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CORRECTIVE MEASURES STUDY REPORT SOLID WASTE MANAGEMENT UNITS 21 AND 54 ZONE E CNC CHARLESTON SC

11/26/2003

CH2M HILL

CORRECTIVE MEASURES STUDY REPORT

SWMUs 21 and 54, Zone E

Charleston Naval Complex
North Charleston, South Carolina

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

CH2M-Jones

November 2003

Contract N62467-99-C-0960

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November 28, 2003

Mr. David Scaturo
South Carolina Department of Health and
Environmental Control
Bureau of Land and Waste Management
2600 Bull Street
Columbia, SC 29201

Re: CMS Report (Revision 0) – SWMUs 21 and 54, Zone E

Dear Mr. Scaturo:

Enclosed please find two copies of the CMS Report (Revision 0) for SWMUs 21 and 54 in Zone E 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 at 352/335-5877, ext. 2280, if you have any questions or comments.

Sincerely,

CH2M HILL

Dean Williamson, P.E.

cc: Dann Spariosu/USEPA, w/att
Rob Harrell/Navy, w/att
Gary Foster/CH2M HILL, w/att

CORRECTIVE MEASURES STUDY REPORT

SWMUs 21 and 54, Zone E

Charleston Naval Complex
North Charleston, South Carolina

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

PREPARED BY
CH2M-Jones

November 2003

Revision 0
Contract N62467-99-C-0960
158814.ZE.EX.25

Certification Page for Corrective Measures Study Report (Revision 0) — SWMUs 21 and 54, Zone E

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

P.E. No. 21428

Dean Williamson, P.E.

11/26/2003

Date

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Acronyms and Abbreviations

BEQ	benzo(a)pyrene equivalent
BRAC	Base Realignment and Closure Act
CA	corrective action
CMS	corrective measures study
CNC	Charleston Naval Complex
COC	chemical of concern
COPC	chemical of potential concern
CSI	confirmatory sampling investigation
CVOC	chlorinated volatile organic compound
DET	Environmental Detachment Charleston
DO	dissolved oxygen
EnSafe	EnSafe Inc.
EPA	U.S. Environmental Protection Agency
ft bls	feet below land surface
ft msl	feet above mean sea level
HI	hazard index
ILCR	Incremental Lifetime Cancer Risk
IM	interim measure
µg/L	microgram per liter
LUC	land use control
LUCMP	land use control management plan
MCL	maximum contaminant level
MCS	media cleanup standard
mg/kg	milligram per kilogram
NAVBASE	Naval Base
ORP	oxidation reduction potential
OSWER	Office of Solid Waste and Emergency Response

Acronyms and Abbreviations, Continued

OWS	oil/water separator
PAH	polycyclic aromatic hydrocarbon
RAO	remedial action objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RI	remedial investigation
RGO	remedial goal option
SCDHEC	South Carolina Department of Health and Environmental Control
SSL	soil screening level
SWMU	solid waste management unit

Section 1.0

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 (BRAC), 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.

Corrective Action (CA) activities are being conducted under the Resource Conservation and Recovery Act (RCRA), with the South Carolina Department of Health and Environmental Control (SCDHEC) as the lead agency for CA activities at the CNC. 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 the CNC.

A RCRA Facility Investigation (RFI) Report Addendum and Corrective Measures Study (CMS) Work Plan were prepared for Solid Waste Management Units (SWMUs) 21 and 54 in Zone E of CNC (CH2M-Jones, 2003). SWMUs 21 and 54 are located in the industrial area of Zone E between Roe Avenue and Cooper River. These sites were combined into one investigation area due to their close proximity and their potential for similar chemicals of potential concern (COPCs). Figure 1-1 illustrates the locations of the sites within the CNC. Figure 1-2 is an aerial photograph of the area.

The RFI Report Addendum and CMS Work Plan presented the remedial action objectives (RAOs) and media cleanup standards (MCSs) proposed for SWMUs 21 and 54, and the RFI Report Addendum and CMS Work Plan report was approved by SCDHEC in July 2003. This CMS report has been prepared by CH2M-Jones to complete the next stage of the CA process for SWMUs 21 and 54.

1.1 Corrective Measures Study Report Purpose and Scope

This CMS report evaluates corrective measure alternatives for polycyclic aromatic hydrocarbons (PAHs), antimony, and lead in subsurface soil and antimony, lead, thallium, and nickel in groundwater at SWMUs 21 and 54. The report consists of: 1) the identification of a set of corrective measure alternatives that are considered to be technically appropriate for addressing chlorinated volatile organic compound (CVOC)-contaminated groundwater;

2) an evaluation of the alternatives using standard criteria from U.S. Environmental Protection Agency (EPA) RCRA guidance; and 3) the selection of a recommended (preferred) corrective measure alternative for the site.

1.2 Background Information

This section of the CMS report presents background information on the facility, site history, and a summary of the nature and extent of the chemicals of concern (COCs) at the site. This information is essential to the understanding of the remedial goal options (RGOs), MCSs, and ultimately the evaluation of corrective measure alternatives for SWMUs 21 and 54. Additional information on the site and hydrogeology in the Zone E area of the CNC is provided in the *Zone E RFI Report, Revision 0* (EnSafe Inc. [EnSafe], 1997).

1.2.1 Facility Description and Site History

SWMU 21, the Old Paint Storage Area, consists of a 20-foot by 180-foot concrete pad constructed in 1942 for welding operations. Beginning in 1973, the slab was used for storage of containerized paint wastes from ship repair and overhaul operations.

SWMU 54, the Former Abrasive Blasting Area, consists of the unpaved area around SWMU 21. The site was used for abrasive blasting of ship components and hull sections. Ship components, including anchor chains, were also painted in this area. SWMU 21 is located completely within the boundary of SWMU 54.

SWMUs 21 and 54 are recommended for an RFI in the current RCRA permit. The area where combined SWMUs 21 and 54 are located is zoned M-2, for heavy marine industrial use. The site is expected to be used for industrial (non-residential) purposes for the foreseeable future. Currently the site is not used for active operations.

The RFI activities initially conducted by the Navy/EnSafe team were described in the Zone E RFI Report, Revision 0 (EnSafe, 1997). Regulatory review was conducted on this document and draft responses to the comments from SCDHEC were prepared by the Navy/EnSafe team. Remaining issues related to the RFI phase of the CA program were addressed in the RFI Report Addendum (CH2M-Jones, 2003). RFI soil and groundwater sampling locations are shown in Figures 1-3 and 1-4, respectively.

1.2.2 COC Summary

Based on the results of the sampling and analysis and evaluation of current contamination levels in the RFI Report Addendum, benzo(a)pyrene equivalents (BEQs), antimony, and

lead were identified as subsurface soil COCs for SWMUs 21 and 54. Antimony and lead were identified due to potential leaching concerns. BEQs were identified due the presence of a few subsurface soil samples with BEQ concentrations above the subsurface soil sitewide reference concentration of 1,400 micrograms per liter ($\mu g/L$).

No surface soil COCs were identified for the industrial land use scenario.

Antimony, lead, nickel, and thallium were identified as groundwater COCs, due to exceedances of either EPA drinking water maximum contaminant levels (MCLs) (antimony, lead, and thallium) or EPA Region III tap water risk-based concentrations (RBCs) at a Hazard Index (HI) = 0.1 (nickel).

1.3 Summary of Subsurface Soil Condition

Subsurface soil locations at which COCs exceed the COPC screening criteria are generally limited in number at SWMUs 21 and 54. Only the two metal COCs (lead and antimony) pose a potential concern for contaminant migration through the soil to groundwater leaching pathway. Figure 1-5 shows the locations of the lead and antimony exceedances of the site-specific SSLs as determined during the RFI. These exceedances occur generally around the periphery of the site and do not appear to represent a large source area in the subsurface soil. Much of the subsurface soil was previously excavated from the site during the interim measures (IMs) conducted by the Environmental Detachment Charleston (DET) and CH2M-Jones. Table 1-1 summarizes the analytical results for the subsurface soil COCs at SWMUs 21 and 54. It can be seen from this table that concentrations of the COCs in most of the subsurface soil samples at the site were well below the COPC screening criteria.

PAH exceedances in the subsurface soil do not represent an exposure or leaching risk; PAHs were retained as COCs because they exceed the CNC sitewide reference concentration. For this reason, land use controls (LUCs) will be used as the appropriate corrective measure for PAHs in subsurface soil. Corrective measures for subsurface soil will focus on addressing antimony and lead.

1.4 Summary of Groundwater Conditions

1.4.1 Summary of Hydrogeologic Setting at SWMUs 21 and 54

SWMUs 21 and 54 are located in the northeastern corner of Zone E at the CNC, where the surface topography is relatively flat and slopes gently towards the Cooper River. Elevations

range between approximately 8 to 10 feet above mean sea level (ft msl) to approximately 4 to 6 ft msl near the Cooper River waterfront. Surface water runoff in this area flows across SWMUs 21 and 54 and discharges via sheet flow into the Cooper River.

Surface Geology

Due to the extensive surface soil disturbance at CNC during the history of its operations, the soils from land surface to depths of up to approximately 6 feet are typically a mixture of artificial fill and native sediments. The extent of fill material present varies extensively, but in the vicinity of SWMUs 21 and 54, undifferentiated clay, sand, gravel, dredged material, and construction debris may be present at or near the land surface. In undisturbed areas, surface deposits consist of Quaternary age (Holocene epoch to recent) fine-grained sands and clays typical of a coastal plain environment, repeatedly reworked by marine and river water erosion prior to development by man.

Subsurface Geology

The Zone E RFI report included the installation of soil borings and more than 185 monitoring wells, from which geologic information was collected to develop geologic cross sections. The data indicate that Quaternary (Pleistocene to Holocene) and Tertiary age unconsolidated sediments were encountered in the subsurface. The lowermost unit encountered is the Tertiary age Ashley Formation member of the Mid-Tertiary age Cooper Group. Overlying the Ashley Formation are younger upper Tertiary and Quaternary age deposits, which are in turn overlain by the Holocene to recent surface soils.

In most of Zone E, the Ashley Formation is encountered in deeper borings, occurring at depths of approximately 16 to 43 feet below land surface (ft bls). However, in northern Zone E, including the area where SWMUs 21 and 54 are located, the Ashley Formation dips downward and was not encountered to depths of 75 ft bls during installation of deep borings as part of the RFI. The deeper occurrence of the Ashley Formation in this part of the CNC is probably due to secondary erosion. In the remainder of Zone E, the top of the Ashley Formation is gently rolling and slopes gently downward to the east toward the Cooper River, with measured thickness approaching 40 feet. The Ashley Formation is comprised of brown to olive marine silts with varying amounts of clay, phosphatic sand and

microfossils. The Ashley Formation's consistency is generally dense to stiff and plastic, with low vertical permeability. The overlying Quaternary age deposits are back barrier and near shore shelf deposits from various past marine transgressions, with subsequent reworking erosion and redeposition. The result is a sequence approximately 15 to 85 feet thick at the CNC and comprised mainly of Pleistocene age Wando Formation sands, silts, and clays, with varying amounts of organic matter, including peat.

In the area where SWMUs 21 and 54 are located, the bottom of the shallow aquifer system is delineated by Quaternary clay at a depth of approximately -37 to -46 ft msl, or approximately 45 to 50 ft bls. The Quaternary clay at SWMUs 21 and 54 is overlain by interbedded sand, silt and clay layers (including marsh clay), with limited layers of peat occurring intermittently, and finally by about 5 feet of fill to land surface.

Hydrogeology

The shallow aquifer system at SWMUs 12 and 54 is an unconfined water table aquifer occurring within the Quaternary sediments. The underlying low-permeability Quaternary clay acts as an aquitard for the shallow aquifer system and as a confining unit for deeper geologic units. The Cooper River acts as a regional discharge boundary for the aquifer to the east. The average saturated aquifer thickness in the SWMU 21 and 54 area, based on the Zone E RFI Report, is approximately 45 feet.

The groundwater COCs at SWMUs 21 and 54 occur within the shallow aquifer at depths ranging from approximately 10 to 15 ft bls.

Regionally in Zone E, the shallow groundwater flow direction is eastward, toward the Cooper River. Because a significant portion of Zone E is along the riverfront, the Cooper River is a major discharge boundary for the shallow aquifer system. Locally at SWMUs 21 and 54, groundwater flow is generally eastward, toward the Cooper River, as indicated in potentiometric surface map in Figure 1-6. Section 2.2 of the *Zone E RFI Report, Revision 0* (EnSafe, 1997) indicates that moderate tidal influence on groundwater elevations has been observed at SWMUs 21 and 54.

1.4.2 COC Distribution in Groundwater

Table 1-2 summarizes all groundwater analyses at the site for the four metal COCs. It can be seen in the table that out of 80 total analyses for the COCs, only 9 exceedances of the applicable screening criteria (MCL or Region III tap water RBC) have been observed. These results indicate that the groundwater impacts at the site are relatively minor.

Table 1-2 shows that no exceedances of the Region III tap water RBC (at HI = 1.0) for nickel have been observed at the site. Nickel was retained as a COC only because of a single exceedance of the Region III tap water RBC at an HI = 0.1. No drinking water MCL exists for nickel. Because no detections of the RBC at an HI = 1 have been observed at the site, nickel concentrations in groundwater do not present an unacceptable risk and nickel should not be retained as a COC.

Figure 1-7 shows groundwater COC concentrations detected in monitoring wells at SWMUs 21 and 54. Of the four wells in which metal exceedances of the MCL have been observed, three wells (E021GW002, E021GW003, and E021GW01R) have had only a single exceedance of the MCL. For wells E021GW002 and E021GW003, the single exceedance occurred in 1996; no exceedances have been observed in either of these wells since that time. In E021GW01R (a replacement well for E021GW01), the single exceedance of thallium occurred during the first time this well was sampled in September 2002, but not during subsequent sampling in October 2002. These limited and sporadic exceedances suggest that factors such as turbidity may have been responsible for these elevated values. Overall, the data indicate that groundwater quality in the vicinity of wells E021GW002, E021GW003, and E021GW01R has had generally little, if any, impacts.

The remaining exceedances of metals in groundwater were measured in Well E054GW002. Elevated thallium occurred during only two sampling events in 1996. However, antimony exceedances have been intermittently observed during three sampling events between 1996 and 2002. Lead was also detected at an elevated concentration during the September 2002 sampling event.

1.5 Overall Approach for Selecting Candidate Corrective Measure Alternatives for SWMUs 21 and 54

Because of the relatively small areal extent of impacted media at SWMUs 21 and 54 and the relatively low levels and sporadic detections of contamination in groundwater, the list of practicable remedial alternatives for this site is limited.

Two remedies will be considered for the subsurface soil and groundwater COCs in the CMS for SWMUs 21 and 54:

- Soil Excavation, Long-term Groundwater Monitoring, and LUCs, and
- Long-term Groundwater Monitoring and LUCs.

1.6 Report Organization

This CMS report consists of the following sections, including this introductory section:

1.0 Introduction — Presents the purpose of and background information relating to this CMS report.

2.0 Remedial Goal Objectives and Evaluation Criteria— Defines the RGOs for SWMUs 21 and 54, in addition to the criteria used in evaluating the corrective measure alternatives for the site.

3.0 Description of Candidate Corrective Measure Alternatives — Describes each of the candidate corrective measure alternatives for addressing CVOCs in groundwater and the LUCs.

4.0 Evaluation and Comparison of Corrective Measure Alternatives — Evaluates each alternative relative to standard criteria, then compares the alternatives and the degree to which they meet or achieve the evaluation criteria.

5.0 Recommended Corrective Measure Alternative — Describes the preferred corrective measure alternative to achieve the MCS and RGOs for CVOCs in groundwater based on a comparison of the alternatives.

6.0 References — Lists the references used in this document.

Appendix A contains cost estimates developed for the proposed corrective measure alternatives.

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

TABLE 1-1
COC Concentrations in Subsurface Soil Samples
CMS Report, SWMUs 21 and 54, Zone E, Charleston Naval Complex

Chemical	Station ID	Sample ID	Date Collected	Concentration	Qualifier	Notes	SSL [a] (DAF=10)	Range of Background Concentrations [b]
Metals (mg/kg)								
Antimony	E054SB003	054SB00302	11/08/95	**138**	=	Mean [antimony] = 22.8	6.6	0.52 - 1.6
	E054SB002	054SB00202	11/09/95	4	J			
	E054SB001	054SB00102	11/09/95	4.8	J			
	E054SB013	054SB01302	11/21/95	2.9	J			
	E054SB014	054SB01402	11/21/95	2.5	J			
	E054SB011	054SB01102	11/21/95	0.82	J			
	E054SB012	054SB01202	11/21/95	0.46	U			
	E054SB010	054SB01002	11/21/95	0.45	U			
	E054SB009	054SB00902	11/21/95	0.46	U			
	E054SB017	054SB01702	11/27/95	0.54	J			
	E054SB018	054SB01802	11/27/95	0.46	J			
	E054SB015	054SB01502	11/27/95	1.2	J			
	E054SB016	054SB01602	11/27/95	4.2	J			
	E054SB021	054SB02102	11/27/95	0.51	U			
	E054SB022	054SB02202	11/27/95	0.49	J			
	E054SB019	054SB01902	11/27/95	1.4	J			
	E054SB020	054SB02002	11/27/95	0.83	J			
	E054SB023	054SB02302	11/27/95	2	J			
	E054SB032	054SB03202	11/27/95	6.4	J			
	E054SB026	054SB02602	11/28/95	0.53	UJ			
	E054SB024	054SB02402	11/28/95	0.44	UJ			
	E054SB025	054SB02502	11/28/95	0.47	UJ			
	E054SB029	054SB02902	11/28/95	0.65	J			
	E054SB030	054SB03002	11/28/95	**27.4**	J			

TABLE 1-1
COC Concentrations in Subsurface Soil Samples
CMS Report, SWMUs 21 and 54, Zone E, Charleston Naval Complex

Chemical	Station ID	Sample ID	Date Collected	Concentration	Qualifier	Notes	SSL [a] (DAF=10)	Range of Background Concentrations[b]
	E054SB028	054SB02802	11/28/95	0.5	UJ			
Antimony	E054SB027	054SB02702	11/28/95	**11.3**	J	Mean [antimony] = 22.8	6.6	0.52 - 1.6
	E054SB031	054SB03102	11/28/95	**28.3**	J			
	E054SB033	054SB03302	11/30/95	2.9	J			
	E054SB040	054SB04002	11/30/95	0.63	J			
	E054SB035	054SB03502	11/30/95	**21.1**	J			
	E054SB049	054SB04902	09/16/02	0.837	J			
	E054SB051	054SB05102	09/16/02	0.547	UJ			
	E054SB050	054SB05002	09/16/02	0.579	UJ			
	E054SB048	054SB04802	09/16/02	**532**	J			
	E054SB052	054SB05202	12/20/02	0.765	UJ			
Lead	E054SB003	054SB00302	11/08/95	**3,430**	=	Mean [lead] = 1,730	616	1.8 - 322
	E054SB002	054SB00202	11/09/95	332	J			
	E054SB001	054SB00102	11/09/95	112	J			
	E054SB005	054SB00502	11/17/95	16.3	J			
	E054SB004	054SB00402	11/17/95	2.6	J			
	E054SB006	054SB00602	11/20/95	28.4	J			
	E054SB008	054SB00802	11/20/95	15.4	J			
	E054SB007	054SB00702	11/20/95	21.7	J			
	E054SB013	054SB01302	11/21/95	349	=			
	E054SB014	054SB01402	11/21/95	165	=			
	E054SB011	054SB01102	11/21/95	80	=			
	E054SB012	054SB01202	11/21/95	20.1	=			
	E054SB010	054SB01002	11/21/95	21.6	=			
	E054SB009	054SB00902	11/21/95	23.9	=			

TABLE 1-1
COC Concentrations in Subsurface Soil Samples
CMS Report, SWMUs 21 and 54, Zone E, Charleston Naval Complex

Chemical	Station ID	Sample ID	Date Collected	Concentration	Qualifier	Notes	SSL [a] (DAF=10)	Range of Background Concentrations[b]
	E054SB017	054SB01702	11/27/95	76.4	J			
	E054SB018	054SB01802	11/27/95	20.6	J			
Lead	E054SB015	054SB01502	11/27/95	66.4	J	Mean [lead] = 1,730	616	1.8 - 322
	E054SB016	054SB01602	11/27/95	161	J			
	E054SB021	054SB02102	11/27/95	4.5	J			
	E054SB022	054SB02202	11/27/95	12.9	J			
	E054SB019	054SB01902	11/27/95	123	J			
	E054SB020	054SB02002	11/27/95	66.2	J			
	E054SB023	054SB02302	11/27/95	85.8	J			
	E054SB032	054SB03202	11/27/95	**1,330**	J			
	E054SB026	054SB02602	11/28/95	12	=			
	E054SB024	054SB02402	11/28/95	14.3	=			
	E054SB025	054SB02502	11/28/95	32.4	=			
	E054SB029	054SB02902	11/28/95	150	=			
	E054SB030	054SB03002	11/28/95	**6,480**	=			
	E054SB028	054SB02802	11/28/95	3.9	=			
	E054SB027	054SB02702	11/28/95	267	=			
	E054SB031	054SB03102	11/28/95	**9,480**	=			
	E054SB033	054SB03302	11/30/95	**1160**	J			
	E054SB040	054SB04002	11/30/95	114	J			
	E054SB035	054SB03502	11/30/95	**32,200**	J			
	E054SB049	054SB04902	09/16/02	365	=			
	E054SB051	054SB05102	09/16/02	8.77	=			
	E054SB050	054SB05002	09/16/02	5.15	=			
	E054SB048	054SB04802	09/16/02	**12,100**	=			

TABLE 1-1
COC Concentrations in Subsurface Soil Samples
CMS Report, SWMUs 21 and 54, Zone E, Charleston Naval Complex

Chemical	Station ID	Sample ID	Date Collected	Concentration	Qualifier	Notes	SSL [a] (DAF=10)	Range of Background Concentrations [b]
	E054SB052	054SB05202	12/20/02	231	=			
Semivolatile Organic Compounds (SVOCs, µg/kg)								
BEQs	E054SB001	054SB00102	11/09/1995	288	=		NA	1,400
	E054SB002	054SB00202	11/09/1995	317	=			
	E054SB003	054SB00302	11/08/1995	1,063	U			
	E054SB004	054SB00402	11/17/1995	1,156	U			
	E054SB005	054SB00502	11/17/1995	1,040	U			
	E054SB006	054SB00602	11/20/1995	1,017	U			
	E054SB007	054SB00702	11/20/1995	1,075	U			
	E054SB008	054SB00802	11/20/1995	1,156	U			
	E054SB009	054SB00902	11/21/1995	439	U			
	E054SB010	054SB01002	11/21/1995	439	U			
	E054SB011	054SB01102	11/21/1995	439	U			
	E054SB012	054SB01202	11/21/1995	439	U			
	E054SB013	054SB01302	11/21/1995	439	U			
	E054SB014	054SB01402	11/21/1995	451	U			
	E054SB015	054SB01502	11/27/1995	890	U			
	E054SB016	054SB01602	11/27/1995	867	U			
	E054SB017	054SB01702	11/27/1995	1,040	=			
	E054SB018	054SB01802	11/27/1995	890	U			
BEQs	E054SB019	054SB01902	11/27/1995	901	U		NA	1,400
	E054SB020	054SB02002	11/27/1995	890	U			
	E054SB021	054SB02102	11/27/1995	971	U			
	E054SB022	054SB02202	11/27/1995	**1,833**	=			

TABLE 1-1
COC Concentrations in Subsurface Soil Samples
CMS Report, SWMUs 21 and 54, Zone E, Charleston Naval Complex

Chemical	Station ID	Sample ID	Date Collected	Concentration	Qualifier	Notes	SSL [a] (DAF=10)	Range of Background Concentrations [b]
	E054SB023	054SB02302	11/27/1995	1,156	U			
	E054SB024	054SB02402	11/28/1995	692	=			
	E054SB025	054SB02502	11/28/1995	924	U			
	E054SB026	054SB02602	11/28/1995	994	U			
	E054SB027	054SB02702	11/28/1995	1,074	=			
	E054SB028	054SB02802	11/28/1995	971	U			
	E054SB029	054SB02902	11/28/1995	684	=			
	E054SB030	054SB03002	11/28/1995	593	=			
	E054SB031	054SB03102	11/28/1995	**475,560**	=	Resampled (054SB05302)		
	E054SB032	054SB03202	11/27/1995	964	=			
	E054SB033	054SB03302	11/30/1995	1,387	U			
	E054SB035	054SB03502	11/30/1995	1,474	=	Resampled (054SB05402)		
	E054SB040	054SB04002	11/30/1995	533	=			
	E054SB052	054SB05202	12/20/02	63.5	J			
	E054SB053	054SB05302	12/20/02	**4,935**	J	Re-sample of 054SB03102		
	E054SB054	054SB05402	12/20/02	22.4	U	Re-sample of 054SB03503		
	E054SB055	054SB05503	12/20/02	**2,164**	J	Intermediate interval (1-2 ft bls) delineation sample		

[a] Listed soil screening levels (SSLs) are either calculated site-specific SSLs or generic SSLs based on a dilution-attenuation factor (DAF) of 10 (1 for VOCs).

[b] Background PAHs Study Report, Technical Information for Development of Background BEQ Values (CH2M-Jones, 2001) or Project Team Notebook and Instructions (CH2M-Jones, 2001) or Background PAHs Study Report (CH2M-Jones, 2001).

U indicates that the compound was not detected. The reported value is the reporting limit.

UJ indicates that the compound was not detected. The reported value is an estimated reporting limit.

J indicates that the compound was detected and the reported value is an estimated concentration.

TABLE 1-1
COC Concentrations in Subsurface Soil Samples
CMS Report, SWMUs 21 and 54, Zone E, Charleston Naval Complex

Chemical	Station ID	Sample ID	Date Collected	Concentration	Qualifier	Notes	SSL [a] (DAF=10)	Range of Background Concentrations [b]

= indicates that the reported value is the measured concentration.

TABLE 1-2
Summary of COC Detections in Groundwater Wells At SWMUs 21 and 54
CMS Report, SWMUs 21 and 54, Zone E, Charleston Naval Complex

Station	Sample	CHEM_NAME	Result	Unit	Qualifier	DATE_COL	Drinking Water MCL	Region III Tap Water RBC
E021GW001	021GW00101	Antimony	4.00000	µg/L	U	04/16/1996	6	NA
E021GW001	021GW00101	Lead	3.00000	µg/L	U	04/16/1996	15	NA
E021GW001	021GW00101	Nickel	1.00000	µg/L	U	04/16/1996	NA	730
E021GW001	021GW00101	Thallium	5.00000	µg/L	U	04/16/1996	2	NA
E021GW001	021GW00102	Antimony	2.10000	µg/L	U	08/08/1996	6	NA
E021GW001	021GW00102	Lead	1.70000	µg/L	U	08/08/1996	15	NA
E021GW001	021GW00102	Nickel	1.90000	µg/L	U	08/08/1996	NA	730
E021GW001	021GW00102	Thallium	4.60000	µg/L	U	08/08/1996	2	NA
E021GW002	021GW00201	Antimony	**10.20000**	µg/L	J	04/16/1996	6	NA
E021GW002	021GW00201	Lead	7.90000	µg/L	=	04/16/1996	15	NA
E021GW002	021GW00201	Nickel	1.40000	µg/L	J	04/16/1996	NA	730
E021GW002	021GW00201	Thallium	5.00000	µg/L	U	04/16/1996	2	NA
E021GW002	021GW00202	Antimony	50.00000	µg/L	U	08/07/1996	6	NA
E021GW002	021GW00202	Lead	13.10000	µg/L	J	08/07/1996	15	NA
E021GW002	021GW00202	Nickel	9.10000	µg/L	J	08/07/1996	NA	730
E021GW002	021GW00202	Thallium	2.70000	µg/L	U	08/07/1996	2	NA
E021GW002	021GW002RM2	Antimony	4.79000	µg/L	U	09/30/2002	6	NA
E021GW002	021GW002RM2	Lead	3.97000	µg/L	U	09/30/2002	15	NA
E021GW002	021GW002RM2	Nickel	2.29000	µg/L	U	09/30/2002	NA	730
E021GW002	021GW002RM2	Thallium	4.99000	µg/L	U	09/30/2002	2	NA
E021GW003	021GW00301	Antimony	4.00000	µg/L	U	04/16/1996	6	NA
E021GW003	021GW00301	Lead	3.00000	µg/L	U	04/16/1996	15	NA
E021GW003	021GW00301	Nickel	1.00000	µg/L	U	04/16/1996	NA	730
E021GW003	021GW00301	Thallium	5.00000	µg/L	U	04/16/1996	2	NA

TABLE 1-2
Summary of COC Detections in Groundwater Wells At SWMUs 21 and 54
CMS Report, SWMUs 21 and 54, Zone E, Charleston Naval Complex

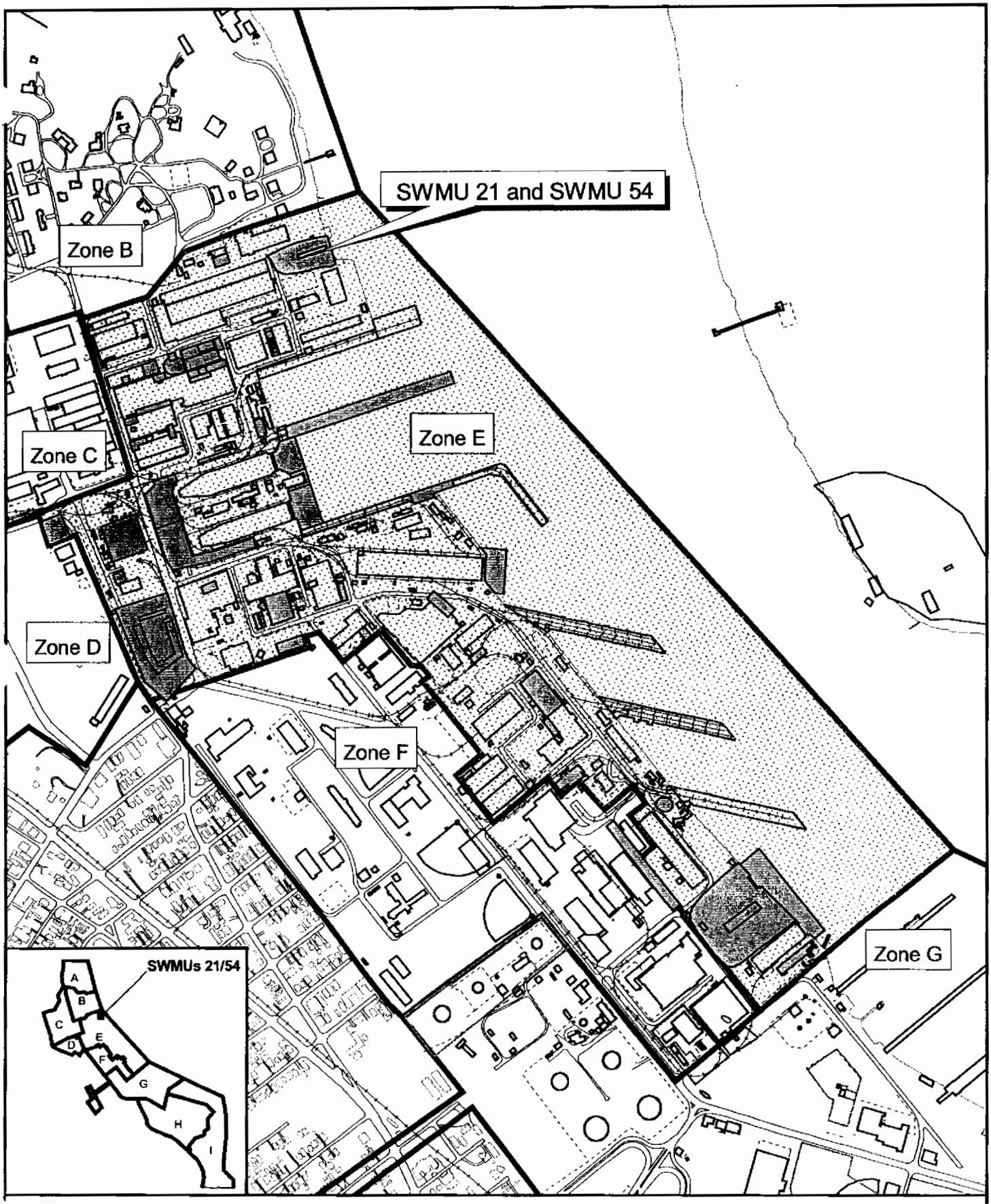
Station	Sample	CHEM_NAME	Result	Unit	Qualifier	DATE_COL	Drinking Water MCL	Region III Tap Water RBC
E021GW003	021GW00302	Antimony	2.40000	µg/L	U	08/07/1996	6	NA
E021GW003	021GW00302	Lead	2.80000	µg/L	J	08/07/1996	15	NA
E021GW003	021GW00302	Nickel	2.80000	µg/L	J	08/07/1996	NA	730
E021GW003	021GW00302	Thallium	2.70000	µg/L	U	08/07/1996	2	NA
E021GW003	021GW00303	Antimony	2.80000	µg/L	U	12/04/1996	6	NA
E021GW003	021GW00303	Lead	1.70000	µg/L	U	12/04/1996	15	NA
E021GW003	021GW00303	Nickel	30.50000	µg/L	J	12/04/1996	NA	730
E021GW003	021GW00303	Thallium	**3.20000**	µg/L	J	12/04/1996	2	NA
E021GW003	021GW00304	Antimony	1.60000	µg/L	U	02/26/1997	6	NA
E021GW003	021GW00304	Lead	1.60000	µg/L	J	02/26/1997	15	NA
E021GW003	021GW00304	Nickel	1.50000	µg/L	J	02/26/1997	NA	730
E021GW003	021GW00304	Thallium	5.00000	µg/L	U	02/26/1997	2	NA
E021GW004	021GW004M2	Antimony	4.79000	µg/L	U	10/01/2002	6	NA
E021GW004	021GW004M2	Lead	2.49000	µg/L	U	10/01/2002	15	NA
E021GW004	021GW004M2	Nickel	0.83700	µg/L	U	10/01/2002	NA	730
E021GW004	021GW004M2	Thallium	4.99000	µg/L	U	10/01/2002	2	NA
E021GW01R	021GW01RM2	Antimony	4.79000	µg/L	U	09/03/2002	6	NA
E021GW01R	021GW01RM2	Lead	12.80000	µg/L	=	09/03/2002	15	NA
E021GW01R	021GW01RM2	Nickel	0.83700	µg/L	U	09/03/2002	NA	730
E021GW01R	021GW01RM2	Thallium	**14.30000**	µg/L	=	09/03/2002	2	NA
E054GW001	054GW00101	Antimony	4.00000	µg/L	U	04/12/1996	6	NA
E054GW001	054GW00101	Lead	3.00000	µg/L	U	04/12/1996	15	NA
E054GW001	054GW00101	Nickel	1.00000	µg/L	U	04/12/1996	NA	730
E054GW001	054GW00101	Thallium	5.00000	µg/L	U	04/12/1996	2	NA

TABLE 1-2
Summary of COC Detections in Groundwater Wells At SWMUs 21 and 54
CMS Report, SWMUs 21 and 54, Zone E, Charleston Naval Complex

Station	Sample	CHEM_NAME	Result	Unit	Qualifier	DATE_COL	Drinking Water MCL	Region III Tap Water RBC
E054GW001	054GW00102	Antimony	2.10000	µg/L	U	08/09/1996	6	NA
E054GW001	054GW00102	Lead	1.70000	µg/L	U	08/09/1996	15	NA
E054GW001	054GW00102	Nickel	0.80000	µg/L	U	08/09/1996	NA	730
E054GW001	054GW00102	Thallium	2.70000	µg/L	U	08/09/1996	2	NA
E054GW002	054GW00201	Antimony	**10.90000**	µg/L	J	04/16/1996	6	NA
E054GW002	054GW00201	Lead	9.00000	µg/L	J	04/16/1996	15	NA
E054GW002	054GW00201	Nickel	1.70000	µg/L	J	04/16/1996	NA	730
E054GW002	054GW00201	Thallium	**5.00000**	µg/L	J	04/16/1996	2	NA
E054GW002	054GW00202	Antimony	11.00000	µg/L	U	08/08/1996	6	NA
E054GW002	054GW00202	Lead	10.60000	µg/L	=	08/08/1996	15	NA
E054GW002	054GW00202	Nickel	2.90000	µg/L	U	08/08/1996	NA	730
E054GW002	054GW00202	Thallium	4.80000	µg/L	U	08/08/1996	2	NA
E054GW002	054GW00203	Antimony	6.40000	µg/L	U	12/04/1996	6	NA
E054GW002	054GW00203	Lead	4.20000	µg/L	U	12/04/1996	15	NA
E054GW002	054GW00203	Nickel	129.00000	µg/L	=	12/04/1996	NA	730
E054GW002	054GW00203	Thallium	**3.60000**	µg/L	J	12/04/1996	2	NA
E054GW002	054GW00204	Antimony	**13.80000**	µg/L	J	02/27/1997	6	NA
E054GW002	054GW00204	Lead	3.30000	µg/L	=	02/27/1997	15	NA
E054GW002	054GW00204	Nickel	7.20000	µg/L	J	02/27/1997	NA	730
E054GW002	054GW00204	Thallium	5.00000	µg/L	U	02/27/1997	2	NA
E054GW002	054GW002M2	Antimony	**24.90000**	µg/L	J	09/30/2002	6	NA
E054GW002	054GW002M2	Lead	**258.00000**	µg/L	=	09/30/2002	15	NA
E054GW002	054GW002M2	Nickel	12.30000	µg/L	J	09/30/2002	NA	730
E054GW002	054GW002M2	Thallium	4.99000	µg/L	U	09/30/2002	2	NA

TABLE 1-2
Summary of COC Detections in Groundwater Wells At SWMUs 21 and 54
CMS Report, SWMUs 21 and 54, Zone E, Charleston Naval Complex

Station	Sample	CHEM_NAME	Result	Unit	Qualifier	DATE_COL	Drinking Water MCL	Region III Tap Water RBC
E054GW003	054GW00301	Antimony	4.00000	µg/L	U	04/12/1996	6	NA
E054GW003	054GW00301	Lead	5.50000	µg/L	=	04/12/1996	15	NA
E054GW003	054GW00301	Nickel	2.80000	µg/L	J	04/12/1996	NA	730
E054GW003	054GW00301	Thallium	5.00000	µg/L	U	04/12/1996	2	NA
E054GW003	054GW00302	Antimony	2.10000	µg/L	U	08/08/1996	6	NA
E054GW003	054GW00302	Lead	1.70000	µg/L	U	08/08/1996	15	NA
E054GW003	054GW00302	Nickel	2.30000	µg/L	U	08/08/1996	NA	730
E054GW003	054GW00302	Thallium	2.70000	µg/L	U	08/08/1996	2	NA



Zone E Boundary
SWMU/AOC Within Zone E Boundary

N

0 800 1600 Feet

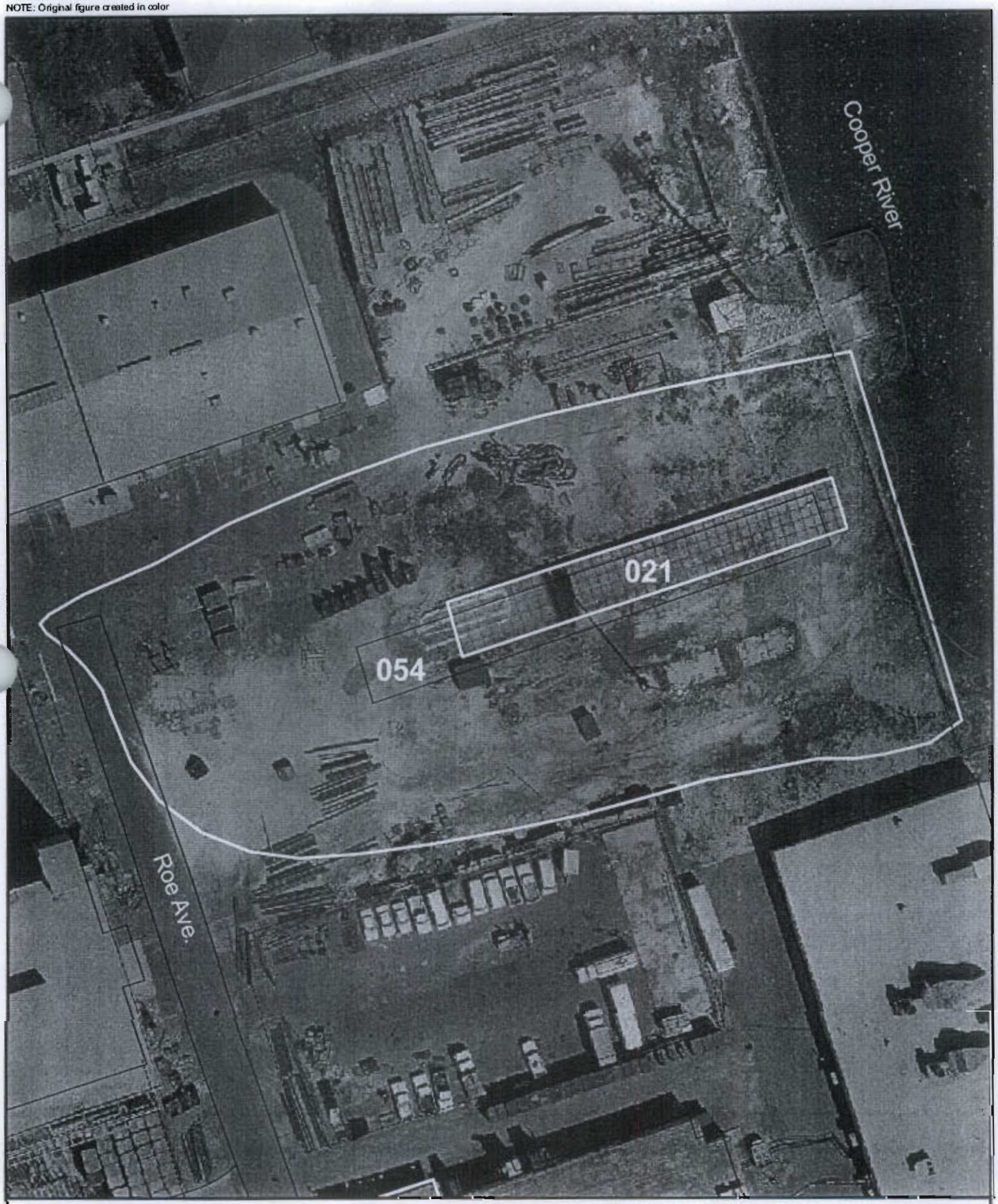
1 inch = 800 feet

Figure 1-1
Zone E Within CNC
SWMUs 21 and 54
Charleston Naval Complex

CH2MHILL

File Path: C:\18gis\Projects\Zone_E\newlocationfigs.apr Date: 29 Apr 2003 14:41 User: NMOUDRY SWMU 21 54 Figure 1-1 Zone E Within CNC

NOTE: Aerial Photo Date is 1997
NOTE: Original figure created in color



Roads
Shoreline
AOC Boundary
SWMU Boundary
Buildings
Zone Boundary

N

0 60 120 Feet

1 inch = 60 feet

Figure 1-2
Aerial Photograph of SWMUs 21 and 54
Site Map
Charleston Naval Complex

CH2MHILL

File Path: C:\Projects\Zone_E\Swmu_21_Swmu_54\AprilCopy\swmu21and54figs.apr, Date: 29 Apr 2008 14:44, User: NWOUDRY, Figure 1-2 site map - SWMU 21 and 54

NOTE: Original figure ... in color

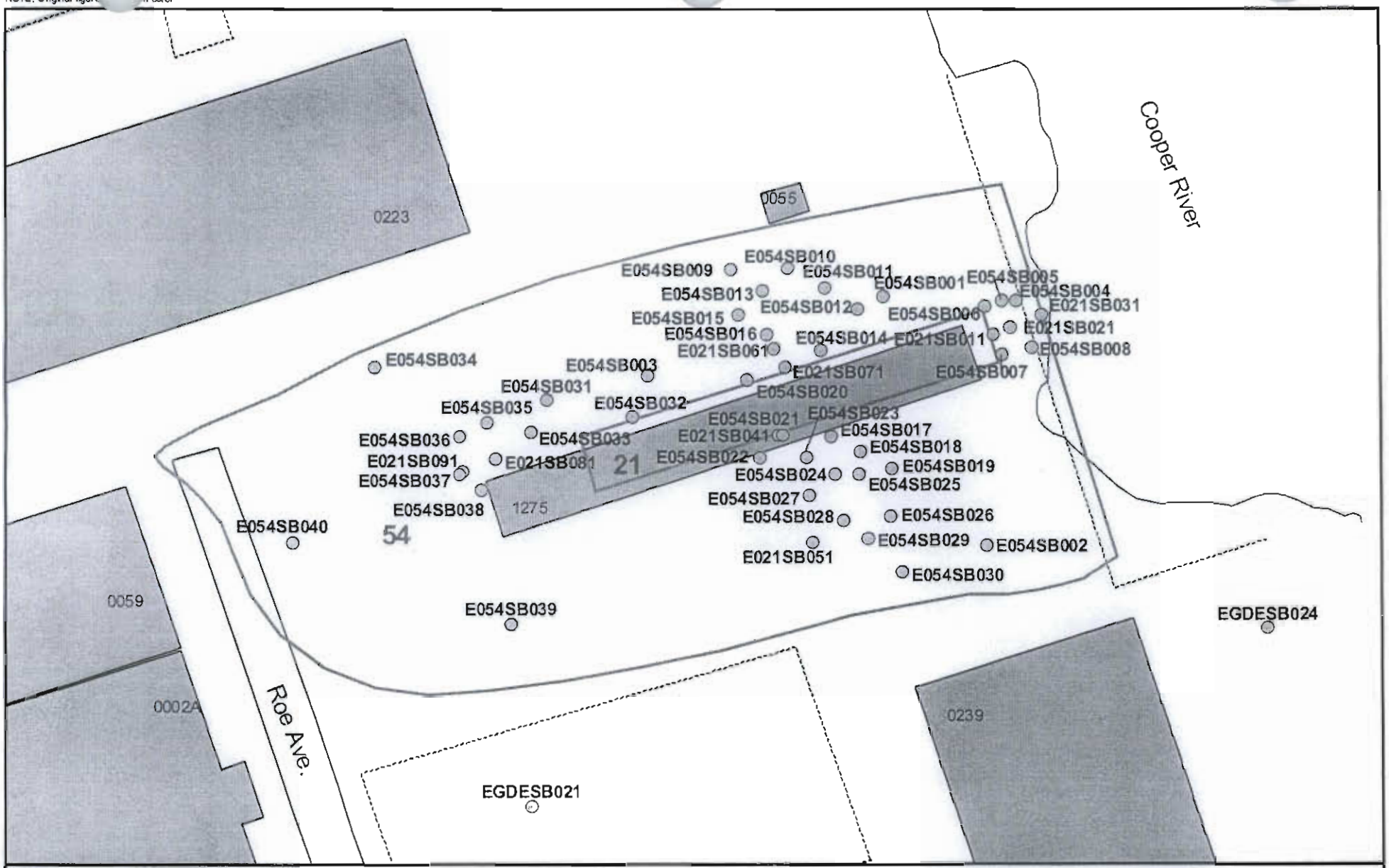


Figure 1-3
RFI Soil Sample Locations
SWMUs 21 and 54, Zone E
Charleston Naval Complex

CH2MHILL

File Path: C:\18gis\Projects\Zone_E\Swmu_21_Swmu_54\Aprs\Copyofswmu21and54fga.apr, Date: 14 Nov 2003 8:31, User: NMOUDRY

NOTE: Original figure [illegible] in color

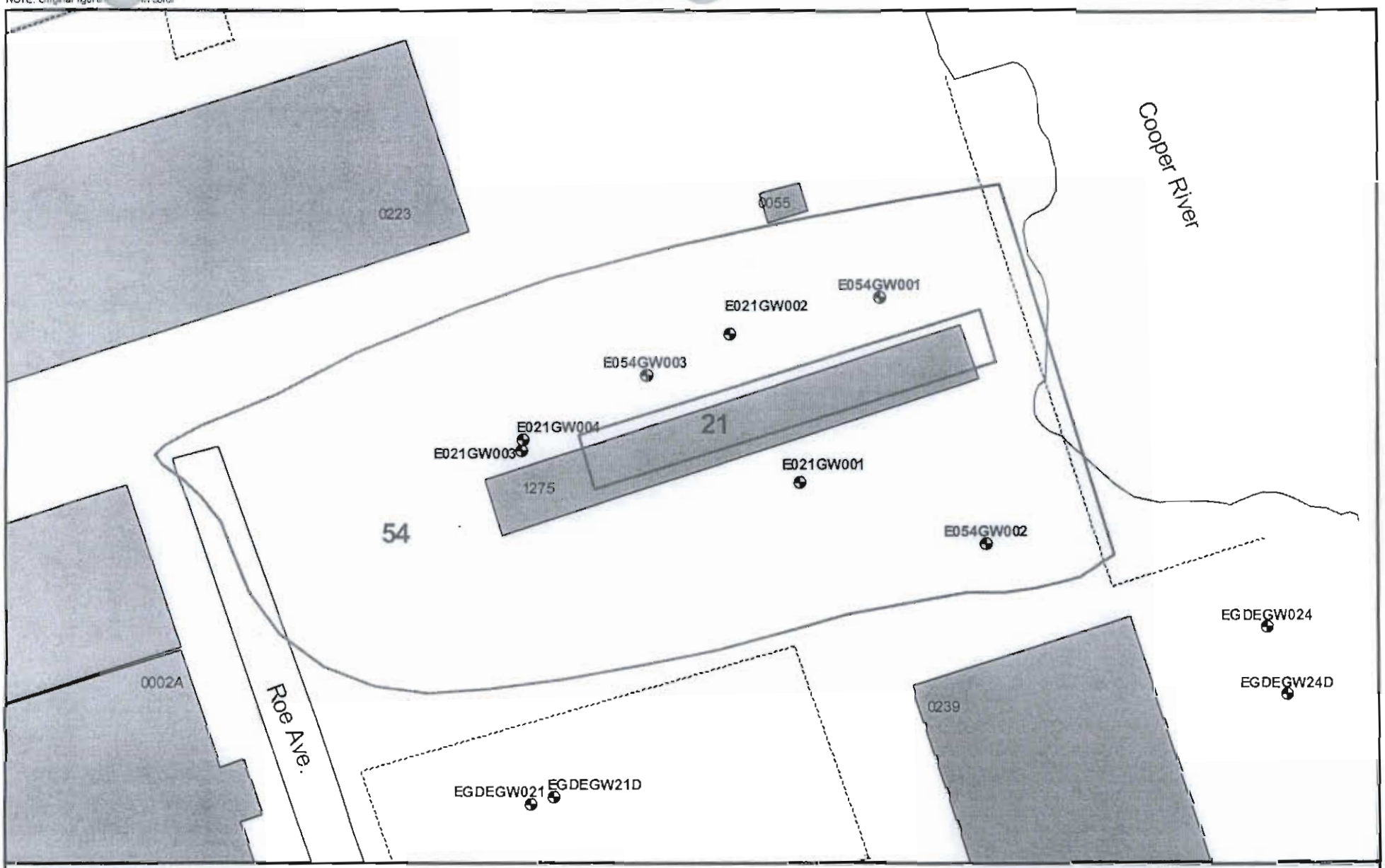


Figure 1-4
RFI Groundwater Monitor Well Locations
SWMUs 21 and 54, Zone E
Charleston Naval Complex

CH2MHILL

File Path: C:\1dgis\Projects\Zone_E\Swmu_21_Swmu_54\Aprs\Copyofswmu21and54figs.apr, Date: 14 Nov 2003 8:19, User: NMOUDRY

NOTE: Aerial Photo Date is 1997
NOTE: Original figure created in color

Figure 1-5
Antimony and Lead SSL Exceedances in Subsurface Soil
SWMUs 21 and 54, Zone E
Charleston Naval Complex

File Path: c:\18gis\cnc\cnc-egis apr, Date: 17 Nov 2003 11:02, User: DWILLIAM, EGIS: Charleston Naval Complex - Figure 1-5 Antimony and Lead SSL Exceedances in Subsurface Soil

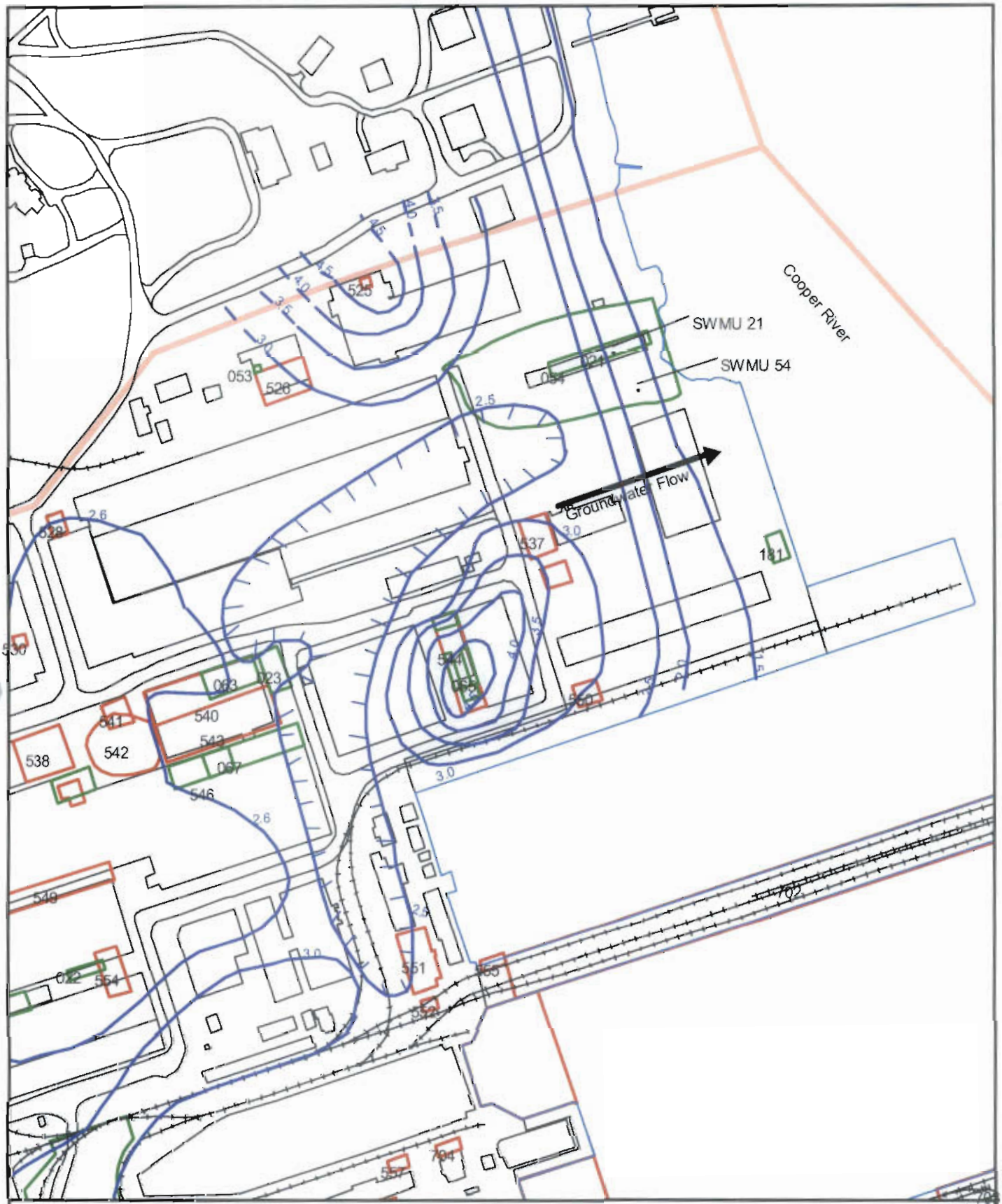


Figure 1-6
Shallow Groundwater Contours
SWMUs 21 and 54, Zone E
Charleston Naval Complex

CH2MHILL

File Path: C:\18gis\Projects\Zone_E\ZoneE_GW\zonee_gw_figs.apr, Date: 04 Jul 2003 10:03, User: NMOUDRY, Figure 4-2 SWMU 21 and 54

NOTE: Aerial Photo Date is 1997
NOTE: Original figure created in color

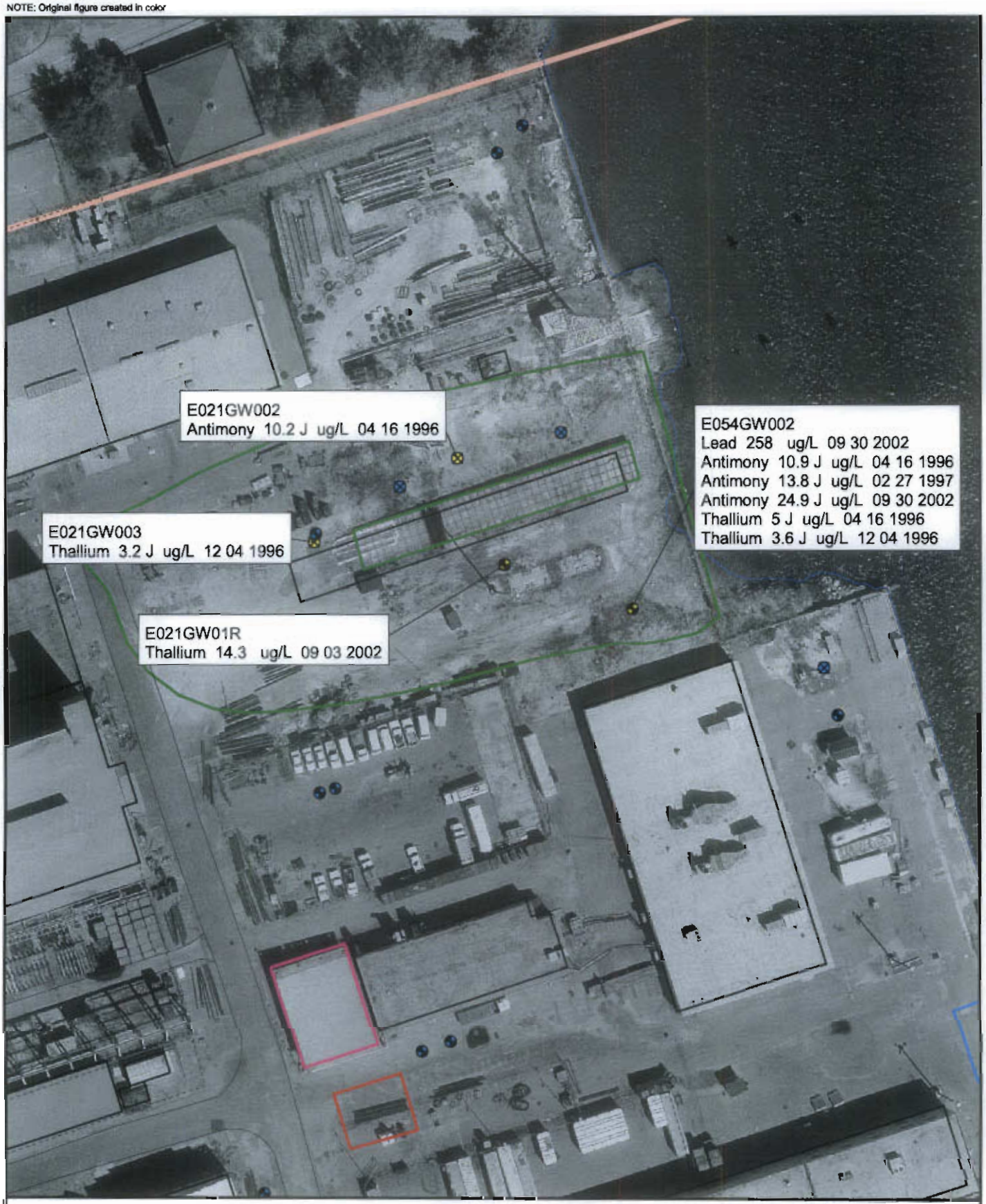


Figure 1-7
Groundwater COC Exceedances
SWMUs 21 and 54, Zone E
Charleston Naval Complex

File Path: c:\18gis\cnc\cnc-egis.apr, Date: 17 Nov 2003 13:53, User: DWILLIAM, EGIS: Charleston Naval Complex - Figure 1-7 Groundwater COC Exceedances

Section 2.0

2.0 Remedial Goal Objectives and Evaluation Criteria

2.1 Remedial Action Objectives

RAOs are medium-specific goals that protect human health and the environment by preventing or reducing exposures under current and future land use conditions. The RAO identified for the subsurface soil at SWMUs 21 and 54 is to achieve concentrations of COCs that are protective of groundwater (prevent leaching of COCs at concentrations that cause concentrations of COCs in groundwater to exceed their target Media Cleanup Standards. The RAO for groundwater is to prevent ingestion of groundwater containing COCs at unacceptable levels and to restore the aquifer to its beneficial use to the extent practicable.

2.2 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. Under the RCRA program, RGOs and MCSs are developed at the end of the risk assessment in the RFI/Remedial Investigation (RI) programs, before completion of the CMS.

RGOs can be based on a variety of criteria, such as specific incremental lifetime cancer risk (ILCR) 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.

The exposure media of concern for SWMUs 21 and 54 are subsurface soil containing PAHs (BEQs), antimony, and lead, and groundwater containing antimony, lead, nickel, and thallium.

For the chemicals identified as COCs in soil and shallow groundwater, the following MCSs were previously proposed in the CMS Work Plan:

COC	Target MCS as Proposed in CMS Work Plan
Soil	
PAHs (BEQs)	CNC Sitewide Reference Concentration for Subsurface Soils - 1,400 µg/kg
Antimony	Site-specific soil screening level (SSL) for the unpaved scenario (6.6 milligram per kilogram [mg/kg] in the RFI Report Addendum)
Lead	Site-specific soil screening level (SSL) for the unpaved scenario (616 mg/kg in the RFI Report Addendum)
Groundwater	
Antimony	MCL for antimony - 6 µg/L
Lead	Drinking water Target Treatment Level for lead - 15 µg/L
Nickel	Region III Tap Water RBC (HI = 1.0) for nickel - 730 µg/L
Thallium	MCL for thallium - 2 µg/L

2.3 Evaluation Criteria

According to the EPA RCRA CA guidance, corrective measure alternatives should be evaluated using the following five criteria:

1. Protection of human health and the environment.
2. Attainment of MCSs.
3. The control of the source of releases to minimize future releases that may pose a threat to human health and the environment.
4. Compliance with applicable standards for the management of wastes generated by remedial activities.
5. Other factors, including (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 these criteria is defined in more detail below:

1. **Protection of 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 criterion may or may not be independent of its ability to

achieve the other criteria. For example, an alternative may be protective of human health, but may not be able to attain the MCSs if the MCSs were not developed based on human health protection factors.

2. **Attainment of MCSs.** The alternatives will be evaluated on the basis of their ability to achieve the MCS defined in this CMS. Another aspect of this criterion is the time frame required to achieve the MCS. Estimates of the time frame for the alternatives to achieve RGOs will be provided.

3. **The control the source of releases.** This criterion deals with the control of releases of contamination from the source (the area in which the contamination originated) and the prevention of future migration to uncontaminated areas.

4. **Compliance with applicable standards for management of wastes.** This criterion deals with the management of wastes derived from implementing the alternatives (i.e., treatment or disposal of zinc-contaminated residuals from groundwater treatment processes). Corrective measure alternatives will be designed to comply with all standards for management of wastes. Consequently, this criterion will not be explicitly included in the detailed evaluation presented in the CMS, but such compliance would be incorporated into the cost estimates for which this criterion is relevant.

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

   a. Long-term reliability and effectiveness

   Corrective measure 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.

   b. 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.

   c. 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.

d. Implementability

The alternatives will be evaluated for their implementability by considering any difficulties associated with conducting the alternatives (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.

e. 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 +100 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.

Section 3.0

3.0 Description of Candidate Corrective Measure Alternatives

3.1 Introduction

Currently available soil and groundwater remedial technologies were screened for applicability to the contaminants and physical conditions present at SWMUs 21 and 54, with only the most viable technologies known for addressing the COCs present at the site selected for alternatives analysis.

Because all of Zone E will undergo LUCs and the BEQ exceedances in subsurface soil are limited in extent and do not pose an exposure or migration risk, LUCs are selected as a presumptive remedy for BEQs in subsurface soils.

Two remedies will be considered for the soil and groundwater metal COCs in the CMS for SWMUs 21 and 54:

- Soil Excavation, Long-term Groundwater Monitoring, and LUCs, and
- Long-term Groundwater Monitoring and LUCs.

The sections below describe each alternative in more detail.

3.2 Alternative 1: Soil Excavation, Long-term Groundwater Monitoring, and LUCs

3.2.1 Description of Alternative

This alternative would first involve continued groundwater monitoring for a period of time necessary to assess whether the sporadic exceedances of the MCL for several metals continues or declines. If the additional monitoring indicates that groundwater continues to be impacted from metals leaching from subsurface soils, excavation of that subsurface soil would be implemented. If the additional monitoring indicates that metals are not leaching at significant concentrations from subsurface soil, no excavation would be performed.

Because much of the soil contamination has been removed by the previous IMs at the site, concentrations of metals in groundwater are expected to decline over time. It is also possible that at least some of the metal exceedances of the MCLs were caused by turbidity in the

samples and are not related to subsurface soil exceedances. Therefore, an initial groundwater monitoring period at this site is warranted to provide a better and more robust analytical database with which to evaluate groundwater quality.

After adequate groundwater data have been collected to evaluate whether the metals exceedances appear to be related to subsurface soil concentrations of the metals and that the groundwater exceedances are likely to continue for a significant duration or that they pose a migration risk to Cooper River, subsurface soil excavation would be considered to remove the subsurface soil areas that are causing the leaching problem. Such excavation would permanently remove the leaching material from the site, which would lead to improvements in groundwater quality over time. As part of this effort, it may be necessary to also collect additional subsurface soils samples and conduct leachability tests to further refine the site-specific SSL values for antimony and lead.

3.2.2 Key Uncertainties

As noted above, it is not yet clear the degree to which metals in subsurface soil are leaching and contributing to the observed metals exceedances in groundwater samples. In the vicinity of wells E021GW01R, E021GW002, and E021GW003, there does not appear to be a significant relationship between subsurface soil exceedances of the SSL and groundwater exceedances of the MCL. If there were a strong relationship between the metals in soil and measured groundwater concentrations, the MCL exceedances in groundwater would be expected to occur more consistently. There may be a relationship between subsurface soil exceedances of the SSL and groundwater exceedances of the MCL in the vicinity of well E054GW002. However, additional monitoring is needed to clarify this relationship and to assess the degree to which turbidity or other factors may be causing the intermittent and sporadic groundwater exceedances at this well.

3.2.3 Other Considerations

LUCs restricting the use of groundwater at the site will be necessary during the period until MCLs are achieved. The LUCs will also address restricting the site use to industrial only.

3.3 Alternative 2: Long-term Groundwater Monitoring and LUCs

3.3.1 Description of Alternative

This alternative would involve long-term monitoring and LUCs only. The four monitoring wells in which MCL exceedances have been observed would continue to be monitored.

LUCs would be implemented to restrict land use to industrial only and to prevent use of shallow groundwater until all COCs are below the MCLs.

Because much of the soil contamination has been removed by the previous IMs at the site, concentrations of metals in groundwater are expected to decline over time. It is also possible that at least some of the metal exceedances of the MCLs were caused by turbidity in the samples and are not related to subsurface soil exceedances. Therefore, groundwater monitoring may indicate that the sporadic MCL exceedances are related only to turbidity or other factors and that significant groundwater contamination is not present.

3.3.2 Key Uncertainties

As with Alternative 1, it is not yet clear the degree to which metals in subsurface soil are leaching and contributing to the observed metals exceedances in groundwater samples. Additional monitoring is expected to clarify the nature of any groundwater quality impacts that exist at the site.

3.3.3 Other Considerations

No other considerations were noted for this alternative.

Section 4.0

4.0 Evaluation and Comparison of Corrective Measure Alternatives

The two corrective measure alternatives were evaluated relative to the evaluative criteria previously described in Section 2.0 and then subjected to a comparative evaluation. A cost estimate for each alternative was also developed; the assumptions and unit costs used for these estimates are included in Appendix A.

4.1 Alternative 1 Soil Excavation, Long-term Groundwater Monitoring, and LUCs

The assumptions for Alternative 1 include the following:

- A base-wide land use control management plan (LUCMP) will be developed for the CNC. The plan will allow for restrictions on the use of groundwater at SWMUs 21 and 54 and other areas and will be developed outside the scope of this CMS.
- An initial groundwater monitoring period will be performed for up to 2 years to better assess the nature and cause of the intermittent COC exceedances of metals. Samples will be collected from the four existing monitoring wells that have had past MCL exceedances on a semi-annual basis. The samples will be analyzed for metal COCs, filtered and unfiltered. Standard field parameters (dissolved oxygen [DO], oxidation reduction potential [ORP], turbidity, temperature) will be monitored in all wells.
- For cost estimating purposes, it is assumed that an area of subsurface soil 20 ft by 20 ft by 3 ft deep would be excavated to mitigate a leaching source of antimony and lead. Once this subsurface soil has been removed, it is assumed that additional groundwater monitoring would continue for up to 3 years, after which all groundwater COCs would be below the MCLs.

4.1.1 Protection of Human Health and the Environment

Alternative 1 is effective at protecting human health because it uses LUCs to prevent the ingestion of, and direct contact with, groundwater until all groundwater COCs are below the MCLs.

5.0 Recommended Corrective Measure Alternative

Two corrective measure alternatives were evaluated for subsurface soil and groundwater COCs using the criteria described in Section 2.0 of this CMS report: Alternative 1: Soil Excavation, Long-term Groundwater Monitoring, and LUCs; and Alternative 2: Long-term Groundwater Monitoring and LUCs.

Based on the alternatives evaluation and RAOs for the site, as identified in Section 2.0, and the current uncertainties associated with each alternative, the preferred corrective measure alternative is Alternative 1: Soil Excavation, Long-term Groundwater Monitoring, and LUCs. Alternative 1 would provide protection of human health and the environment by first performing additional groundwater monitoring to determine the degree to which leaching of metals from subsurface soil is impacting groundwater and then, if necessary, excavating those subsurface soil. This alternative also provides for maintaining the current and planned future use of the site as industrial while site COCs exceed applicable levels for unrestricted land use. LUCs would prevent residential and other unrestricted land uses, including installation of water supply wells that could expose sensitive populations.

An LUCMP is being developed for the industrial areas of the CNC, and SWMUs 21 and 54 will be added to the plan. The LUCMP will limit future site activities to those that would limit exposure to groundwater. The expected reliability of this alternative is good. Should monitoring data indicate that this alternative is not as effective as expected, additional measures could be safely implemented.

6.0 References

CH2M-Jones. *RFI Report Addendum and CMS Work Plan, SWMUs 21 and 54, Zone E, Charleston Naval Complex*. Revision 0. May 2003.

EnSafe Inc. *Zone E RFI Report, NAVBASE Charleston, Revision 0*. November 1997.

EnSafe Inc./Allen & Hoshall. *Zone E RFI Report Workplan*. 1995.

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 (EPA). Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. Office of Solid Waste and Emergency Response (OSWER) Final Directive 9200.4-17P. 1999.

COMPARISON OF TOTAL COST OF REMEDIAL SOLUTIONS

Site: Charleston Naval Complex
Location: Combined SWMU 83
Phase: Corrective Measures Study
Base Year: 2003
Date: 01/08/03

	Alternative Number 1	Alternative Number 2
Total Project Duration (Years)	5	30
Capital Cost	$30,000	$0
Annual O&M Cost	$7,000	$7,000
Total Present Value of Solution	$68,000	$69,000

Disclaimer: The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This is an order-of-magnitude cost estimate that is expected to be within -50 to +100 percent of the actual project costs.

Alternative: Number 1 — **COST ESTIMATE SUMMARY**

Elements: Subsurface Soil Excavation, Long term Groundwater Monitoring and LUCs

Site: Charleston Naval Complex

Location: SWMUs 21 54

Phase: Corrective Measures Study

Base Year: 2003

Date: 11/10/03

Description: Excavation of contaminated soil, disposal offsite at permitted landfill, backfill with clean soil. Groundwater monitoring for 3 years after excavation

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Pre-excavation Monitoring					
Semi-annual groundwater sampling	4	ea	$3,000	$12,000	Semi-annual for 2 years, 5 wells for metals
Subsurface Soil Excavation					
Confirmation Sampling	1	EA	$2,400	$2,400	See Confirmation Worksheet
Removal, Disposal and Backfill	1	EA	$18,000	$18,000	See Excavation 1 Worksheet
SUBTOTAL				$20,400	
Contingency	30%		$20,400	$6,120	
SUBTOTAL				**$26,520**	
Project Management	3%		$26,520	$796	
Remedial Design	5%		$26,520	$1,326	
Construction Management	7%		$26,520	$1,856	
SUBTOTAL				**$3,978**	
TOTAL CAPITAL COST				**$30,000**	

OPERATIONS AND MAINTENANCE COST

Post-excavation sampling costs

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Semi-annual Sampling for metals	1	ea	$6,000	$6,000	
SUBTOTAL				$6,000	
Allowance for Misc. Items	15%		$6,000	$900	
SUBTOTAL				$6,900	
TOTAL ANNUAL O&M COST				**$7,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 7%

Years	COST TYPE	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR (7%)	PRESENT VALUE	NOTES
0	CAPITAL COST	$30,000	$30,000	1.000	$30,000	
3	ANNUAL O&M COST	$7,000	$7,000	2.624	$18,370	
		$37,000			$48,370	
	PRESENT VALUE OF LUC				$20,000	
	TOTAL PRESENT VALUE OF ALTERNATIVE				**$68,000**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000).

Alternative: **Subtask** **COST WORKSHEET 1**

Element: **Confirmation Testing**

Site:	Charleston Naval Complex	**Prepared By:** DFW	**Checked By:**
Location:	Combined SWMU 83	**Date:** 01/08/2003	**Date:**
Phase:	Corrective Measures Study		
Base Year:	2003		

WORK STATEMENT

Costs for soil confirmation sample collection, shipment and analysis on a per event basis.
Total of 70 samples: 4 excavation wall samples plus 1 excav. floor sample, for each excavation
5 samples per excavation

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Equipment & Labor					
Jar Kits	5	EA	$10	$50	CH2M-Jones Est.
Coolers	1	EA	$10	$10	CH2M-Jones Est.
Disposable Gloves	1	BOXES	$20	$20	CH2M-Jones Est.
Collection of samples	6	HR	$68	$408	CH2M-Jones Est.
Sample Shipment	1	EA	$20	$20	CH2M-Jones Est.
Sample Analysis (metals)	5	SAMPLE	$95	$475	GEL, PEL, STL average
Data Validation	10	HR	$100	$1,000	CH2M-Jones Est.
SUBTOTAL				$1,983	
Allowance for Misc. Items	20%		$1,983	$396.60	
SUBTOTAL				$2,380	
TOTAL COST				**$2,400**	

OPERATION AND MAINTENANCE COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
SUBTOTAL				$0	
Allowance for Misc. Items	20%		$0	$0	
SUBTOTAL				$0	
TOTAL O&M COST				**$0**	

Source of Cost Data

1. Analytical Bid Form - Charleston Naval Complex - Level II

Alternative: **Subtask** **COST WORKSHEET 2**

Element: **Subsurface Soil Excavation and Disposal**

Site: Charleston Naval Complex
Location: SWMUs 21 54
Phase: Corrective Measures Study
Base Year: 2003

Prepared By: DFW **Date:** 11/10/2003
Checked By: **Date:**

WORK STATEMENT

Excavate soil and haul to disposal area; backfill with clean soil and restore surface to original condition.

See quantity calcs

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Mob/demob/decon	1	EA	$1,000	$1,000	
Utility checks and permits	6	HR	$100	$600	CH2M-Jones Est.
Excavation (soil) - machine	1	weeks	$3,000	$3,000	CH2M-Jones Est.
Clean Fill	51	CY	$15	$765	CH2M-Jones Est.
Site Operator-Oversight	40	HR	$100	$4,000	CH2M-Jones Est.
Waste characterization TCLP	3	EA	$150	$450	
Contam Soil disposal - Non-Haz	67	Tons	$45	$3,015	CH2M-Jones Est.
SUBTOTAL				$12,830	
Allowance for Misc. Items	40%		$12,830	$5,132	30% Scope + 10% Bid
SUBTOTAL				$17,962	
TOTAL UNIT COST				**$18,000**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
SUBTOTAL				$0	
Allowance for Misc. Items	20%		$0	$0	
SUBTOTAL				$0	
TOTAL ANNUAL O&M COST				**$0**	

Source of Cost Data

1. Means. 2002. Environmental Remediation Cost Data - Assemblies, 8th Edition. R.S. Means Company Kingston, MA.
2. CH2M-Jones -historic costs for CNC excavations at other sites, 2001-2002.