT IS ASSOCIATED WITH DEPOSITION OF THE Qs3 SAND UNIT.
Qs_3	A YELLOW-BROWN TO OLIVE-BROWN, VERY-FINE TO FINE GRAINED SAND. MAY HAVE SOME VERY-FINE BLACK GRAINS AND VARYING SILT CONTENT.
Qsl_2	A YELLOW-BROWN TO OLIVE-BROWN, CLAYEY SILT.
Qm_2	A DARK GREY TO BLACK, ORGANIC RICH, CLAYEY SILT (MARSH CLAY) THAT IS ASSOCIATED WITH DEPOSITION OF THE Qs2 SAND UNIT.
Qs_2	A GREY, VERY FINE TO FINE SAND WITH TRACE TO SOME SILT, TYPICALLY CONTAINING VERY FINE BLACK GRAINS AND/OR WHITE SHELL FRAGMENTS.
Qsl_1	A YELLOW-BROWN TO OLIVE-BROWN, SOMETIMES CLAYEY SILT.
Qm_1	A DARK GREY TO BLACK, ORGANIC RICH, CLAYEY SILT (MARSH CLAY) WITH AN OCCASIONAL THIN SAND (Qms).
Qc	A GREY-GREEN TO BLUE-GREEN, FIRM TO STIFF, PLASTIC, INORGANIC CLAY.
Qs_1	LIGHT TO DARK BROWN/GREY, VERY FINE TO FINE SAND WITH TRACE SILT CONTENT. THERE IS A PHOSPHATE PEBBLE LAG AT THE BASAL CONTACT WITH THE UNDERLYING ASHLEY FORMATION.

TERTIARY AGE UNITS

Unit	Description
Ta	AN OLIVE-BROWN TO YELLOW-BROWN, CALCAREOUS CLAYEY SILT - ASHLEY FORMATION.

LEGEND:

DEEP MONITORING WELL W/ ID NUMBER

SHALLOW MONITORING WELL W/ ID NUMBER

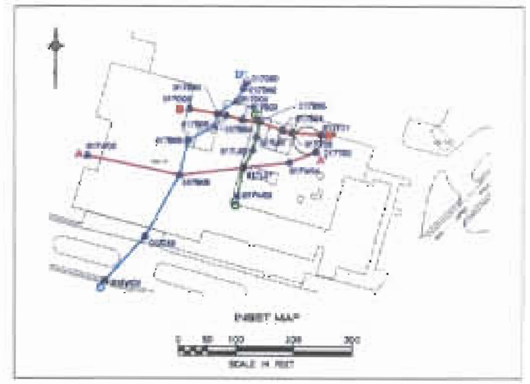
GEOLOGIC CONTACTS - DASHED WHERE INFERRED

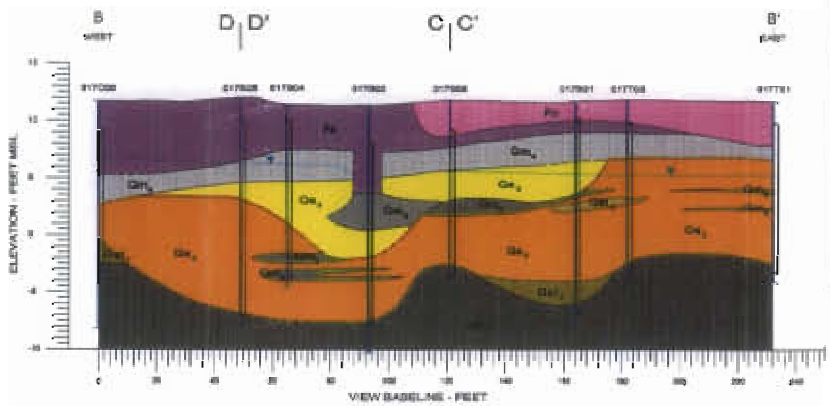
GROUNDWATER ELEVATION SURFACE

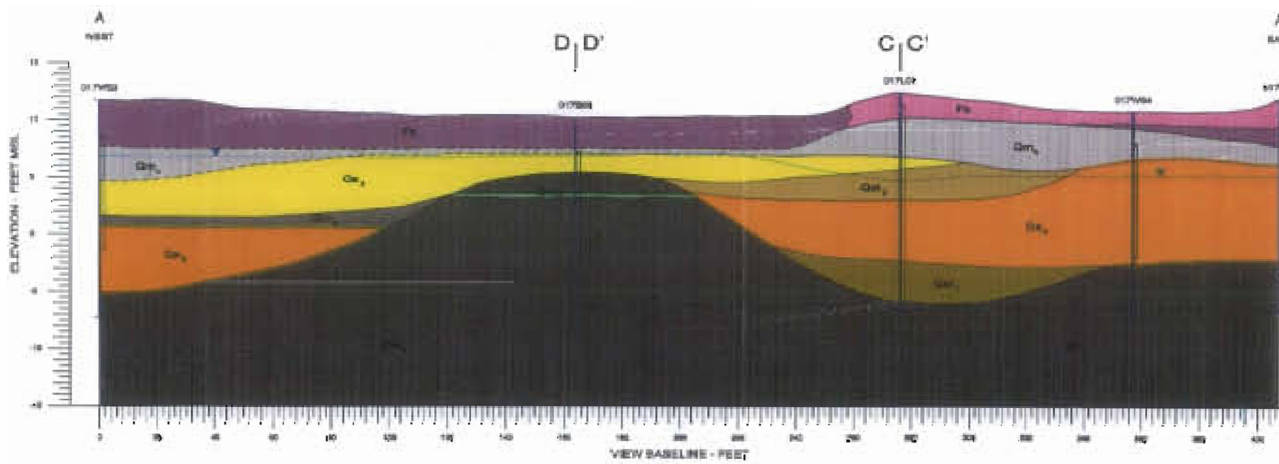
WELL BORING/SCREENED INTERVAL

D | D' INTERSECTING CROSS-SECTION

VERTICAL SCALE
HORIZONTAL SCALE
VERTICAL EXAGGERATION







REVISIONS

ZONE H
RCRA FACILITY INVESTIGATION
ADDENDUM REPORT
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC

GEOLOGIC CROSS-SECTIONS
A-A' AND B-B'

LITHOSTRATIGRAPHIC UNITS

FILL UNITS

Fc — FILL CLAY: INORGANIC CLAYS AND SILTS. MAY CONTAIN THIN SAND INTERVALS.

Fs — FILL SAND: TYPICALLY A VERY-FINE GRAINED ORANGE SAND.

QUATERNARY AGE UNITS

Qm_4 — THE MOST RECENTLY DEPOSITED DARK GREY TO BLACK, ORGANIC RICH CLAYEY SILT (MARSH CLAY).

Qm_3 — A DARK GREY TO BLACK, ORGANIC RICH, CLAYEY SILT (MARSH CLAY) THAT IS ASSOCIATED WITH DEPOSITION OF THE Qs3 SAND UNIT.

Qs_3 — A YELLOW-BROWN TO OLIVE-BROWN, VERY-FINE TO FINE GRAINED SAND. MAY HAVE SOME VERY-FINE BLACK GRAINS AND VARYING SILT CONTENT.

Qst_2 — A YELLOW-BROWN TO OLIVE-BROWN, CLAYEY SILT.

Qm_2 — A DARK GREY TO BLACK, ORGANIC RICH, CLAYEY SILT (MARSH CLAY) THAT IS ASSOCIATED WITH DEPOSITION OF THE Qs2 SAND UNIT.

Qs_2 — A GREY, VERY FINE TO FINE SAND WITH TRACE TO SOME SILT. TYPICALLY CONTAINING VERY FINE BLACK GRAINS AND/OR WHITE SHELL FRAGMENTS.

Qst_1 — A YELLOW-BROWN TO OLIVE-BROWN, SOMETIMES CLAYEY SILT.

A DARK GREY TO BLACK, ORGANIC RICH, CLAYEY SILT (MARSH CLAY) WITH AN OCCASIONAL THIN SAND (Qms).

Qc — A GREY-GREEN TO BLUE-GREEN, FIRM TO STIFF, PLASTIC, INORGANIC CLAY.

Qs_1 — LIGHT TO DARK BROWN/GREY, VERY FINE TO FINE SAND WITH TRACE SILT CONTENT. THERE IS A PHOSPHATE PEBBLE LAG AT THE BASAL CONTACT WITH THE UNDERLYING ASHLEY FORMATION.

TERTIARY AGE UNITS

Ta — AN OLIVE-BROWN TO YELLOW-BROWN, CALCAREOUS CLAYEY SILT - ASHLEY FORMATION.

LEGEND:

DEEP MONITORING WELL W/ ID NUMBER

SHALLOW MONITORING WELL W/ ID NUMBER

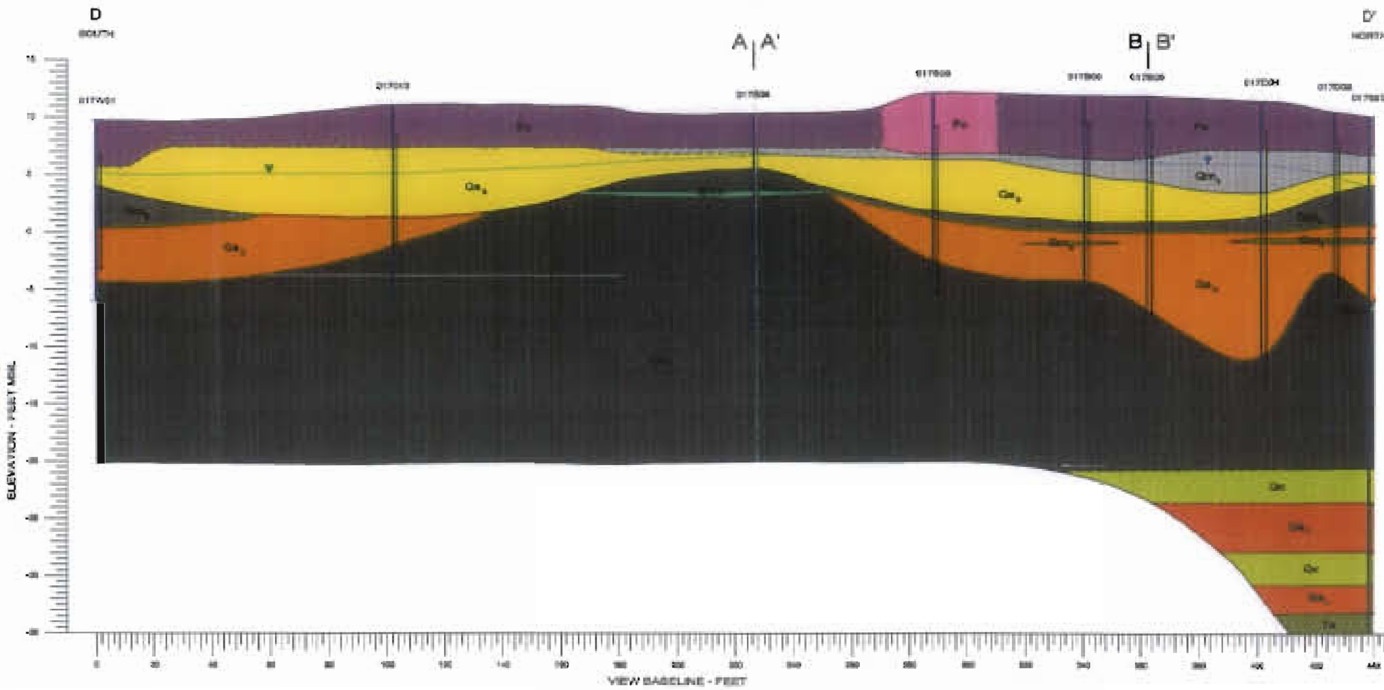
GEOLOGIC CONTACTS - DASHED WHERE INFERRED

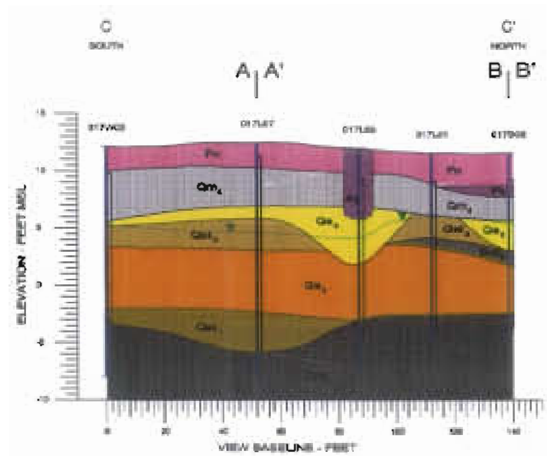
GROUNDWATER ELEVATION SURFACE

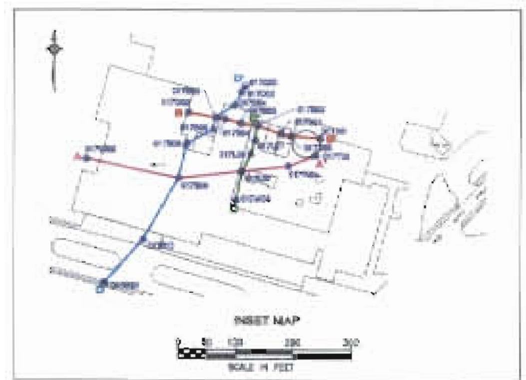
WELL SCREENED/OPEN INTERVAL

A | A' — INTERSECTING CROSS-SECTION

VERTICAL SCALE: 1"=5'
HORIZONTAL SCALE: 1"=20'
VERTICAL EXAGGERATION = 4

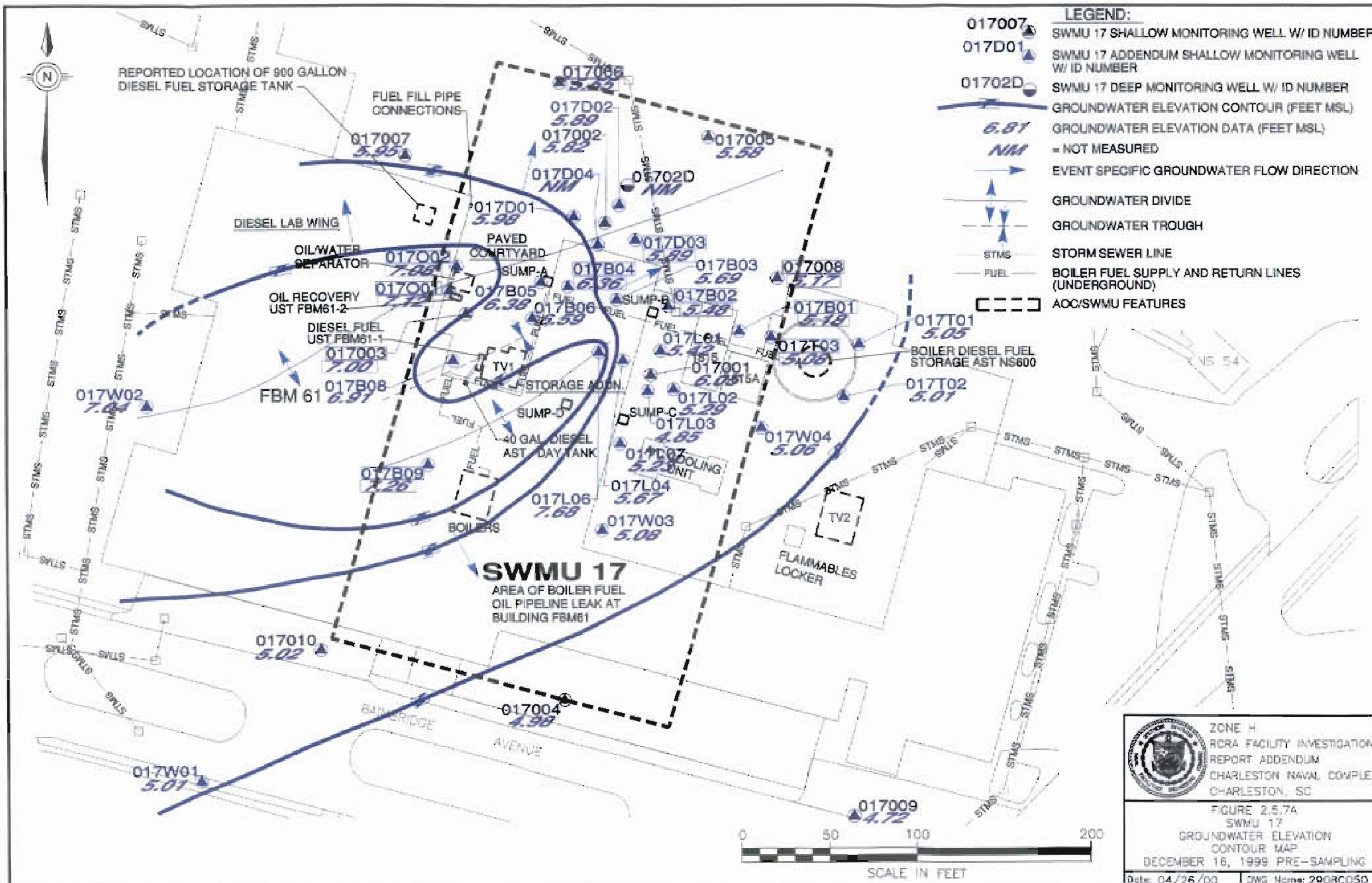


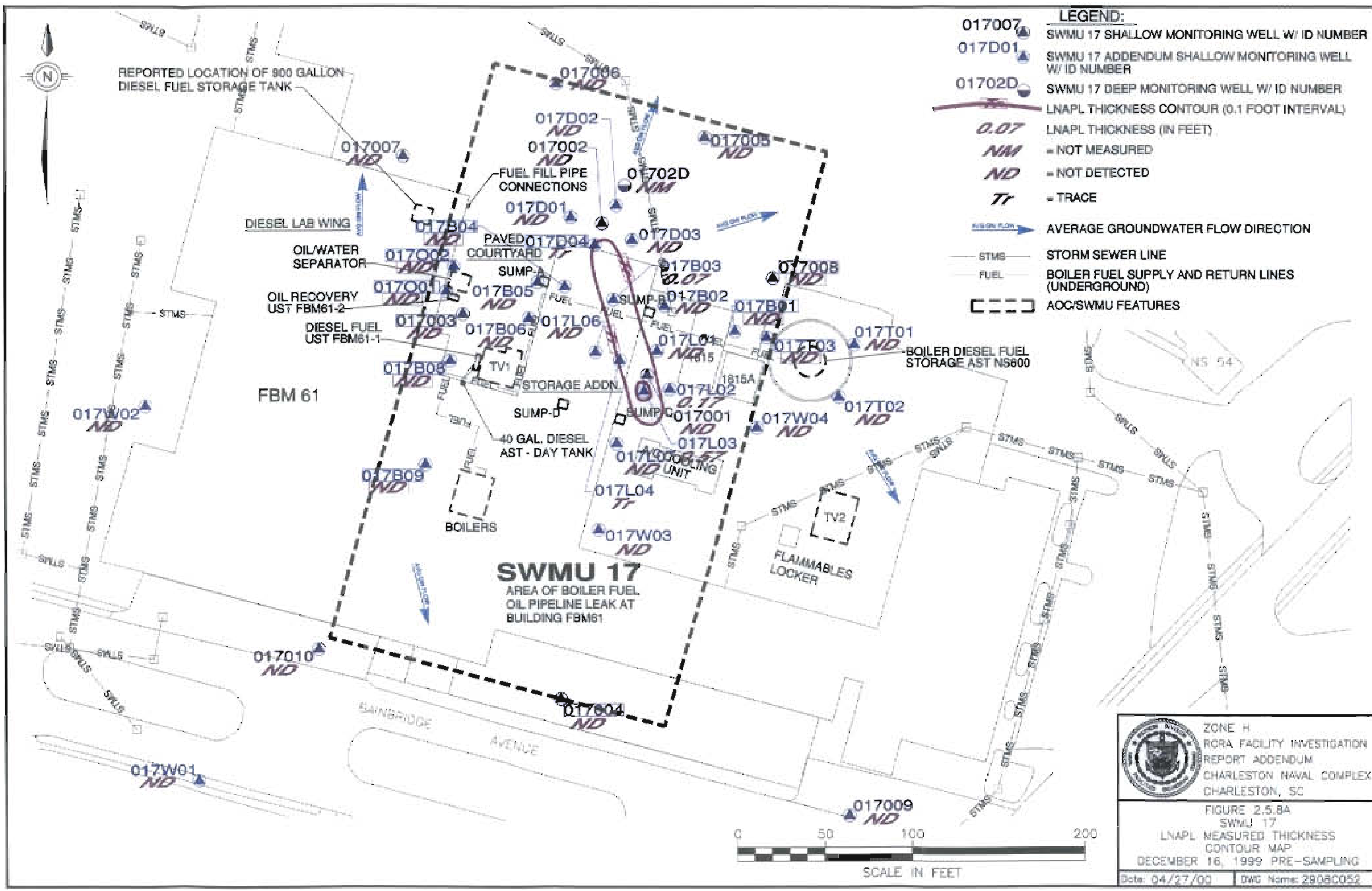


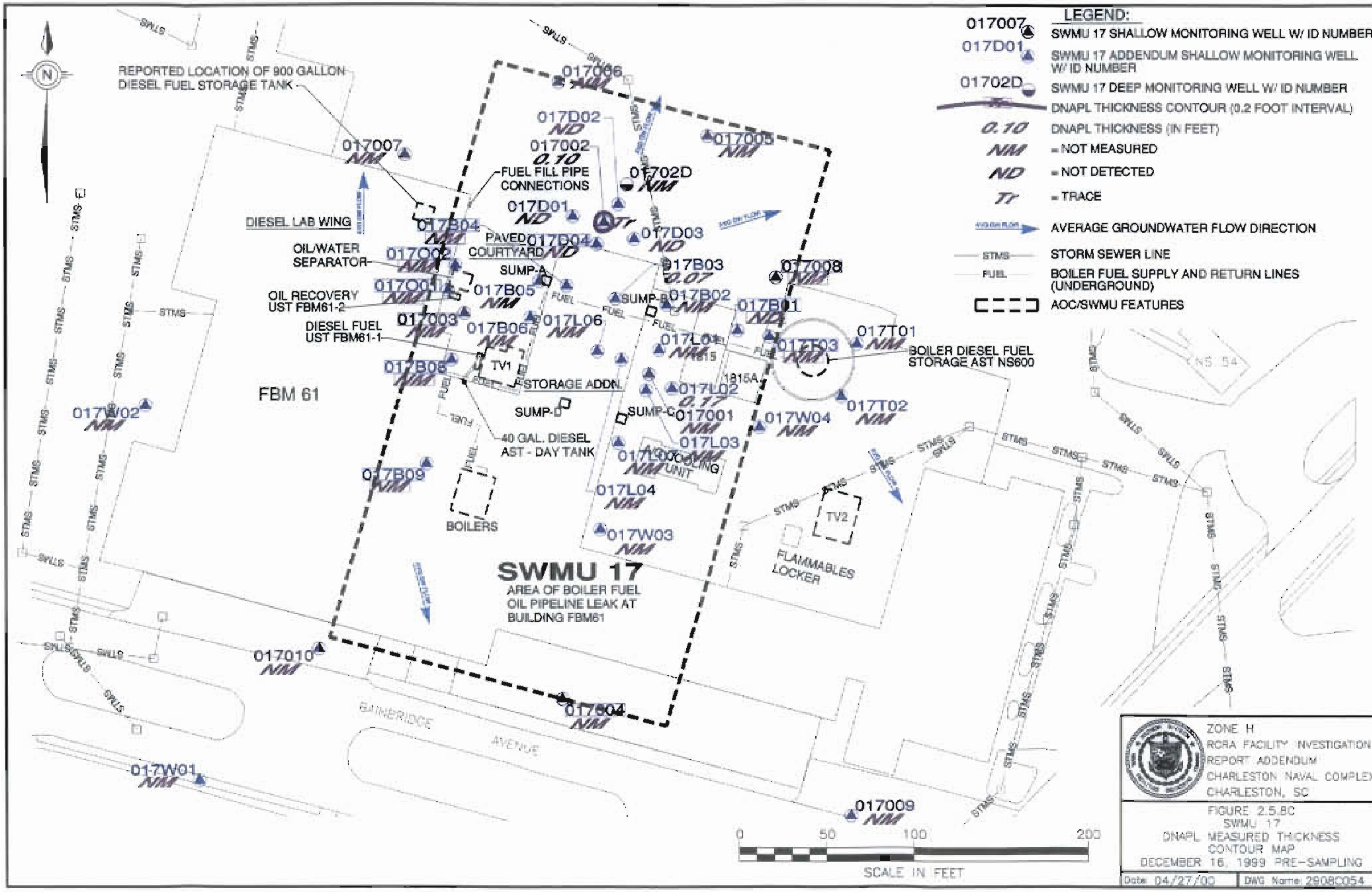


ZONE H
RCRA FACILITY INVESTIGATION
ADDENDUM REPORT
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC

GEOLOGIC CROSS-SECTIONS


LEGEND:
017007 SWMU 17 SHALLOW MONITORING WELL W/ ID NUMBER
017D01 SWMU 17 ADDENDUM SHALLOW MONITORING WELL W/ ID NUMBER
01702D SWMU 17 DEEP MONITORING WELL W/ ID NUMBER
GROUNDWATER ELEVATION CONTOUR (FEET MSL)
6.87 GROUNDWATER ELEVATION DATA (FEET MSL)
NM = NOT MEASURED
EVENT SPECIFIC GROUNDWATER FLOW DIRECTION
GROUNDWATER DIVIDE
GROUNDWATER TROUGH
STMS STORM SEWER LINE
FUEL BOILER FUEL SUPPLY AND RETURN LINES (UNDERGROUND)
AOC/SWMU FEATURES
REPORTED LOCATION OF 900 GALLON DIESEL FUEL STORAGE TANK
FUEL FILL PIPE CONNECTIONS
DIESEL LAB WING
OIL/WATER SEPARATOR
PAVED COURTYARD
OIL RECOVERY UST FBM61-2
DIESEL FUEL UST FBM61-1
FBM 61
STORAGE ADDN.
40 GAL DIESEL AST DAY TANK
BOILERS
COOLING UNIT
BOILER DIESEL FUEL STORAGE AST NS600
FLAMMABLES LOCKER
SWMU 17
AREA OF BOILER FUEL OIL PIPELINE LEAK AT BUILDING FBM61
BAINBRIDGE AVENUE
017006 5.82
017D02 5.89
017002 5.82
017005 5.58
017007 5.95
017D04 NM
01702D NM
017D01 5.98
017D03 5.89
017O02 7.08
017O01 7.12
017B04 6.36
017B03 5.69
017008 5.17
017B05 6.38
017B06 6.59
017B02 5.48
017B01 5.18
017T01 5.05
017L01 5.42
017T03 5.08
017001 6.03
017003 7.00
017B08 6.97
017W02 7.04
017T02 5.07
017L02 5.29
017L03 4.85
017W04 5.06
017B09 7.26
017D07 5.23
017L04 5.67
017L06 7.68
017W03 5.08
017010 5.02
017004 4.98
017W01 5.01
017009 4.72
0 50 100 200
SCALE IN FEET
ZONE H
RCRA FACILITY INVESTIGATION REPORT ADDENDUM
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC
FIGURE 2.5.74
SWMU 17
GROUNDWATER ELEVATION CONTOUR MAP
DECEMBER 16, 1999 PRE-SAMPLING
Date: 04/26/00
DWG Name: 2908C050


LEGEND:
017007 SWMU 17 SHALLOW MONITORING WELL W/ ID NUMBER
017D01 SWMU 17 ADDENDUM SHALLOW MONITORING WELL W/ ID NUMBER
01702D SWMU 17 DEEP MONITORING WELL W/ ID NUMBER
LNAPL THICKNESS CONTOUR (0.1 FOOT INTERVAL)
0.07 LNAPL THICKNESS (IN FEET)
NM = NOT MEASURED
ND = NOT DETECTED
Tr = TRACE
AVERAGE GROUNDWATER FLOW DIRECTION
STMS STORM SEWER LINE
FUEL BOILER FUEL SUPPLY AND RETURN LINES (UNDERGROUND)
AOC/SWMU FEATURES
REPORTED LOCATION OF 900 GALLON DIESEL FUEL STORAGE TANK
FUEL FILL PIPE CONNECTIONS
DIESEL LAB WING
OIL/WATER SEPARATOR
OIL RECOVERY UST FBM61-2
DIESEL FUEL UST FBM61-1
PAVED COURTYARD
SUMP-A
SUMP-B
SUMP-C
SUMP-D
STORAGE ADDN
40 GAL. DIESEL AST - DAY TANK
BOILERS
COOLING UNIT
FBM 61
BOILER DIESEL FUEL STORAGE AST NS600
NS 54
TV1
TV2
FLAMMABLES LOCKER
1815
1815A
SWMU 17
AREA OF BOILER FUEL OIL PIPELINE LEAK AT BUILDING FBM61
BAINBRIDGE AVENUE
017006 ND
017D02 ND
017002 ND
017005 ND
017007 ND
01702D NM
017D01 ND
017B04 ND
017D04 Tr
017D03 ND
017O02 ND
017O01 ND
017B05 ND
017B03 0.07
017B02 ND
017B01 ND
017008 ND
017003 ND
017B06 ND
017L06 ND
017L01 ND
017T03 ND
017T01 ND
017B08 ND
017L02 0.17
017001 ND
017T02 ND
017W02 ND
017W04 ND
017L03 0.57
017L05 ND
017B09 ND
017L04 Tr
017W03 ND
017010 ND
017004 ND
017W01 ND
017009 ND
SCALE IN FEET
0 50 100 200
ZONE H
RCRA FACILITY INVESTIGATION
REPORT ADDENDUM
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC
FIGURE 2.5.8A
SWMU 17
LNAPL MEASURED THICKNESS
CONTOUR MAP
DECEMBER 16, 1999 PRE-SAMPLING
Date: 04/27/00
DWG Name: 2908C052


LEGEND:
017007 SWMU 17 SHALLOW MONITORING WELL W/ ID NUMBER
017D01 SWMU 17 ADDENDUM SHALLOW MONITORING WELL W/ ID NUMBER
01702D SWMU 17 DEEP MONITORING WELL W/ ID NUMBER
DNAPL THICKNESS CONTOUR (0.2 FOOT INTERVAL)
0.10 DNAPL THICKNESS (IN FEET)
NM = NOT MEASURED
ND = NOT DETECTED
Tr = TRACE
AVERAGE GROUNDWATER FLOW DIRECTION
STMS STORM SEWER LINE
FUEL BOILER FUEL SUPPLY AND RETURN LINES (UNDERGROUND)
AOC/SWMU FEATURES
REPORTED LOCATION OF 900 GALLON DIESEL FUEL STORAGE TANK
DIESEL LAB WING
OIL/WATER SEPARATOR
OIL RECOVERY UST FBM61-2
DIESEL FUEL UST FBM61-1
FUEL FILL PIPE CONNECTIONS
PAVED COURTYARD
SUMP-A
SUMP-B
SUMP-C
SUMP-D
STORAGE ADDN.
40 GAL. DIESEL AST - DAY TANK
BOILERS
FBM 61
BOILER DIESEL FUEL STORAGE AST NS600
FLAMMABLES LOCKER
TV1
TV2
SWMU 17
AREA OF BOILER FUEL OIL PIPELINE LEAK AT BUILDING FBM61
BAINBRIDGE AVENUE
017006 NM
017D02 ND
017002 0.10
01702D NM
017005 NM
017007 NM
017D01 ND
017B04 NM
017D04 ND
017D03 ND
017B03 0.07
017008 NM
017B02 NM
017B01 ND
017T01 NM
017T03 NM
017B05 NM
017L06 NM
017B06 NM
017L01 NM
017L02 0.17
017001 NM
017T02 NM
017W04 NM
017L03 NM
017L05 NM
017L04 NM
017W03 NM
017B08 NM
017B09 NM
017W02 NM
017010 NM
017004 NM
017W01 NM
017009 NM
0 50 100 200
SCALE IN FEET
ZONE H
RCRA FACILITY INVESTIGATION REPORT ADDENDUM
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC
FIGURE 2.5.8C
SWMU 17
DNAPL MEASURED THICKNESS CONTOUR MAP
DECEMBER 16, 1999 PRE-SAMPLING
Date: 04/27/00
DWG Name: 2908C054

APPENDIX B

SCDHEC and EPA Comments on CMS Work Plan Revision 0

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General Comments:

Comment:

1. Recognizing that the BCT has had several discussions regarding the content of post-RFI documents, the Department still asserts that the CMS Work Plan should be executed as a stand-alone document, providing text, figures and tables that present a clear picture of the most recent understanding of the nature and extent of final COCs and corresponding risk (i.e. summary and conclusions of RFI). Although it is built upon work done in the RFI, the Corrective Measures phase an independent study and should be presented as such.
   The figures presented in this document should be revised to show the areal extent of COCs above background and risk levels as well as groundwater contours illustrating the extent of PCBs and NAPL. The Department is not requiring additional figures, but recommends revising the current ones.
   The Department is willing to discuss and scope out revisions to the current figures and suggests establishing a document template for future submittals.

Response:

We will address this comment in two ways.

1. We will provide selected figures from the RFI Addendum Report as an Appendix to the CMS Work Plan. These figures will include the SWMU boundary, contour maps showing the extent of contamination, groundwater flow direction, NAPL extent, and hydrogeologic cross sections that reflect the understanding of the site conditions at the time that the RFI Addendum was prepared. An appropriate reference to these figures will be made in Section 1 of the CMS Work Plan. Most of these issues (SWMU boundary, geologic cross sections, groundwater flow direction, NAPL extent) are adequate representations of these issues for the purposes of this CMS WP.

Specific figures from the Ensafe RFI addendum to be included in the appendix for this purpose are:

Figure 2.2.2A SWMU 17 and Adjacent Areas of Investigation

Figure 2.5.4A Summary of COCs in Surface Soil

Figure 2.5.4B Summary of Soil-to-Groundwater CMCOCs in Surface Soil

Figure 2.5.4C Summary of CMCOCs in Subsurface Soil

Figure 2.5.4D Summary of Groundwater Migration CMCOCs and COCs in Shallow Groundwater

Figure 2.5.5A Geologic Cross Sections A-A′ and B-B′

Figure 2.5.5B Geologic Cross Sections C-C′ and D-D′

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Figure 2.5.7A Groundwater Elevation Contour Map 12/16/1999

Figure 2.5.8A LNAPL Measured Thickness Contour Map 12/16/1999

Figure 2.5.8C DNAPL Measured Thickness Contour Map 12/16/1999

2. Figures in Section 2 of the CMS Work Plan will be modified to include our current understanding of the extent of contamination based upon any new sampling results, the COC refinement presented, and the development of media cleanup standards.

Specific Comments:

Comment:

1. Section 2.2, page 2-5, line 4+: The BCT has had several discussions regarding SSL calculations and their role in the RFI and CMS processes. One of the primary concerns has been the use of the assumption that heavily paved areas account for a reduced infiltration rate, and therefore a higher DAF. The Navy may use this assumption during the remedy selection process given that appropriate controls and maintenance are put into place, however the current DAF and corresponding SSLs should be recalculated without this constraint to represent an uncontrolled condition. In the event that this changes the final list of COCs, all pertinent sections should be revised accordingly.

Response:

Comment noted. A new DAF will be calculated assuming no paved areas, to represent the unrestricted land use scenario, as suggested by DHEC. The SSLs estimated using the new DAF would be used to develop a COC list for unrestricted land use. The CMS Work Plan text will be modified to include any new COCs identified during screening against new SSLs for unrestricted land use. The existing DAF in the CMS Work Plan that is representative of conditions at SWMU 17 will be used to represent future industrial land use, which will be the focus of the CMS.

Comment:

2. Section 2.3, page 2-9, line 14+: During the RFI WP Addendum scoping it was agreed that an additional round of sampling would be performed at SWMU 17 before benzidine could potentially be eliminated as a COPC. The Department will not eliminate this constituent until the data confirms that it is not present. It is recommended that the Navy complete this investigation prior to revising the CMS WP or recognize the uncertainty of benzidine as a COC.

Response:

Comment noted. Sampling for benzidine is being addressed by the RFI team to resolve RFI addendum comments.

Comment:

3. The Section 3.0 introduction should note that the CMS will include a section discussing the land use scenario rationale. The introduction should also address

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the fact that an industrial scenario decision would trigger the requirement for development of a Land Use Control Plan for the CNC.

Response:

Comment noted. This modification will be made to the text.

Comment:

4. Section 3.1 should include a description of land use and institutional controls as a corrective measure technology.

Response:

Comment noted. This modification will be made to the text.

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Comment:

1. The referenced CMS work plan is not just a "generic CMS format document" as the Chapter 1 and 2 provides the completion, conclusion, and recommendations of the RFI report. This is the first time that. the Navy has developed the final list of constituents of concern (COC) from the preliminary COCs using the uncertainty analysis process. Therefore, in order to streamline the review and approval process the Department recommends scoping of such documents in the future.

Response:

Comment noted.

Comment:

2. Table 2-2. Page 2-5.
   Section: Chemical Above SSLs but not in Groundwater Above Criteria.
   These table and text indicates that the PAH are exceeding the calculated site specific SSLs but are not considered as COCs because they are related to LNAPL. This may be true in theory but still they should be included in the list of COCs for this site. There may not be a need to select separate correction action as LNAPL remediation may address the PAH contamination also. The goal is to identify all releases and to provide subsequent data supporting their clean up. Please add the PAHs to the list of COCs after site specific SSL are recalculated (as per Elizabeth Frady's comment).

Response:

The SSLs will be recalculated using the no pavement scenario for unrestricted land use, as described in our response to Elizabeth Frady's specific comment #1. Those PAHs that exceed the recalculated SSL and are present in groundwater at concentrations that exceed the MCL will be included as COCs in the revised list.

Comment:

3. Table 2-3. SWMU 17 Subsurface Soil COC-Evaluation of Potential for Air Emissions from Subsurface Soil COPCs. Page 2-7.
   The Air emission exposure pathway evaluation is being deferred so that EPA-Region IV can assist in the review of this portion of the referenced document.

Response:

Comment noted. If necessary, revised figures will be produced for the CMS based on the EPA review of the air emission exposure pathway and any new COCs identified by EPA based on their evaluation of the indoor air pathway will be identified.

Comment:

4. Based on the review it appears that SWMU 17 is the first site where final corrective action is being proposed for industrial land use. Therefore, the Navy should note that the selection of industrial land use as final clean up goal for this site would require the development of a Land Use Control Management Plan for CNC and its incorporation into the permit prior to or concurrent with the selection of corrective

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action for SWMU17. The Department recommends having a discussion regarding this subject and the initiation of scoping for CNC - Land Use Control Management Plan.

Response:

Comment noted. We agree that discussions on land use management controls and the initiation of scoping for the Land Use Control Management Plan should be initiated soon, preferably during development of the CMS.

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Comment:

1. Section 1.5, Page 1-6; SUMMARY OF CONCLUSIONS FROM RFI ADDENDUM

This section is a summary of the Ensafe RFI Report Addendum (2000) and uses this as the overall conceptual site model. It must be noted that the RFI Report Addendum has not been approved. The Department's review of the RFI Report Addendum has generated numerous comments indicating the full extent of contamination has not been defined at SWMU 17. Those comments on the RFI Report Addendum related to SWMU 17 indicate that ten supporting figures representing the extent of contamination require revision. These RFI Report Addendum comments were discussed during the 12 January 2001 scoping meeting between CH2M Hill and the Department. The result of this discussion is that CH2M Hill is going to address DHEC's comments and will revise the figures in the RFI Report Addendum.

The Department's main concern is that the horizontal and vertical extent of NAPL and dissolved contamination has not been completely defined. The Navy should recognize the facts stated in this comment during the development of the CMS Workplan

Response:

Comment noted. RFI Addendum comments on the nature and extent of contamination are currently being resolved by the RFI team. Current discussions about these issues will be incorporated, as appropriate, into the development of Revision 1CMS WP. The outcome of the comment resolution will be incorporated into the work planning process for the CMS.

Comment:

2. Figures 1-1 through 1-6 and 2-1 through 2-15

These figures in this document have several problems, namely; the boundary of the SWMU has not been identified, groundwater flow has not been indicated, cross sections of the site have not been included, the extent of soil and groundwater contamination (horizontal and vertical) has not been represented, the extent of LNAPL has not been indicated, the extent of DNAPL has not been indicated and areas which require further delineation have not been represented. The CMS WP was an opportunity to demonstrate the most current understanding of the extent of site contamination. At the present time, the extent of contamination at SWMU 17 is subject to various interpretations. Misunderstanding the extent of contamination could adversely impact the remedial efforts at this site. Some remedial efforts potentially impacted would be the type of remedial system selected, the calculated

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time of the system operation, the cost of system operation and ultimately the success of the remedial effort.

Please be advised, it is not necessary for the RFI Report to be a totally "complete and approved" package for the CMS to begin nor is it useful or necessary to copy all the figures in an RFI Report for the CMS Workplan. The delineation issues, however, should be addressed with respect to the COCs for this site before the workplan is approved.

Response:

Figure modifications required for the RFI Addendum are being addressed separately by the RFI Addendum Team. Certain Figures from the RFI Addendum will be included in Section 1 of the CMS Work Plan as an Appendix. See our response to Elizabeth Frady's comments for a list of specific figures from the RFI Addendum to be included in the revision 1 CMS WP as an appendix. Existing figures from the CMS Work Plan that show the COCs in each impacted media will be contoured to show the extent of contamination and modified to show the SWMU boundary, as also noted in our response to Elizabeth Frady's comments.

Comment:

3. The Department is willing to scope the CMS Workplan and to conduct site visits with the Navy and CH2M Hill in order to speed the review and approval of the CMS Workplan.

Response:

Comment noted. Your willingness to work with us to effectively move the remedial planning process forward at this very important site is appreciated.

APPENDIX C

Calculation of Site-Specific DAFs, SWMU 17

Appendix C1. Soil Screening Levels (SSLs) Calculated Using Site-Specific DAF Value for Future Industrial Land Use at SWMU 17

Site(s)	Hydraulic Conductivity K (m/yr)	Hydraulic Gradient I (m/m)	Aquifer Thickness da (m)	Source Length Sw (m)	Infiltration Rate I' (m/yr)	Mixing Zone d (m)	DAF	Generic SSLs DAF 1	Generic SSLs DAF 20	Site Specific SSLs (Calculated from Calculated DAF)
Aroclor-1260**	445.008	0.01	11.15	27.4	0.00762	2.9	63.8	0.9	18	57.42
Benzene	445.008	0.01	11.15	22.9	0.00762	2.5	63.8	0.002	0.03	0.095
Benzo(a)anthracene*	445.008	0.01	11.15	22.9	0.00762	2.5	63.8	0.08	2	6.43
Benzo(a)pyrene*	445.008	0.01	11.15	22.9	0.00762	2.5	63.8	0.4	8	25.52
Benzo(b)fluoranthene*	445.008	0.01	11.15	22.9	0.00762	2.5	63.8	0.2	5	16.07
Chlorobenzene	445.008	0.01	11.15	27.4	0.00762	2.9	63.8	0.07	1	3.14
Ethylbenzene	445.008	0.01	11.15	22.9	0.00762	2.5	63.8	0.7	13	41.36
1,2-dichlorobenzene	445.008	0.01	11.15	27.4	0.00762	2.9	63.8	0.9	17	54.12
1,3-dichlorobenzene@	445.008	0.01	11.15	27.4	0.00762	2.9	63.8	0.1	2	6.38
1,4-dichlorobenzene	445.008	0.01	11.15	27.4	0.00762	2.9	63.8	0.1	2	6.38
1,2-dichloroethene	445.008	0.01	11.15	27.4	0.00762	2.9	63.8	0.02	0.4	1.28
Hexachlorobenzene*	445.008	0.01	11.15	27.4	0.00762	2.9	63.8	0.1	2	6.38
Naphthalene	445.008	0.01	11.15	22.9	0.00762	2.5	63.8	4	84	268.43
Styrene*	445.008	0.01	11.15	27.4	0.00762	2.9	63.8	0.2	4	12.76
1,2,4-trichlorobenzene	445.008	0.01	11.15	27.4	0.00762	2.9	63.8	0.3	5	15.84
1,1,2,2-tetrachloroethane	445.008	0.01	11.15	27.4	0.00762	2.9	63.8	0.0002	0.003	0.009

K is based on the USGS survey (USGS, 1999)
I is based on groundwater elevation differences and distance (47') between 017B04 (6.36') and 017D03 (5.89') (Figure 2.5.7A, Zone H RFI Addendum)
da is based on general depth to water down to the top of ashley formation within Zone H (Zone H RFI)
I' is based on 25% (heavily paved area) of the simulated recharge rate (0.10 ft/yr ~ 0.03048 m /yr x 25% = 0.00762 m/yr, USGS, 1999).
Sw for benzene, ethylbenzene, and naphthalene base on northeast GW flow direction and area depicted in Figure 2.5.29 (75 feet ~ 22.9 m, Zone H RFI Addendum)
Sw for all other constituents is based on northeast GW flow direction and area depicted in Figure 2.5.24 (90 feet ~ 27.4 m, Zone H RFI Addendum)
* - chemicals were detected in subsurface soil, but not in site groundwater
@ - A generic SSL was not available for 1,3-dichlorobenzene, therefore, SSL for 1,4-dichlorobeneze was used
** - SSL for PCBs is calculated using an MCL = 0.0005 mg/L, Koc =309000, and H'=0.017
SSL, Kd, Koc, H', and default values for additional parameters from USEPA's *Soil Screening Guidance: User's Guide, EPA/540/R-96/018, April 1998.*
USGS, 1999- *Hydrogeology and Simulation of Ground-water flow in the surficila aquifer system in the area of Charleston Naval Base, North Charleston, South Carolina,* 1995-97, by Bruce G. Campbell and Ted R. Campbell. United States Geologicla Survey, Adminstrative Report, Columbia, SC.

Appendix C2. Soil Screening Levels (SSLs) Calculated for Future Hypothetical Unrestricted Land Use (Residential)[@@] at SWMU 17

Site(s)	Hydraulic Conductivity K (m/yr)	Hydraulic Gradient I (m/m)	Aquifer Thickness da (m)	Source Length Sw (m)	Infiltration Rate I' (m/yr)	Mixing Zone d (m)	DAF	Generic SSLs DAF 1	Generic SSLs DAF 20	Site Specific SSLs (Calculated from Site-Specific DAF)
Aroclor-1260**	445.008	0.01	11.15	27.4	0.03048	3.1	17.4	0.9	18	15.7
Benzene	445.008	0.01	11.15	22.9	0.03048	2.6	17.4	0.002	0.03	0.026
Benzo(a)anthracene*	445.008	0.01	11.15	22.9	0.03048	2.6	17.4	0.08	2	1.74
Benzo(a)pyrene*	445.008	0.01	11.15	22.9	0.03048	2.6	17.4	0.4	8	6.98
Benzo(b)fluoranthene*	445.008	0.01	11.15	22.9	0.03048	2.6	17.4	0.2	5	4.35
Chlorobenzene	445.008	0.01	11.15	27.4	0.03048	3.1	17.4	0.07	1	0.87
Ethylbenzene	445.008	0.01	11.15	22.9	0.03048	2.6	17.4	0.7	13	11.35
1,2-dichlorobenzene	445.008	0.01	11.15	27.4	0.03048	3.1	17.4	0.9	17	14.83
1,3-dichlorobenzene[@]	445.008	0.01	11.15	27.4	0.03048	3.1	17.4	0.1	2	1.74
1,4-dichlorobenzene	445.008	0.01	11.15	27.4	0.03048	3.1	17.4	0.1	2	1.74
1,2-dichloroethene	445.008	0.01	11.15	27.4	0.03048	3.1	17.4	0.02	0.4	0.35
Hexachlorobenzene*	445.008	0.01	11.15	27.4	0.03048	3.1	17.4	0.1	2	1.74
Naphthalene	445.008	0.01	11.15	22.9	0.03048	2.6	17.4	4	84	73.24
Styrene*	445.008	0.01	11.15	27.4	0.03048	3.1	17.4	0.2	4	3.49
1,2,4-trichlorobenzene	445.008	0.01	11.15	27.4	0.03048	3.1	17.4	0.3	5	4.37
1,1,2,2-tetrachloroethane	445.008	0.01	11.15	27.4	0.03048	3.1	17.4	0.0002	0.003	0.003

Footnote:

K is based on the USGS survey (USGS, 1999)

I is based on groundwater elevation differences and distance (47') between 017B04 (6.36') and 017D03 (5.89') (Figure 2.5.7A, Zone H RFI Addendum

da is based on general depth to water down to the top of ashley formation within Zone H (Zone H RFI)

I' is based on no pavement (future land development removing buildings and pavements).

Sw for benzene, ethylbenzene, and naphthalene base on northeast GW flow direction and area depicted in Figure 2.5.29 (75 feet ~ 22.9 m, Zone H RFI Addendum)

Sw for all other constituents is based on northeast GW flow direction and area depicted in Figure 2.5.24 (90 feet ~ 27.4 m, Zone H RFI Addendum)

@ - A generic SSL was not available for 1,3-dichlorobenzene, therefore, SSL for 1,4-dichlorobeneze was used

@@ - Future land use assumes no pavement or buildings or other structures are present over the contaminted subsurface soil

* - chemicals were detected in subsurface soil, but not in site groundwater

** - SSL for PCBs is calculated using an MCL = 0.0005 mg/L, Koc =309000, and H'=0.017

SSL, Kd, Koc, H', and default values for additional parameters from USEPA's *Soil Screening Guidance: User's Guide, EPA/540/R-96/018, April 1998.*

USGS, 1999- *Hydrogeology and Simulation of Ground-water flow in the surficila aquifer system in the area of Charleston Naval Base, North Charleston, South Carolina* 1995-97, by Bruce G. Campbell and Ted R. Campbell. United States Geologicla Survey, Adminstrative Report, Columbia, SC.

APPENDIX D

Johnson and Ettinger Model Parameters and Simulation Output

DATA E SHEET

VERSION 1.2
September, 1998

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
71432	2000	Benzene

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
23	30	225	0	225	0	0	SL		

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.3	0.0065	0	0	0	0	0	0	0	0

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
90	40	2760	1710	609	0.1	1

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

RESUL SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
1.79E+02	NA	1.79E+02	1.05E+06	1.79E+02

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

DATA [illegible] SHEET

VERSION 1.2
September, 1998

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
156592	265	cis-1,2-Dichloroethylene

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_0 (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
				Totals must add up to value of L_t (cell D28)					
23	30	225	0	225	0	0	SL		

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.3	0.0065	0	0	0	0	0	0	0	0

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
90	40	2760	1710	609	0.1	1

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	250	1.0E-06	1
				Used to calculate risk-based soil concentration.	

RESUL . SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	2.45E+04	2.45E+04	1.55E+06	2.45E+04

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

DATA SHEET

VERSION 1.2
September, 1998

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [x]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
108907	159000	Chlorobenzene

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
23	30	225	0	225	0	0	SL		

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.3	0.0065	0	0	0	0	0	0	0	0

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
90	40	2760	1710	609	0.1	1

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

RESULT SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	5.82E+04	5.82E+04	7.72E+05	5.82E+04

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

DATA SHEET

VERSION 1.2
September, 1998

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
95501	1600	1,2-Dichlorobenzene

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
				Totals must add up to value of L_t (cell D28)					
23	30	225	0	225	0	0	SL		

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.3	0.0065	0	0	0	0	0	0	0	0

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
90	40	2760	1710	609	0.1	1

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	250	1.0E-06	1
				Used to calculate risk-based soil concentration.	

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	3.06E+06	3.06E+06	6.58E+05	6.58E+05

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

DATA [illegible] SHEET

VERSION 1.2
September, 1998

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
106467	11000	1,4-Dichlorobenzene

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
				Totals must add up to value of L_t (cell D28)					
23	30	225	0	225	0	0	SL		

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.3	0.0065	0	0	0	0	0	0	0	0

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
90	40	2760	1710	609	0.1	1

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	9.56E+06	9.56E+06	3.11E+05	3.11E+05

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

DATA SHEET

VERSION 1.2
September, 1998

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES	X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES	

ENTER Chemical CAS No. (numbers only, no dashes)	**ENTER** Initial soil conc., C_R (μg/kg)	Chemical
120821	93000	1,2,4-Trichlorobenzene

ENTER Average soil temperature, T_S (°C)	**ENTER** Depth below grade to bottom of enclosed space floor, L_F (cm)	**ENTER** Depth below grade to top of contamination, L_t (cm)	**ENTER** Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	**ENTER** Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	**ENTER** Thickness of soil stratum B, (Enter value or 0) h_B (cm)	**ENTER** Thickness of soil stratum C, (Enter value or 0) h_C (cm)	**ENTER** Soil stratum A SCS soil type (used to estimate soil vapor permeability)		**ENTER** User-defined stratum A soil vapor permeability, k_v (cm²)
23	30	225	0	225	0	0	SL	OR	

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	**ENTER** Stratum A soil total porosity, n^A (unitless)	**ENTER** Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	**ENTER** Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	**ENTER** Stratum B soil dry bulk density, ρ_b^B (g/cm³)	**ENTER** Stratum B soil total porosity, n^B (unitless)	**ENTER** Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	**ENTER** Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	**ENTER** Stratum C soil dry bulk density, ρ_b^C (g/cm³)	**ENTER** Stratum C soil total porosity, n^C (unitless)	**ENTER** Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	**ENTER** Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.3	0.0065	0	0	0	0	0	0	0	0

ENTER Enclosed space floor thickness, L_{crack} (cm)	**ENTER** Soil-bldg. pressure differential, ΔP (g/cm-s²)	**ENTER** Enclosed space floor length, L_B (cm)	**ENTER** Enclosed space floor width, W_B (cm)	**ENTER** Enclosed space height, H_B (cm)	**ENTER** Floor-wall seam crack width, w (cm)	**ENTER** Indoor air exchange rate, ER (1/h)
90	40	2760	1710	609	0.1	1

ENTER Averaging time for carcinogens, AT_C (yrs)	**ENTER** Averaging time for noncarcinogens, AT_{NC} (yrs)	**ENTER** Exposure duration, ED (yrs)	**ENTER** Exposure frequency, EF (days/yr)	**ENTER** Target risk for carcinogens, TR (unitless)	**ENTER** Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

RESUL. _ SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	1.90E+07	1.90E+07	3.53E+06	3.53E+06

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

DATA ENTRY SHEET

VERSION 1.2
September, 1998

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
100414	3600	Ethylbenzene

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell D28): Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
23	30	225	0	225	0	0	SL		

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.3	0.0065	0	0	0	0	0	0	0	0

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
90	40	2760	1710	609	0.1	1

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (μg/kg)	Indoor exposure soil conc., noncarcinogen (μg/kg)	Risk-based indoor exposure soil conc., (μg/kg)	Soil saturation conc., C_{sat} (μg/kg)	Final indoor exposure soil conc., (μg/kg)
NA	2.15E+06	2.15E+06	4.37E+05	4.37E+05

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	2.15E+06	2.15E+06	4.37E+05	4.37E+05

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

DATA SHEET

VERSION 1.2
September, 1998

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [X]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	**ENTER** Initial soil conc., C_R (μg/kg)	Chemical
100425	590	Styrene

ENTER Average soil temperature, T_S (°C)	**ENTER** Depth below grade to bottom of enclosed space floor, L_F (cm)	**ENTER** Depth below grade to top of contamination, L_t (cm)	**ENTER** Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	**ENTER** Totals must add up to value of L_t (cell D28) Thickness of soil stratum A, h_A (cm)	**ENTER** Thickness of soil stratum B, (Enter value or 0) h_B (cm)	**ENTER** Thickness of soil stratum C, (Enter value or 0) h_C (cm)	**ENTER** Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	**ENTER** User-defined stratum A soil vapor permeability, k_v (cm²)
23	30	225	0	225	0	0	SL		

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	**ENTER** Stratum A soil total porosity, n^A (unitless)	**ENTER** Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	**ENTER** Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	**ENTER** Stratum B soil dry bulk density, ρ_b^B (g/cm³)	**ENTER** Stratum B soil total porosity, n^B (unitless)	**ENTER** Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	**ENTER** Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	**ENTER** Stratum C soil dry bulk density, ρ_b^C (g/cm³)	**ENTER** Stratum C soil total porosity, n^C (unitless)	**ENTER** Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	**ENTER** Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.3	0.0065	0	0	0	0	0	0	0	0

ENTER Enclosed space floor thickness, L_{crack} (cm)	**ENTER** Soil-bldg. pressure differential, ΔP (g/cm-s²)	**ENTER** Enclosed space floor length, L_B (cm)	**ENTER** Enclosed space floor width, W_B (cm)	**ENTER** Enclosed space height, H_B (cm)	**ENTER** Floor-wall seam crack width, w (cm)	**ENTER** Indoor air exchange rate, ER (1/h)
90	40	2760	1710	609	0.1	1

ENTER Averaging time for carcinogens, AT_C (yrs)	**ENTER** Averaging time for noncarcinogens, AT_{NC} (yrs)	**ENTER** Exposure duration, ED (yrs)	**ENTER** Exposure frequency, EF (days/yr)	**ENTER** Target risk for carcinogens, TR (unitless)	**ENTER** Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	1.28E+07	1.28E+07	1.63E+06	1.63E+06

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

DATA ENTRY SHEET

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CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
79345	3800	1,1,2,2-Tetrachloroethane

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_o (cm)	ENTER Totals must add up to value of L_t (cell D28): Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
23	30	225	0	225	0	0	SL		

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.3	0.0065	0	0	0	0	0	0	0	0

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
90	40	2760	1710	609	0.1	1

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

RESU. SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
5.99E+02	NA	5.99E+02	2.40E+06	5.99E+02

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

DATA SHEET

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CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [x]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [ ]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
127184	1000	Tetrachloroethylene

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
				Totals must add up to value of L_t (cell D28)					
23	30	225	0	225	0	0	SL		

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.3	0.0065	0	0	0	0	0	0	0	0

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
90	40	2760	1710	609	0.1	1

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	250	1.0E-06	1
				Used to calculate risk-based soil concentration.	

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

INCREMENTAL RISK CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
1.85E+03	NA	1.85E+03	2.53E+05	1.85E+03

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

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CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES: X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES:

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
108883	3200	Toluene

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
23	30	225	0	225	0	0	SL		

Totals must add up to value of L_t (cell D28) (applies to h_A, h_B, h_C)

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.3	0.0065	0	0	0	0	0	0	0	0

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
90	40	2760	1710	609	0.1	1

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

RESULTS SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (μg/kg)	Indoor exposure soil conc., noncarcinogen (μg/kg)	Risk-based indoor exposure soil conc., (μg/kg)	Soil saturation conc., C_{sat} (μg/kg)	Final indoor exposure soil conc., (μg/kg)
NA	5.09E+05	5.09E+05	7.39E+05	5.09E+05

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

DATA SHEET

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CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES | X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES |

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (μg/kg)	Chemical
106423	18500	p-Xylene

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_o (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
				Totals must add up to value of L_t (cell D28)					
23	30	225	0	225	0	0	SL		

ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
1.5	0.43	0.3	0.0065	0	0	0	0	0	0	0	0

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)
90	40	2760	1710	609	0.1	1

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

RESUL. . SHEET

RISK-BASED SOIL CONCENTRATION CALCULATIONS:

Indoor exposure soil conc., carcinogen (µg/kg)	Indoor exposure soil conc., noncarcinogen (µg/kg)	Risk-based indoor exposure soil conc., (µg/kg)	Soil saturation conc., C_{sat} (µg/kg)	Final indoor exposure soil conc., (µg/kg)
NA	1.72E+07	1.72E+07	5.09E+05	5.09E+05

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA

ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

Appendix D1: SWMU 17 Subsurface Soil COC - Evalution of Potential for Air Emission from Subsurface Soil VOCs

	Concentration		RBC(SSL-Air) - Residential		RBC(SSL-Air) - Industrial		SSL-Air	
	Maximum	Average	Virginia	Connecticut	Virginia	Connecticut	(J-E Model, Tier 2)[c]	Industrial -Air
COC	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	COC?
Benzene	7.2	2	0.66	1	1.1	113	0.18	**Yes**
Chlorobenzene	790	159	10	31	14	106	58.2	**Yes**
1,2-Dichloroethene (total)	0.270	0.265	NA	15**	NA	22[a]	24.5	No
1,2-Dichlorobenzene	1.8	1.6	240	240	330	818	658	No
1,3 Dichlorobenzene	22	10	NA	240	NA	818	NA	No
1,4 Dichlorobenzene	40	11	840	950	1200	3270	311	No
1,2,4-Trichlorobenzene	410	93	700	NA	980	NA	3532	No
Ethylbenzene	5.3	3.6	440	1650	610	5672	437	No
Styrene	0.59	0.59	1100	8	1500	28	1628	No
1,1,2,2-Tetrachloroethane	3.8	NA	0.46	1	0.77	1	0.6	No[b]
Tetrachloroethene	1	NA	8.3	11	14	27	1.85	No
Toluene	5.5	3.2	130	760	180	2615	509	No
Xylene (total)	21	18.5	NA	500	NA	1702	509	No

[a] - 1122-TCA was detected in only one sample.

[b] - value is from Michigan Department of Environmental Quality (MI-DEQ) Part 201, June, 2000- for cis- and trans-DCE

[c] - Johnson-Ettinger model is from EPA website, and assumptions used are listed in Tbale 2-3b.

Virginia - *Virginia Voluntary Remediation Regulations,(9VAC 20-160-0)*

Connecticut - State of Connecticut Department of Environmental Protection guidance tables (Appendix E to Sections 22a-133k-1 through 22a-133k, of Regulation of Connecticut State Agencies Volatilization Criteria for Groundwater).

Appendix D2: SWMU 17 J-E[a] Tier 2 model site-sepcific input assumptions for Indoor air protective soil levels		
Assumptions/Input Factorss:	**Value**	**Basis**
Subsurface soil concentration =	average	Table 2-3
Avg GW temp =	23^{0} C	Site-specific Measured by Ensafe
Soil Type =	Sandy loam	Site-specific from Soil Boring Logs (Fs)
Depth to GW (cm) =	165	Site-Specific, 5.5 ft
Slab thickness (cm) =	90	Estimate, 3 ft
Slab below grade (cm) =	60	Estimate, 2 ft
Soil water filled porosity (cm^3/cm^3) =	0.3	Default value in J-E
Exposure Duration (years) =	25	Site-Specific
Enclosed space floor length, Lb (cm) =	2790	Annex, Building FBM 61
Enclosed space floor width, Wp (cm) =	1710	Annex, Building FBM 61
Enclosed space height, Hb (cm) =	540	Annex, Building FBM 61
Floor-wall seam crack width, w (cm) =	0.1	Default value in J-E
Indoor air exchange rate, ER (1/h) =	1	Site-specific, Open entrance w/ high ventilation in Annex area

Note:

a =Johnson-Ettinger Model is from EPA website at http://www.epa.gov/superfund/programs/risk/airmodel/johnson_ettinger.htm