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TECHNICAL MEMORANDUM RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION AREA OF CONCERN 721 CNC CHARLESTON SC
7/1/2003
ENSAFE INC.

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY
CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA
CTO-0164

AOC 721 RFI TECHNICAL MEMORANDUM
Revision: 0

SOUTHDIV Contract Number:
N62467-89-D-0318

Prepared for:

DEPARTMENT OF THE NAVY
SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORTH CHARLESTON, SOUTH CAROLINA

Prepared by:

ENSAFE INC.
313 WINGO WAY
MOUNT PLEASANT, SOUTH CAROLINA 29464
(843) 884-0029

July 2003

Release of this document requires the prior notification of the Commanding Officer of the Southern Division, Naval Facilities Engineering Command, Naval Base Charleston, South Carolina.

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

Date: July 2003
Signature: _____
Name: Charles A. Vernoy
Title: Task Order Manager

CERTIFICATION PAGE

REGISTERED SOUTH CAROLINA PROFESSIONAL ENGINEER CERTIFICATION. I certify that the data and interpretations presented in this *AOC 721 RFI Technical Memorandum* are true and accurate to the best of my knowledge as a registered South Carolina Professional Engineer.

_____ _____

Henry Fellers, P.E. Date
Registration Number 19318

ACRONYMS

AOC	Area of Concern
BCT	Base Realignment and Closure Act Cleanup Team
BEQ	Benzo(a)pyrene Equivalent
BGS	Below Ground Surface
C	Contingent
CLEAN	Comprehensive Long-Term Environmental Action Navy
CMS	Corrective Measures Study
CNC	Charleston Naval Complex
COC	Constituent of Concern
COPC	Constituent of Potential Concern
CSAP	Comprehensive Sampling and Analysis Plan
DET	Navy Environmental Detachment
ERA	Ecological Risk Assessment
HHRA	Human Health Risk Assessment
HSWA	Hazardous and Solid Waste Amendment
IM	Interim Measure
ISM	Interim Stabilization Measure
MCL	Maximum Contaminant Level
MHW	Mean High Water
MSL	Mean Sea Level
NFA	No Further Action
ORP	Oxidation/Reduction Potential
P	Primary
PCB	Polychlorinated Biphenyl
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SAP	Sampling and Analysis Plan
SCDHEC	South Carolina Department of Health and Environmental Control
SSL	Soil Screening Level
SSV	Sediment Screening Value
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit

TDS	Total Dissolved Solid
TOC	Total Organic Carbon
TSS	Total Suspended Solid
V	Verification
VOC	Volatile Organic Compound

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1.0 INTRODUCTION

The Area of Concern (AOC) 721 Technical Memorandum (TM) summarizes the sampling activities and environmental data collected in accordance with the AOC 721 RCRA Facility Investigation (RFI) Work Plan. Field activities and resulting data by environmental media are presented in Section 2 of the TM. This TM provides information needed to define the nature and extent of contamination related to coal pile activities and the recommendation to continue with the RFI process without additional sampling.

Figure 1-1 depicts the Charleston Naval Complex (CNC). AOC 721 is located in the northernmost portion of Zone C of the CNC, and is west of Avenue D north and just south of Noisette Creek as illustrated in Figure 1-2. The site area consists of made-ground that was constructed in the early 1920s using dredge materials and includes a 650 foot long drainage ditch that discharges into Noisette Creek. A coal storage facility was located within the AOC 721/SWMU 44 area from 1941 until 1996. The existing bulk coal pile and surface soil were removed to a visual standard during an Interim Measure (IM) conducted in 1996. Post 1996 IM removal action site features are illustrated in Figure 1-3.

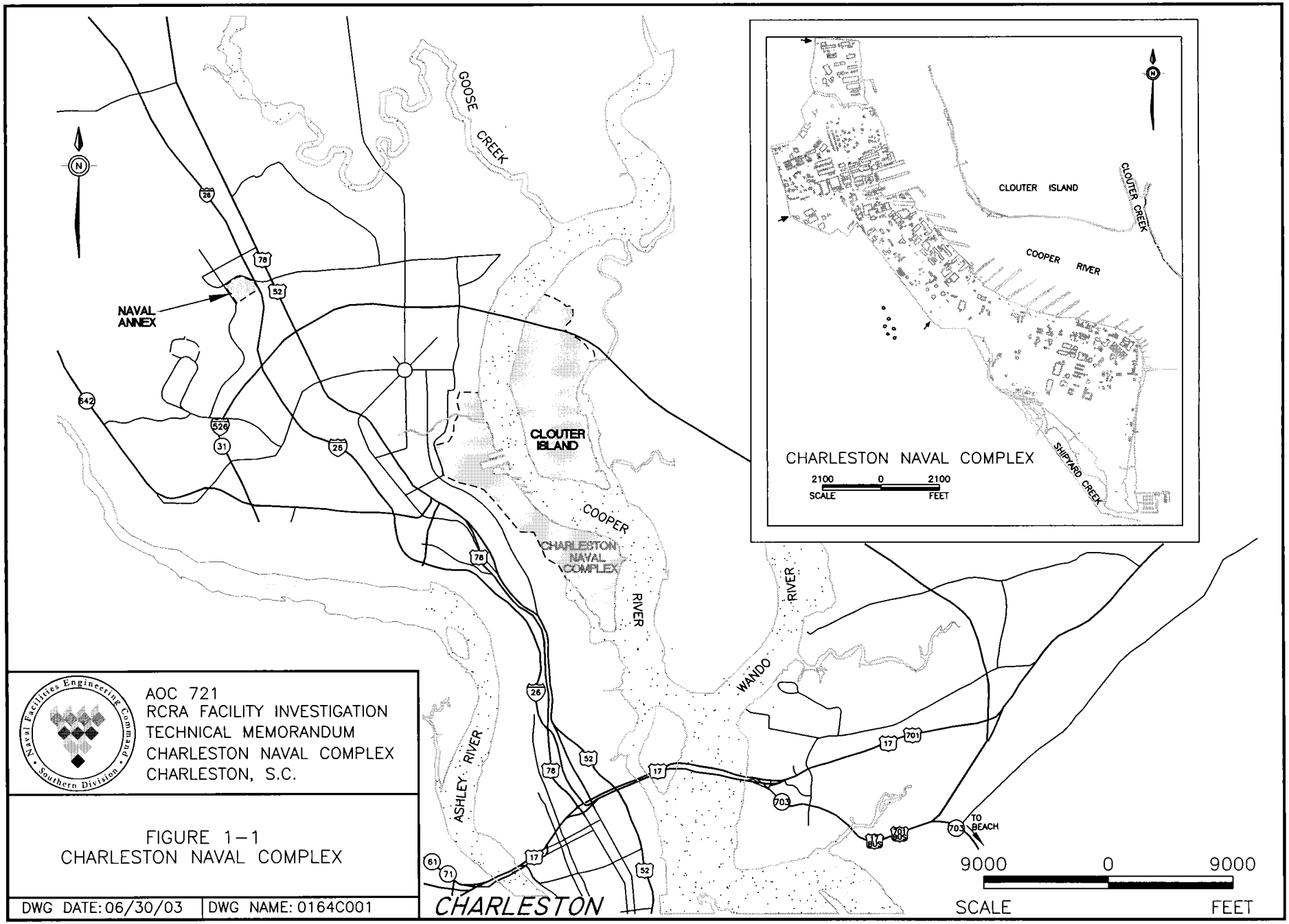
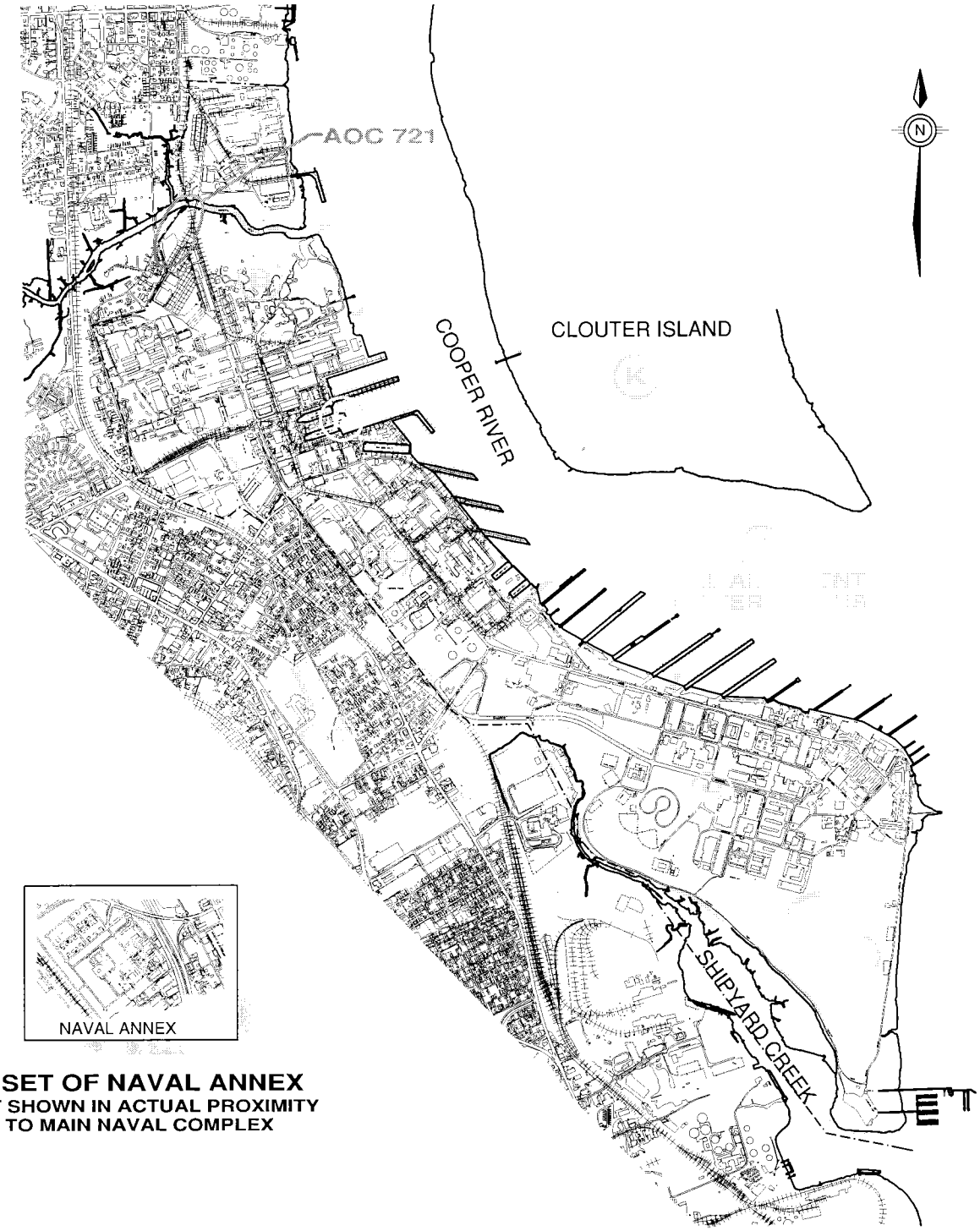


FIGURE 1-1
CHARLESTON NAVAL COMPLEX



INSET OF NAVAL ANNEX
NOT SHOWN IN ACTUAL PROXIMITY TO MAIN NAVAL COMPLEX

2000 1000 0 2500 5000
2500 1500 500
SCALE IN FEET

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AOC 721
RCRA FACILITY INVESTIGATION
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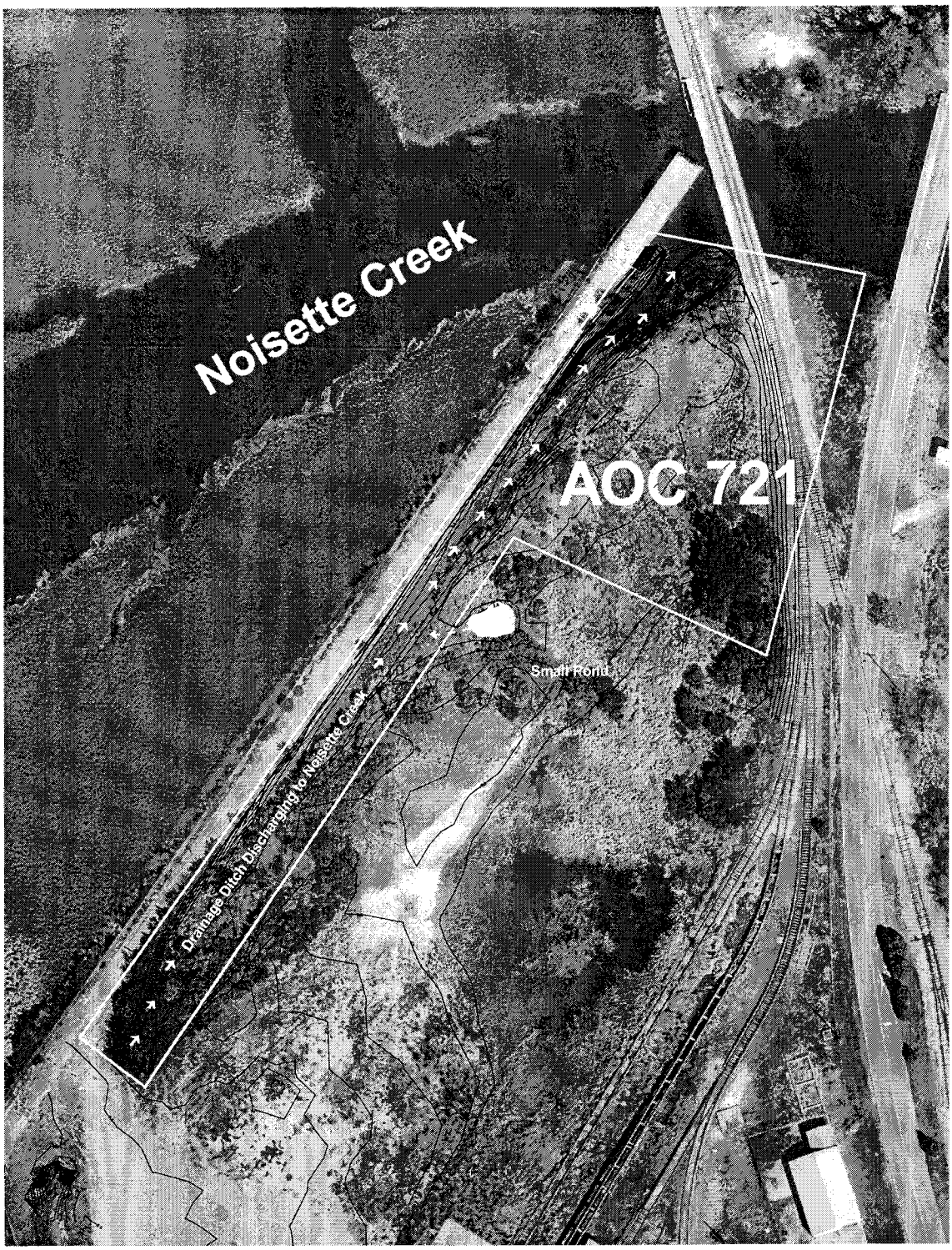
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC

FIGURE 1-2
SITE LOCATION MAP
CHARLESTON NAVAL COMPLEX

Date: 06/20/03 | DWG Name: 0164C002



60 0 60 Feet

LEGEND

Surface Topographic Contours

Ditch Drainage

AOC 721 RFI Boundary

AOC 721
RCRA FACILITY INVESTIGATION
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC

FIGURE 1-3
AOC 721 Site Features Map

Date: JUNE 2003 | AOC 721 TECH MEMO.apr

2.0 FIELD INVESTIGATION

Field activities and analytical results for the AOC 721 RFI Work Plan are described in the following sections by environmental media type. Surface soil, groundwater, sediment, and surface water samples were collected in accordance with the AOC 721 RFI Work Plan, analyzed by Southwest Laboratory of Oklahoma, a South Carolina Department of Health and Environmental Control (SCDHEC) certified laboratory following SW-846 analytical methods, and the data evaluated by Heartland Environmental Services according to current United States Environmental Protection Agency (USEPA) Data Validation Guidelines.

2.1 Soil Sampling and Analysis

Soil sampling was performed at five SWMU 44 sampling areas in order to complete delineation of inorganic and semivolatile exceedances recorded during the Zone C RFI. AOC 721 soil samples associated with these areas were analyzed for specific groups of parameters. SWMU 44/AOC 721 sample areas are as follows:

SWMU 44	**AOC 721**
044SB005	721SB001 sample series
044SB006	721SB006 sample series
044SB025	721SB008 sample series
044SB027	721SB007 sample series
044M0017	721SB002 – 721SB005 sample series

Samples were collected in two rounds. The 20 first-round samples were collected from the five AOC 721 sample areas and consisted of offsets to original SWMU 44 sample locations. Twelve second-round soil samples were collected at offsets to first-round AOC 721 soil boring locations that had detections in location specific parameters that exceeded screening criteria. Second-round samples were collected to confirm that AOC 721 results mirror those of SWMU 44. However, second round soil sampling as proposed at the May 2003 BCT meeting was based on non-validated data in order to expedite the RFI. Analytical results were screened against the AOC 721 background, Risk Based Concentration (RBC), and Sediment Screening Value (SSV) criteria in accordance with the December 2001 CNC Project Team Notebook. To complete the RFI process, AOC 721 soil analytical data will be screened against agreed upon SWMU 44 Soil Screening Levels criteria and results will be presented in the RFI report.

Soil samples were collected from the upper interval (0 to 1 ft bgs) at a total of 32 locations (Figure 2-1). Table 2.1 compares AOC 721 analytes detected in soil to screening criteria.

2.1.1 INORGANICS

721SB001 Sample Series

Soil samples from this location were not analyzed for inorganic constituents.

721SB002 – 721SB005 Sample Series

Arsenic, mercury, selenium, and thallium were detected in sediment sample 044M001701 at concentrations exceeding screening criteria used in developing the AOC 721 RFI work plan. Samples were collected from locations 721SB002, 721SB003, 721SB004, and 721SB005 that offset 044M0017. Second-round samples were collected at offset locations 721SB02A, 721SB03A, 721SB04A, and 721SB05A.

Arsenic detections exceeded RBC and SSV screening criteria at all locations. AOC 721 background for arsenic was exceeded in all locations except 721SB003 and 721SB04A. Concentrations of arsenic in 721SB002-721SB005 series samples are comparable to portions of SWMU 44 that were subjected to removal actions for arsenic in soil at three locations beneath the 1996 coal footprint.

Non-validated first-round data for thallium was originally viewed as exceeding background and RBC screening criteria at locations 721SB003, and 721SB004. Second-round offset locations 721SB03A and 721SB04A were subsequently proposed and scheduled based on first-round non-validated data to expedite the RFI. Consequently, thallium had been included in the second-round samples even though it was subsequently validated out as non-detect due to detections in laboratory preparation blanks. Second-round samples also had thallium detections in validated data that will be validated out due to identical detections in laboratory preparation blanks. Therefore, thallium is non-detect for all soil samples.

721SB006 Sample Series

Arsenic, selenium, and thallium were detected in soil sample 044SS00601 at concentrations that exceeded screening criteria used in developing the AOC 721 RFI work plan. First-round samples

were collected from locations 721SB06A, 721SB06B, 721SB06C, and 721SB06D that offset 721SB006. Second-round samples were collected at offset locations 721SB06E, 721SB06F, 721SB06G, and 721SB06H.

Arsenic was detected at all locations and at concentrations that exceeded RBC and SSV criteria. Detections of arsenic also exceeded AOC 721 background at all locations where analyzed except 721SB06B. Concentrations of arsenic in 721SB006 series samples are comparable to portions of SWMU 44 that were subjected to removal actions for arsenic in soil at three locations beneath the 1996 coal footprint.

Non-validated first-round data for thallium was originally viewed as exceeding background and RBC screening criteria at locations 721SB06A, 721SB06B, 721SB06C, and 721SB06D. Second-round offset locations 721SB06E, 721SB06F, 721SB06G, and 721SB06H were subsequently proposed and scheduled based on first-round non-validated data to expedite the RFI. Consequently, thallium had been included in the second-round samples even though it was subsequently validated out as non-detect due to detections in laboratory preparation blanks. Second-round samples also had thallium detections in validated data that will be validated out due to identical detections in laboratory preparation blanks. Therefore, thallium is non-detect for all soil samples.

721SB007 Sample Series

Samples for this series were analyzed for thallium. There were no detections in 721SB007 samples.

721SB008 Sample Series

Samples for this series were analyzed for beryllium, cobalt, and zinc. There were no exceedances detected in 721SB008 samples.

2.1.2 ORGANICS

721SB001 Sample Series

Semivolatile compounds (2-methynaphthalene, chrysene, naphthalene, pyrene, and phenathrene) were detected in SWMU 44 sample 044SS00501 at concentrations exceeding screening criteria used to develop the AOC 721 RFI work plan. Sample 721SB00101 was collected to address potential sheet flow transport of these compounds to AOC 721. Concentrations of the four compounds

detected at 721SB001 (chrysene, naphthalene, pyrene, and phenathrene) were less than RBC values but greater than the SSV. Chrysene, naphthalene, pyrene, and phenathrene were also detected in the subsequent four offset locations 721SB01A, 721SB01B, 721SB01C, and 721SB01D. Detections at 721SB01A and 721SB01B were all below RBC and SSV concentrations. Phenanthrene and pyrene concentrations at 721SB01C were less than RBC values, but remained slightly above SSV concentration values. Chrysene, phenanthrene, and pyrene detections at 721SB01D were less than RBC values but remained slightly above SSV concentration values (Figure 2.1).

The 1996 coal removal action was completed to a visual standard and not to analytical criteria. Coal dust and fragments worked into the surface soil during operation of the facility remain in the matrix and were observed in soil samples collected for semivolatile compounds. Distribution of semi-volatile compound concentrations presented in Figure 2.1 suggests that the removal was more complete in some areas than in others.

721SB002 – 721SB005 Sample Series

Soil samples from these locations were not analyzed for organic constituents.

721SB006 Sample Series

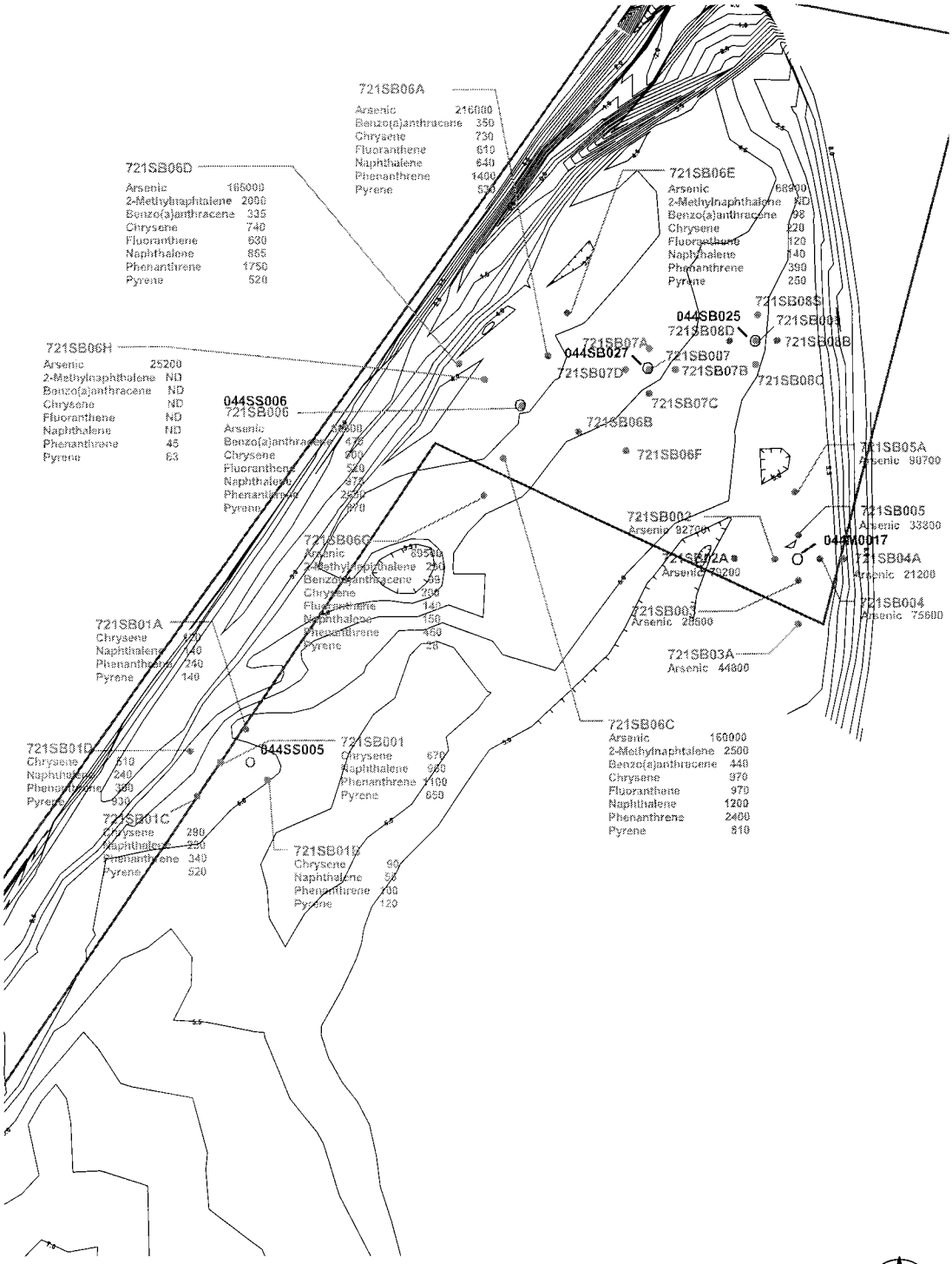
Semivolatile compounds (2-methynaphthalene, benzo(a)anthracene, chrysene, fluoranthene, naphthalene, pyrene, and phenathrene) were detected in SWMU 44 sample 044SS00601 at concentrations exceeding screening criteria consisting of AOC 721 background, and RBC and SSV values used to develop the AOC 721 RFI work plan. Benzo(a)anthracene, chrysene, fluoranthene, naphthalene, pyrene, and phenathrene were detected at 721SB006, and offset locations 721SB06A, 721SB06B, 721SB06C, and 721SB06D. Locations 721SB06C, and 721SB06D also had detections of 2-methylnaphthelene. All detections exceeded the SSV concentration of 330μg/kg, but were less than listed RBC values. Second-round samples were collected at offset locations 721SB06E, 721SB06F, 721SB06G, and 721SB06H to further delineate the SSV exceedance. All detections decreased to either non-detect or were less than the SSV concentration value except for phenanthrene at locations 721SB06E and 721SB06G. Detections of semivolatile compounds in 721SB006 series soil samples are due to the same mechanism stated for the 721SB001 series.

721SB007 Sample Series

Soil samples from this location were not analyzed for organic constituents.

721SB008 Sample Series

Soil samples from this location were not analyzed for organic constituents.



AOC 721
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CHARLESTON NAVAL COMPLEX
CHARLESTON, SC

FIGURE 2-1
Surface Soil Detection Exceedance Map
Concentrations in Micrograms/Kilogram

Date: JUNE 2003 | AOC 721 TECH MEMO.apr

Table 2.1
AOC 721 Analytes Detected in Surface Soils
Charleston Naval Complex, Charleston SC

Parameter	Sample ID	Date Sampled	Result	BKG AOC 721 Surface Soil	RBC	SSV
Inorganic Elements (mg/kg)						
Arsenic (As)	721SB00201	04/24/03	92.7	28.7	0.43	7.24
	721SB00301	04/24/03	28.6	28.7	0.43	7.24
	721SB00401	04/24/03	75.6	28.7	0.43	7.24
	721SB00501	04/24/03	33.8	28.7	0.43	7.24
	721SB00601	04/24/03	68.6	28.7	0.43	7.24
	721SB02A01	06/03/03	79.2	28.7	0.43	7.24
	721SB03A01	06/03/03	44.8	28.7	0.43	7.24
	721SB04A01	06/03/03	21.2	28.7	0.43	7.24
	721SB05A01	06/03/03	90.7	28.7	0.43	7.24
	721SB06A01	04/24/03	216	28.7	0.43	7.24
	721SB06B01	04/24/03	23.7	28.7	0.43	7.24
	721SB06C01	04/24/03	160	28.7	0.43	7.24
	721SB06D01	04/24/03	165	28.7	0.43	7.24
	721SB06E01	06/03/03	68.9	28.7	0.43	7.24
	721SB06G01	06/03/03	89.5	28.7	0.43	7.24
	721SB06H01	06/03/03	25.2	28.7	0.43	7.24
Beryllium (Be)	721SB00801	04/24/03	1.5	1.7	16	NL
	721SB08A01	04/24/03	0.57	1.7	16	NL
	721SB08B01	04/24/03	0.49	1.7	16	NL
	721SB08C01	04/24/03	1.0	1.7	16	NL
	721SB08D01	04/24/03	0.98	1.7	16	NL
Cobalt (Co)	721SB00801	04/24/03	19.5	11.4	160	NL
	721SB08A01	04/24/03	4.3	11.4	160	NL
	721SB08B01	04/24/03	8.1	11.4	160	NL
	721SB08C01	04/24/03	7.0	11.4	160	NL
	721SB08D01	04/24/03	7.5	11.4	160	NL

Table 2.1
AOC 721 Analytes Detected in Surface Soils
Charleston Naval Complex, Charleston SC

Parameter	Sample ID	Date Sampled	Result	BKG AOC 721 Surface Soil	RBC	SSV
Mercury (Hg)	721SB00201	04/24/03	0.17	1.5	2.3	0.13
	721SB00301	04/24/03	0.24	1.5	2.3	0.13
	721SB00401	04/24/03	0.13	1.5	2.3	0.13
	721SB00501	04/24/03	0.13	1.5	2.3	0.13
Selenium (Se)	721SB06A01	04/24/03	7.2	2.8	39	NL
	721SB06C01	04/24/03	5.0	2.8	39	NL
	721SB06D01	04/24/03	7.6	2.8	39	NL
Zinc (Zn)	721SB00801	04/24/03	211	226	2300	124
	721SB08A01	04/24/03	153	226	2300	124
	721SB08B01	04/24/03	74.9	226	2300	124
	721SB08C01	04/24/03	106	226	2300	124
	721SB08D01	04/24/03	147	226	2300	124
Semivolatile Compounds (μg/kg)						
2-METHYLNAPHTHALENE	721SB06C01	04/24/03	2500	NA	160000	330
	721SB06D01	04/24/03	2000	NA	160000	330
	721SB06E01	06/03/03	270	NA	160000	330
	721SB06G01	06/03/03	290	NA	160000	330
BENZO(A)ANTHRACENE	721SB00601RA	04/24/03	430	NA	870	330
	721SB06A01	04/24/03	350	NA	870	330
	721SB06B01	04/24/03	87	NA	870	330
	721SB06C01	04/24/03	440	NA	870	330
	721SB06D01	04/24/03	335	NA	870	330
	721SB06E01	06/03/03	98	NA	870	330
	721SB06G01	06/03/03	99	NA	870	330
CHRYSENE	721SB00101	04/24/03	670	NA	87000	330
	721SB00601RA	04/24/03	940	NA	87000	330
	721SB01A01	06/03/03	120	NA	87000	330

Table 2.1
AOC 721 Analytes Detected in Surface Soils
Charleston Naval Complex, Charleston SC

Parameter	Sample ID	Date Sampled	Result	BKG AOC 721 Surface Soil	RBC	SSV
	721SB01B01	06/03/03	90	NA	87000	330
	721SB01C01	06/03/03	290	NA	87000	330
	721SB01D01	06/03/03	510	NA	87000	330
	721SB06A01	04/24/03	730	NA	87000	330
	721SB06B01	04/24/03	180	NA	87000	330
	721SB06C01	04/24/03	970	NA	87000	330
	721SB06D01	04/24/03	740	NA	87000	330
	721SB06E01	06/03/03	220	NA	87000	330
	721SB06G01	06/03/03	200	NA	87000	330
FLUORANTHENE	721SB00601RA	04/24/03	680	NA	310000	330
	721SB06A01	04/24/03	610	NA	310000	330
	721SB06B01	04/24/03	160	NA	310000	330
	721SB06C01	04/24/03	970	NA	310000	330
	721SB06D01	04/24/03	630	NA	310000	330
	721SB06E01	06/03/03	120	NA	310000	330
	721SB06G01	06/03/03	140	NA	310000	330
NAPHTHALENE	721SB00101	04/24/03	960	NA	160000	330
	721SB00601RA	04/24/03	1000	NA	160000	330
	721SB01A01	06/03/03	140	NA	160000	330
	721SB01B01	06/03/03	55	NA	160000	330
	721SB01C01	06/03/03	230	NA	160000	330
	721SB01D01	06/03/03	240	NA	160000	330
	721SB06A01	04/24/03	640	NA	160000	330
	721SB06B01	04/24/03	180	NA	160000	330
	721SB06C01	04/24/03	1200	NA	160000	330
	721SB06D01	04/24/03	865	NA	160000	330
	721SB06E01	06/03/03	140	NA	160000	330

Table 2.1
AOC 721 Analytes Detected in Surface Soils
Charleston Naval Complex, Charleston SC

Parameter	Sample ID	Date Sampled	Result	BKG AOC 721 Surface Soil	RBC	SSV
	721SB06G01	06/03/03	150	NA	160000	330
PHENANTHRENE	721SB00101	04/24/03	1100	NA	NL	330
	721SB00601RA	04/24/03	2000	NA	NL	330
	721SB01A01	06/03/03	240	NA	NL	330
	721SB01B01	06/03/03	100	NA	NL	330
	721SB01C01	06/03/03	340	NA	NL	330
	721SB01D01	06/03/03	390	NA	NL	330
	721SB06A01	04/24/03	1400	NA	NL	330
	721SB06B01	04/24/03	320	NA	NL	330
	721SB06C01	04/24/03	2400	NA	NL	330
	721SB06D01	04/24/03	1750	NA	NL	330
	721SB06E01	06/03/03	390	NA	NL	330
	721SB06G01	06/03/03	460	NA	NL	330
	721SB06H01	06/03/03	45	NA	NL	330
PYRENE	721SB00101	04/24/03	650	NA	230000	330
	721SB00601RA	04/24/03	600	NA	230000	330
	721SB01A01	06/03/03	140	NA	230000	330
	721SB01B01	06/03/03	120	NA	230000	330
	721SB01C01	06/03/03	520	NA	230000	330
	721SB01D01	06/03/03	930	NA	230000	330
	721SB06A01	04/24/03	530	NA	230000	330
	721SB06B01	04/24/03	140	NA	230000	330
	721SB06C01	04/24/03	810	NA	230000	330
	721SB06D01	04/24/03	520	NA	230000	330
	721SB06E01	06/03/03	250	NA	230000	330
	721SB06G01	06/03/03	280	NA	230000	330
	721SB06H01	06/03/03	63	NA	230000	330

Notes:

BKG	=	Background
RBC	=	Risk Based Concentration
SSV	=	Sediment Screening Value
µg/kg	=	micrograms/kilogram
mg/kg	=	milligrams/kilogram
NL	=	Not Listed
NA	=	Not Applicable

2.2 Groundwater Sampling

Groundwater samples for laboratory analysis were collected from existing monitoring wells 044005, 044006, and 044007 (Figure 2-2). Table 2.2A compares AOC 721 COPCs that were detected in groundwater the AOC 721 background, Maximum Contaminant Level (MCL), RBC, and ecological screening criteria. Groundwater samples were collected to characterize potential groundwater contamination and establish geochemical patterns in accordance with the AOC 721 work plan. Analytes detected in groundwater samples collected during the AOC 721 RFI are discussed below.

2.2.1 INORGANIC

Arsenic

Detection of arsenic occurred in wells 044005 and 044006 during the last two sampling events and in well 044007 during all four events. However, detected concentrations in wells 044005 and 044006 were below background, MCL, and Saltwater Surface Water criteria. All detections of arsenic in well 044007 exceeded all three screening criteria. Detected concentrations of arsenic in wells 044005 and 044006 were uniform and close in value. Concentrations detected in well 044007 varied greatly and were orders of magnitude greater than those in 044005 and 044006. However, the mean concentration of arsenic in samples collected from well 044007 during AOC 721 sampling is 115.5μg/L. Arsenic detections and variation in concentrations is the result of geochemical fluctuations and not release from an upland source. Groundwater geochemistry is discussed in Section 2.2.3.

Beryllium

The only detection of beryllium that occurred during AOC 721 sampling was in the first event at well 044005. The detected concentration did not exceed any screening criteria.

Cobalt

The only detection of cobalt that occurred during AOC 721 sampling was in the first event at well 044006. The detected concentration did not exceed any screening criteria.

Iron

Detections of iron in groundwater occurred in the first two events at well 044005, and in all four events at wells 044006 and 044007. None of the detections exceeded background.

Selenium

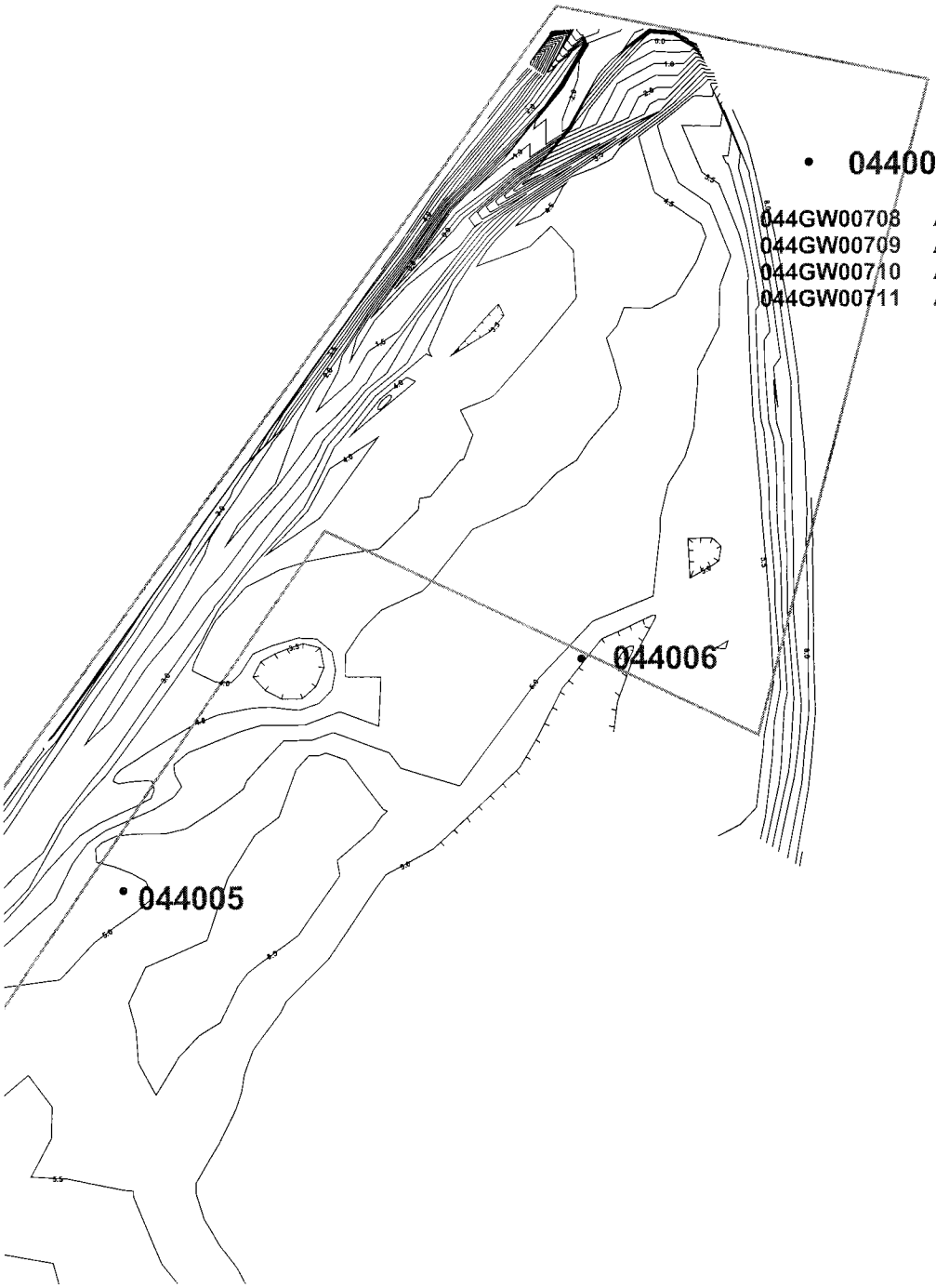
The only detection of selenium that occurred during AOC 721 sampling was in the second event at well 044005. The detected concentration did not exceed screening criteria.

Vanadium

Detections of vanadium in groundwater occurred in the second event at well 044005, and in the second and third events at wells 044006 and 044007. The detected concentrations did not exceed screening criteria.

2.2.2 ORGANICS

Groundwater samples collected during the first round of AOC 721 sampling were analyzed for 2-methynaphthalene, benzo(a)anthracene, chrysene, fluoranthene, naphthalene, pyrene, and phenathrene. There were no detections of these compounds in groundwater during the first sampling event. Therefore, additional samples were not collected for semivolatile compounds.



40 0 40 Feet

LEGEND

- AOC 721 Groundwater Sample Location
- Surface Topographic Contours
- AOC 721 RFI Boundary

AOC 721
RCRA FACILITY INVESTIGATION
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC

FIGURE 2-2
Groundwater Detection Exceedances
Concentrations in Micrograms/Liter

Date: JUNE 2003 | AOC 721 TECH MEMO.apr

Table 2.2A
AOC 721 Analyte Detections in Groundwater
Charleston Naval Complex, Charleston SC

Parameter	Sample ID	Date Sampled	Result	BKG AOC 721 Groundwater	MCL	RBC	Saltwater Surface Water Chronic	Saltwater Surface Water Acute
Inorganic Elements (μg/l)								
Arsenic (As)	044GW00509	5/21/2003	2.1	43	50	0.045	36	69
	044GW00510	06/05/03	2.8	43	50	0.045	36	69
	044GW00609	5/21/2003	2.1	43	50	0.045	36	69
	044GW00610	06/05/03	2.2	43	50	0.045	36	69
	044GW00708	04/22/03	66.9	43	50	0.045	36	69
	044GW00709	5/5/2003	136	43	50	0.045	36	69
	044GW00710	5/21/2003	53.2	43	50	0.045	36	69
	044GW00711	06/05/03	206	43	50	0.045	36	69
Beryllium (Be)	044GW00507	04/22/03	0.54	4.8	4	7.3	NL	NL
Cobalt (Co)	044GW00607	04/22/03	2.4	74.6	NL	220	NL	NL
Iron (Fe)	044GW00507	04/22/03	725	31900	300	1100	NL	NL
	044GW00508	5/5/2003	128	31900	300	1100	NL	NL
	044GW00607	04/22/03	4540	31900	300	1100	NL	NL
	044GW00608	5/5/2003	3625	31900	300	1100	NL	NL
	044GW00609	5/21/2003	3020	31900	300	1100	NL	NL
	044GW00610	06/05/03	1430	31900	300	1100	NL	NL
	044GW00708	04/22/03	1190	31900	300	1100	NL	NL
	044GW00709	5/5/2003	4420	31900	300	1100	NL	NL
	044GW00710	5/21/2003	1280	31900	300	1100	NL	NL
	044GW00711	06/05/03	6330	31900	300	1100	NL	NL
Selenium (Se)	044GW00708	04/22/03	5.7	26.7	50	18	71	300
Vanadium (V)	044GW00508	5/5/2003	1.1	12.9	NL	26	NL	NL
	044GW00608	5/5/2003	1.2	12.9	NL	26	NL	NL
	044GW00609	5/21/2003	1.1	12.9	NL	26	NL	NL
	044GW00708	04/22/03	3.9	12.9	NL	26	NL	NL

Table 2.2A
AOC 721 Analyte Detections in Groundwater
Charleston Naval Complex, Charleston SC

Parameter	Sample ID	Date Sampled	Result	BKG AOC 721 Groundwater	MCL	RBC	Saltwater Surface Water Chronic	Saltwater Surface Water Acute
	044GW00709	5/5/2003	1.8	12.9	NL	26	NL	NL
	044GW00710	5/21/2003	4.1	12.9	NL	26	NL	NL
Miscellaneous Compounds (mg/l)								
TOTAL ORGANIC CARBON	044GW00507	04/22/03	28.3	NA	NL	NL	NL	NL
	044GW00508	5/5/2003	31.1	NA	NL	NL	NL	NL
	044GW00509	5/21/2003	31.7	NA	NL	NL	NL	NL
	044GW00510	06/05/03	41.0	NA	NL	NL	NL	NL
	044GW00607	04/22/03	11.35	NA	NL	NL	NL	NL
	044GW00608	5/5/2003	14.55	NA	NL	NL	NL	NL
	044GW00609	5/21/2003	16.2	NA	NL	NL	NL	NL
	044GW00610	06/05/03	11.0	NA	NL	NL	NL	NL
	044GW00708	04/22/03	6.2	NA	NL	NL	NL	NL
	044GW00709	5/5/2003	8.6	NA	NL	NL	NL	NL
	044GW00710	5/21/2003	6.6	NA	NL	NL	NL	NL
	044GW00711	06/05/03	14.2	NA	NL	NL	NL	NL
TDS	044GW00507	04/22/03	12600	NA	NL	NL	NL	NL
	044GW00508	5/5/2003	14000	NA	NL	NL	NL	NL
	044GW00509	5/21/2003	13800	NA	NL	NL	NL	NL
	044GW00607	04/22/03	7815	NA	NL	NL	NL	NL
	044GW00608	5/5/2003	7470	NA	NL	NL	NL	NL
	044GW00609	5/21/2003	7715	NA	NL	NL	NL	NL
	044GW00708	04/22/03	699	NA	NL	NL	NL	NL
	044GW00709	5/5/2003	1150	NA	NL	NL	NL	NL
	044GW00710	5/21/2003	940	NA	NL	NL	NL	NL
	044GW00710	5/21/2003	942	NA	NL	NL	NL	NL
	044GW00510	06/05/03	15100	NA	NL	NL	NL	NL

Table 2.2A
AOC 721 Analyte Detections in Groundwater
Charleston Naval Complex, Charleston SC

Parameter	Sample ID	Date Sampled	Result	BKG AOC 721 Groundwater	MCL	RBC	Saltwater Surface Water Chronic	Saltwater Surface Water Acute
	044GW00610	06/05/03	7560	NA	NL	NL	NL	NL
	044GW00711	06/05/03	1130	NA	NL	NL	NL	NL

Notes:

BKG	=	Background
MCL	=	Maximum Contaminant Level
RBC	=	Risk Based Concentration
µg/L	=	micrograms/liter
mg/L	=	milligrams/liter
NL	=	Not Listed
NA	=	Not Applicable

2.2.3 Groundwater Geochemistry

Detections of arsenic in groundwater at well 044007 have exceeded background, RBC, and ecological screening criteria 8 times in 11 sampling events even though coal was not stored near this well location. Arsenic was also detected in wells 044004, 044005, and 044006 which are closer to the 1996 coal pile footprint. Arsenic concentrations in wells 044004, 044005, and 044006 were greatest in samples from well 044004 and ranged from 10.5 μg/L to 34.0 μg/L. However, these detections did not exceed AOC 721 screening criteria. Samples for evaluating groundwater geochemistry were collected 4 times over a 6 week period from wells 044005, 044006, and 044007 to evaluate:

- temporal variations in detected arsenic concentrations
- evaluate temporal variations in groundwater geochemistry
- determine the reason for arsenic detections in well 044007 which is located furthest from the footprint.

Concentrations of soluble arsenic in groundwater are frequently dependent upon redox conditions. Arsenates that have adsorbed onto hydrous iron and manganese oxides are relatively insoluble but may be released into groundwater under reducing conditions such as the release of Fe^{2+} into groundwater along with adsorbed arsenic during reduction of hydrous iron oxide.

Oxidation-reduction (redox) conditions and biological activity affect the concentration of dissolved arsenic in groundwater. Redox reactions involve the transfer of electrons but not necessarily molecular oxygen. Electron activity in a solution may therefore be expressed in volts. This may be qualitatively measured using an ORP meter. Voltages that are positive show a tendency for oxidizing conditions while voltages that are negative show a tendency for reducing conditions. Electron activity is also proportional to the ratio of reduced ion species to oxidized ion species and may be used to qualitatively estimate redox potential. Biological activity through bacterial decomposition of organic material may also affect redox conditions. Consequently, the reduction of chemical species through biological activity is affected by the distribution and type of organic material available. The amount of organic carbon in a sample is determined through laboratory analysis.

A Horiba U-22 and flow-through cell were used to measure pH, conductivity, ORP, dissolved oxygen

(DO), total dissolved solids (TDS), and salinity of well purge water prior to collecting groundwater samples. Horiba U-22 values recorded just prior to sample collection were compared to laboratory TOC, total iron (Fe), and arsenic analyses, and HACH spectrophotometric analysis for Fe and reduced iron (Fe^{2+}). Table 2.2B presents laboratory and field data collected for evaluating oxidation/reduction potential in groundwater.

Groundwater data were plotted on a graph to evaluate trends in parameters reflecting redox conditions, and arsenic concentrations in groundwater over time (Figures 2-2A, 2-2B, and 2-2C). TDS was plotted as a measure of dissolved constituents. DO was also plotted to see if a correlation with this parameter exists even though molecular oxygen may not be involved.

REDOX CONDITIONS

ORP readings were all negative values and ranged from -68 mv in sample 044GW00708 to -367 mv in sample 044GW00510 indicating that there is a tendency for reducing conditions. TOC is available for bacterial decay in groundwater and ranged from 6.2 mg/L in sample 044GW00708 to 41 mg/L in sample 044GW00510. Dissolved oxygen data appear to parallel ORP in wells 044006 and 044007, but not 044005. Laboratory results for Fe analysis ranged from non-detect in samples 044GW00509 and 044GW00510 to 6.33 mg/L in sample 044GW00711. For comparison, HACH method Fe was non-detect in all samples collected from well 044005 and ranged from 0.949 mg/L in sample 044GW00708 to 3.558 mg/L in sample 044GW00711. HACH method Fe^{2+} detections ranged from 0.883 mg/L in sample 044GW00610 to 3.665 mg/L in sample 044GW00711. Reduced iron was not detected in samples from well 044005. Detections of reduced iron were greater than half of the total iron detected using spectrophotometric analysis in the field, except for sample 044GW00711 in which all iron detected was in a reduced state.

Well 044005

The two arsenic detections were very close to detection limits and occurred in samples where Fe was not detected. ORP readings in samples from this well were the lowest values recorded for AOC 721. However, TOC concentrations in this well were the highest values recorded for AOC 721. Iron concentrations in samples collected from well 044005 were very low in comparison to 044006 and 044007, and reduced iron was not detected in groundwater from this location. Purge water emitted a hydrogen sulfide odor which further evidenced a reducing environment. However, the

geochemical environment at this location is of a different nature since none of the other wells had similar odor.

Well 044006

The two arsenic detections were very close to detection limits and occurred in samples where Fe concentrations were lower than in the previous two samples when arsenic was not detected. There were only trace level detections of arsenic after ORP values dropped from -164 mv to -305 mv. However, concentrations of Fe and Fe^{2+} decreased along with TOC concentrations indicating decreased solubility and release into groundwater. Even though Fe detected in laboratory analysis is comparable to that of well 044007 and there are indications that this is a reducing environment, the lack of detected arsenic may be due either to other reactions inhibiting solubility, or there simply is very little arsenic at this location.

A black precipitate was observed throughout water in the container of what was previously clear purge water as it had emerged from the discharge, but there was not an odor of hydrogen sulfide. This precipitate was not observed in purge water from either well 044005 or 044007 indicating that the geochemical environment at well 044006 differs slightly from that of the other wells.

Well 044007

Analytical data for TOC, Fe, Fe^{2+}, and arsenic have parallel trends over time indicating a very strong relationship between geochemical conditions and arsenic concentrations in groundwater. The strong relationship between TOC, arsenic, Fe, and Fe^{2+} verifies that arsenic detections in groundwater samples from 044007 are the result of geochemical reactions and not from an anthropomorphic source. A dynamic geochemical environment at this location is illustrated by variations in arsenic and iron concentrations, and the redox parameters recorded during the six-week AOC 721 RFI groundwater program.

Table 2.2B
AOC 721 Groundwater Redox Evaluation Data
Charleston Naval Complex, Charleston SC

Location	Sample Date			
	4/22/2003	5/5/2003	5/21/2003	6/5/2003
Well 044005				
pH	7.82	6.9	7.09	7.2
Conductivity (mS/cm)	20.9	24.3	22	18.3
ORP (mv)	-330	-360	-344	-367
DO (mg/L)	0.62	0.31	1.36	1.21
TOC (mg/L)	28.3	31.1	31.7	41
TDS (g/L)	12,600	14,000	13,800	15,100
SAL (%)	1.25	1.49	1.33	1.1
Fe 8147 (mg/L)	ND	ND	ND	ND
Fe 2 8146 (mg/L)	NA	NA	ND	ND
Fe Lab (mg/L)	0.725	0.128	0.0556u	0.0556u
As Lab (mg/L)	0.0025u	0.0025u	0.0021J	0.0028J
Well 044006				
pH	7.75	6.87	7.13	7.2
Conductivity (mS/cm)	15.7	14.3	14.4	9.4
ORP (mv)	-164	-212	-305	-250
DO (mg/L)	0.43	0.43	1.3	1.75
TOC (mg/L)	11.8	14.6	17.5	11
TDS (g/L)	7,815	7,470	7,715	7,560
SAL (%)	0.91	0.91	0.82	0.5
Fe 8147 (mg/L)	2.55	2.475	2.953	1.699
Fe 2 8146 (mg/L)	NA	NA	1.875	0.883
Fe Lab (mg/L)	4.62	3.52	2.9	1.43
As Lab (mg/L)	0.0025u	0.0025u	0.0021J	0.0022J
Well 044007				
pH	7.66	6.83	6.95	7.07
Conductivity (mS/cm)	1.18	2.07	1.65	1.9
ORP (mv)	-68	-136	-110	-101
DO (mg/L)	2.36	0.54	1.43	1.85
TOC (mg/L)	6.2	8.6	6.6	14.2
TDS (g/L)	699	1,150	940	1,130
SAL (%)	0.5	0.1	0.08	0.1
Fe 8147 (mg/L)	0.949	2.985	1.649	3.558
Fe 2 8146 (mg/L)	NA	NA	0.868	3.665
Fe Lab (mg/L)	1.19	4.42	1.28	6.33
As Lab (mg/L)	0.0669	0.136	0.0532	0.206

Notes:
mS/cm = milliSiemens/centimeter
mv = millivolt
g/L = gram/liter

%	=	percent
mg/L	=	milligram/liter
NA	=	Not Analyzed
ND	=	Not Detected
U	=	non-detect
J	=	estimated value

Figure 2-2A
Well 044005 Groundwater Geochemical Data

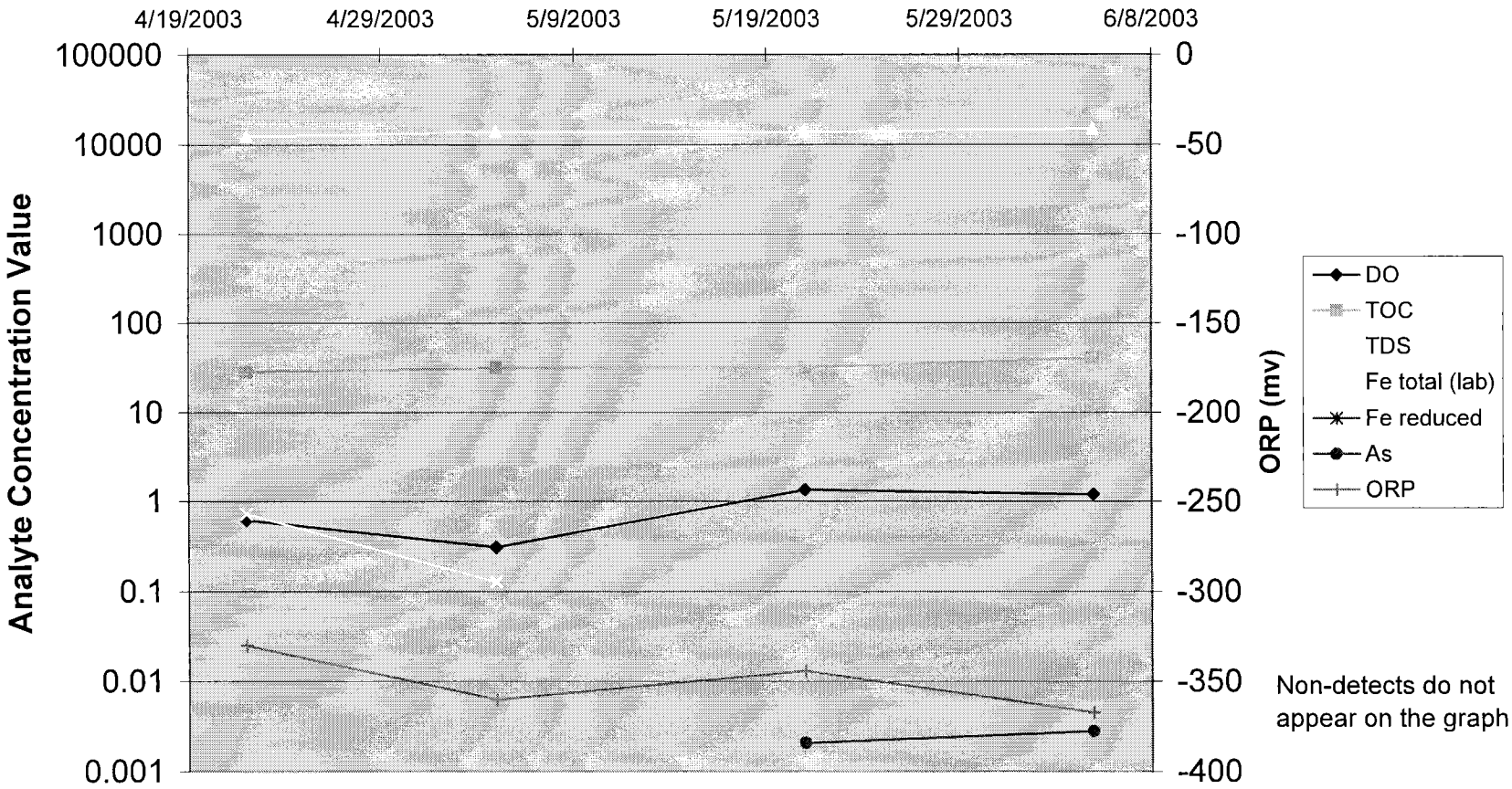


Figure 2-2B
Well 044006 Groundwater Geochemical Data

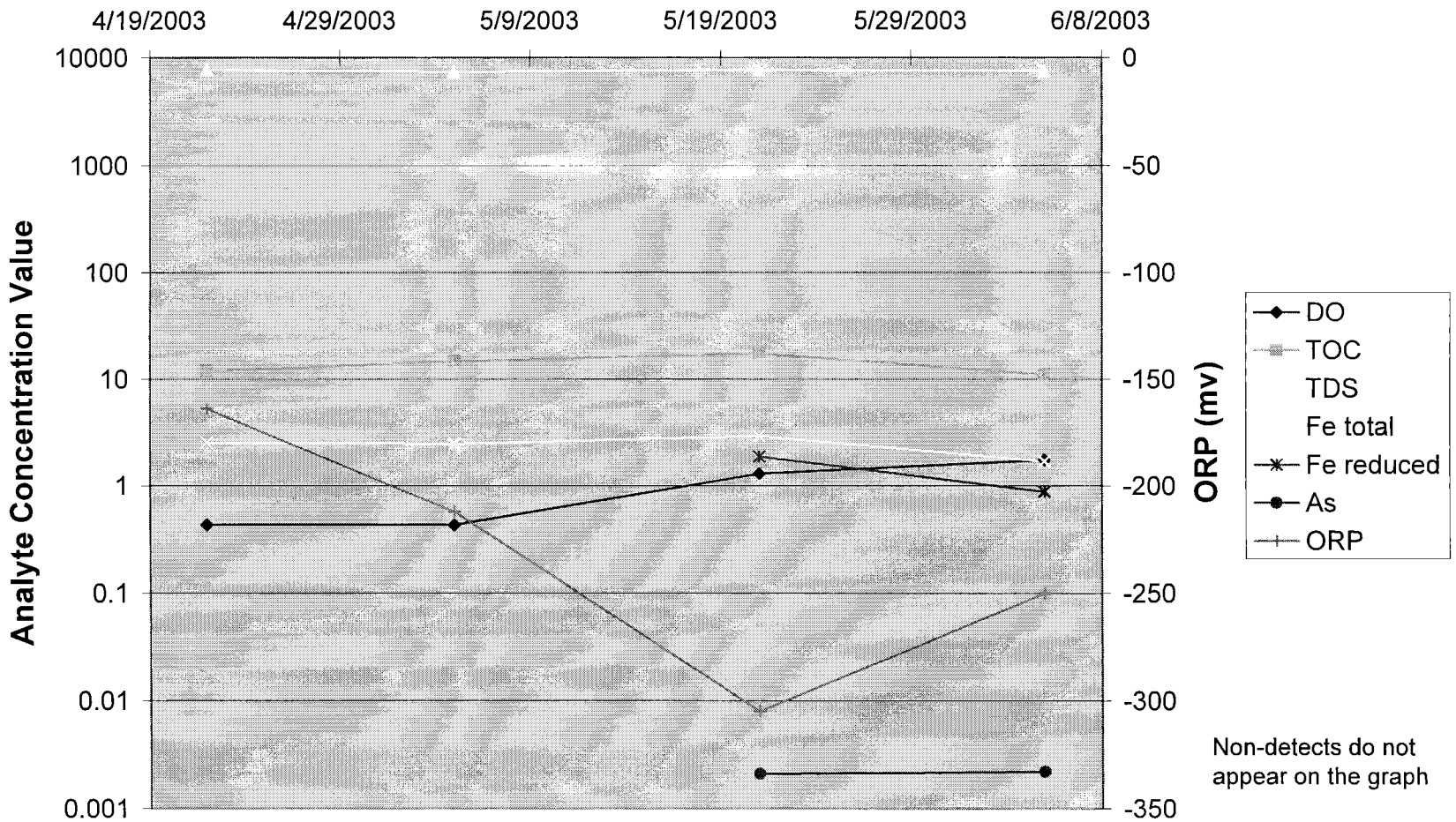
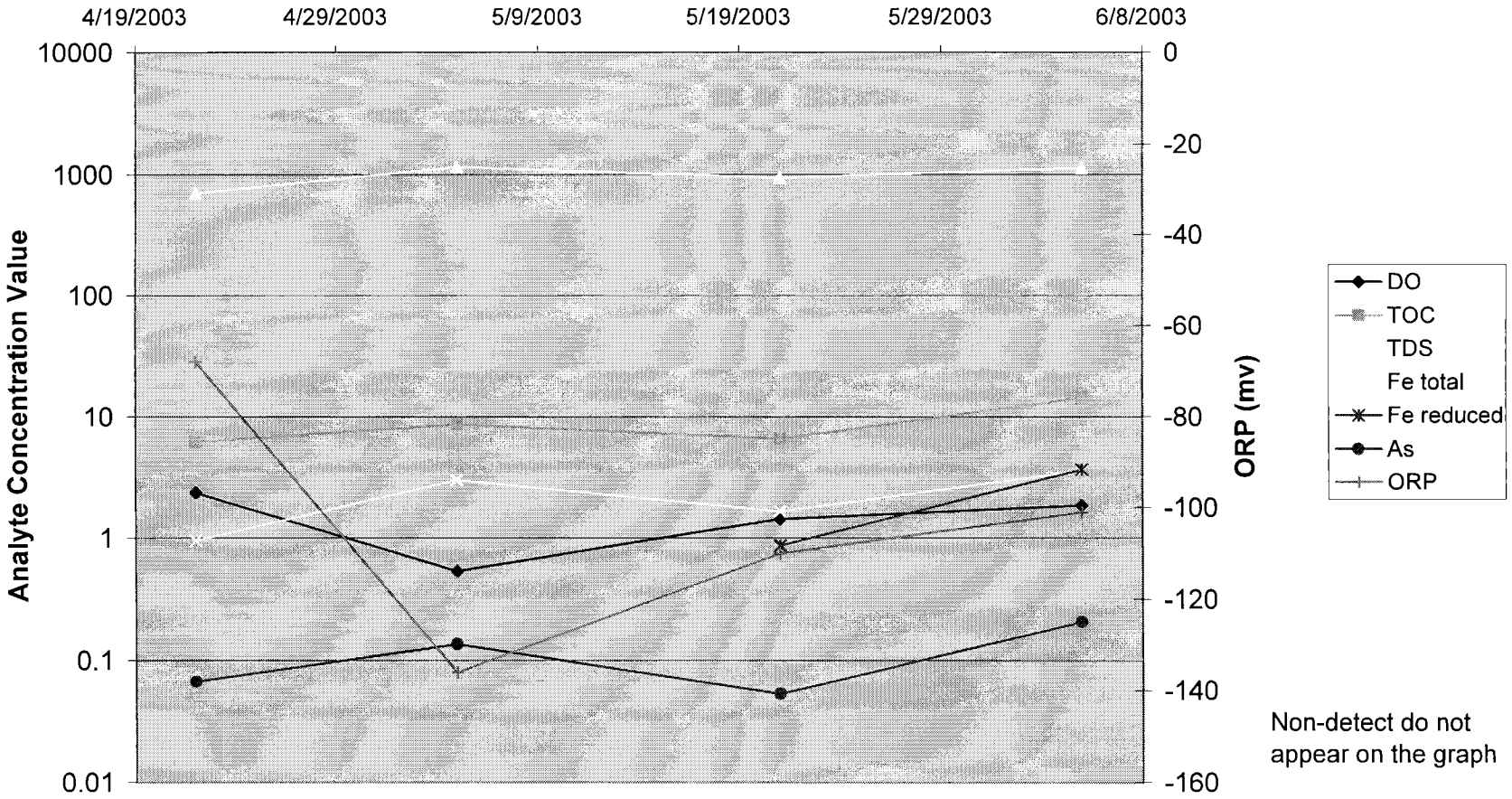


Figure 2-2C
Well 044007 Groundwater Geochemical Data



Non-detect do not appear on the graph

2.3 Sediment Sampling

Sediment samples for laboratory analysis were collected from 13 locations (721MD001 – 721MD013) along the northeast trending drainage ditch (Figure 2-3). Table 2.3 compares AOC 721 analytes detected in sediments to appropriate screening criteria. Detected analytes are discussed below.

2.3.1 INORGANICS

Arsenic

All sediment samples collected from the drainage ditch had detections of arsenic. Detected concentrations ranged from 2.5 mg/kg at 721MD013 to 75.9 mg/kg at 721MD005. All of the detections exceeded the RBC. Although 10 of the 13 detections exceeded the SSV concentration, only four exceeded AOC 721 background.

Beryllium

Seven of 13 sediment samples collected from the drainage ditch had detections of beryllium that ranged from 0.72 mg/kg at 721MD003 to 5.4 mg/kg at 721MD005. None of the detections exceeded the RBC, and only three of the seven detections exceeded AOC 721 background. There is no SSV listed for beryllium.

Cobalt

All sediment samples collected from the drainage ditch had detections of cobalt that ranged from 0.77 mg/kg at 721MD012 to 33.2 mg/kg at 721MD005. None of the detections exceeded the RBC, and only two of the 13 detections exceeded AOC 721 background. There is no SSV listed for cobalt.

Mercury

All sediment samples collected from the drainage ditch had detections of mercury that ranged from 0.044 mg/kg at 721MD013 to 1.1 mg/kg at 721MD010. None of the detections exceeded the RBC or AOC 721 background. However, 11 of the 13 detections exceeded the SSV concentration.

Zinc

All sediment samples collected from the drainage ditch had detections of zinc that ranged from 31.7 mg/kg at 721MD013 to 699 mg/kg at 721MD010. None of the detections exceeded the RBC, four

of the 13 detections exceeded AOC 721 background, and six detections exceeded the SSV. concentration.

2.3.2 ORGANICS

2-Methylnaphthalene

All sediment samples collected from the drainage ditch had detections of 2-methylnaphthalene that ranged from 30 μg/kg at 721MD002 to 940 μg/kg at 721MD009. None of the detections exceeded the RBC, and six detections exceeded the SSV.

Benzo(a)anthracene

All sediment samples collected from the drainage ditch had detections of benzo(a)anthracene that ranged from 38 μg/kg at 721MD012 to 1400 μg/kg at 721MD009. Two of the detections exceeded the RBC, and five detections exceeded the SSV.

Chrysene

All sediment samples collected from the drainage ditch had detections of chrysene that ranged from 66 μg/kg at 721MD012 to 1500 μg/kg at 721MD009. None of the detections exceeded the RBC, and seven detections exceeded the SSV.

Fluoranthene

All sediment samples collected from the drainage ditch had detections of fluoranthene that ranged from 79 μg/kg at 721MD012 to 5400 μg/kg at 721MD013. None of the detections exceeded the RBC, and eight detections exceeded the SSV.

Naphthalene

Nine of 13 sediment samples collected from the drainage ditch had detections of naphthalene that ranged from 81 μg/kg at 721MD012 to 570 μg/kg at 721MD009. None of the detections exceeded the RBC, and 5 of the 9 detections exceeded the SSV.

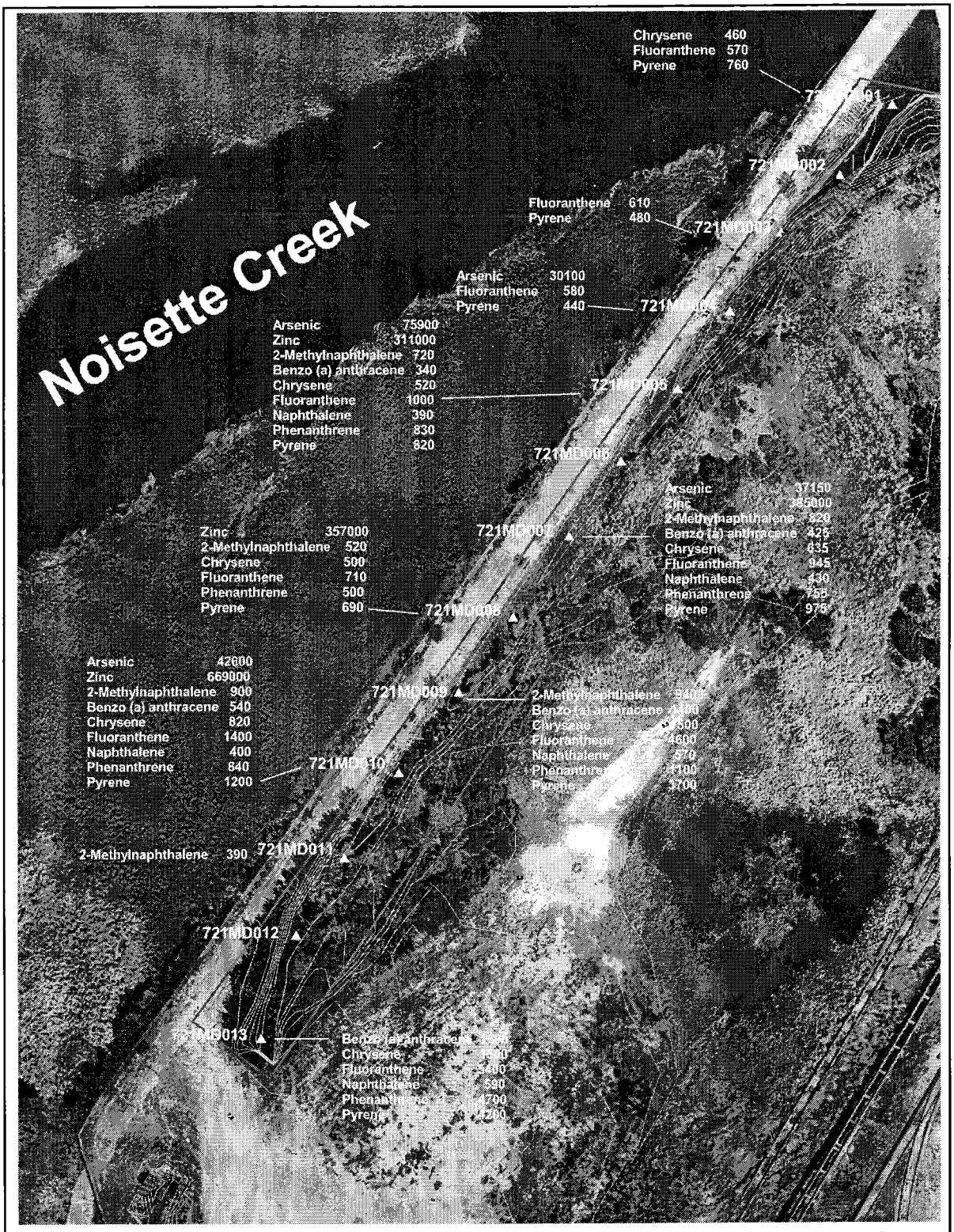
Phenanthrene

All sediment samples collected from the drainage ditch had detections of phenanthrene that ranged from 74 μg/kg at 721MD002 to 4700 μg/kg at 721MD013. No RBC value is listed for this

compound. Six detections exceeded the SSV.

Pyrene

All sediment samples collected from the drainage ditch had detections of pyrene that ranged from 76 μg/kg at 721MD012 to 4200 μg/kg at 721MD013. None of the detections exceeded the RBC, and nine detections exceeded the SSV.



50 0 50 Feet

LEGEND

AOC 721 Ditch Sediment Sample

Surface Topographic Contours

AOC 721
RCRA FACILITY INVESTIGATION
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC

FIGURE 2-3
Sediment Sample Detection Excedances
Concentrations in Micrograms/Kilogram

Date: JUNE 2003 | AOC 721 TECH MEMO.apr

Table 2.3
AOC 721 Analytes Detected in Sediment
Charleston Naval Complex

Parameter	Sample ID	Date Sampled	Result	BKG AOC 721 Surface Soil	RBC	SSV
Inorganic Elements (mg/kg)						
Arsenic (As)	721MD00101	04/23/03	15.9	28.7	0.43	7.24
	721MD00201	04/23/03	17.1	28.7	0.43	7.24
	721MD00301	04/23/03	15	28.7	0.43	7.24
	721MD00401	04/23/03	30.1	28.7	0.43	7.24
	721MD00501	04/23/03	75.9	28.7	0.43	7.24
	721MD00601	04/23/03	5.9	28.7	0.43	7.24
	721MD00701	04/23/03	37.15	28.7	0.43	7.24
	721MD00801	04/23/03	28	28.7	0.43	7.24
	721MD00901	04/23/03	21.6	28.7	0.43	7.24
	721MD01001	04/23/03	42.6	28.7	0.43	7.24
	721MD01101	04/23/03	12.6	28.7	0.43	7.24
	721MD01201	04/23/03	3.5	28.7	0.43	7.24
	721MD01301	04/23/03	3.8	28.7	0.43	7.24
Beryllium (Be)	721MD00101	04/23/03	0.88	1.7	16	NL
	721MD00301	04/23/03	0.72	1.7	16	NL
	721MD00401	04/23/03	2	1.7	16	NL
	721MD00501	04/23/03	5.4	1.7	16	NL
	721MD00901	04/23/03	1.2	1.7	16	NL
	721MD01001	04/23/03	2	1.7	16	NL
	721MD01101	04/23/03	0.46	1.7	16	NL
Cobalt (Co)	721MD00101	04/23/03	5.2	11.4	160	NL
	721MD00201	04/23/03	2.8	11.4	160	NL
	721MD00301	04/23/03	4.5	11.4	160	NL
	721MD00401	04/23/03	11.6	11.4	160	NL
	721MD00501	04/23/03	33.2	11.4	160	NL
	721MD00601	04/23/03	1.6	11.4	160	NL
	721MD00701	04/23/03	7.2	11.4	160	NL

Table 2.3
AOC 721 Analytes Detected in Sediment
Charleston Naval Complex

Parameter	Sample ID	Date Sampled	Result	BKG AOC 721 Surface Soil	RBC	SSV
	721MD00801	04/23/03	5.2	11.4	160	NL
	721MD00901	04/23/03	4.1	11.4	160	NL
	721MD01001	04/23/03	10.5	11.4	160	NL
	721MD01101	04/23/03	2.3	11.4	160	NL
	721MD01201	04/23/03	0.77	11.4	160	NL
	721MD01301	04/23/03	1	11.4	160	NL
Zinc (Zn)	721MD00101	04/23/03	118	266	2300	124
	721MD00201	04/23/03	50.7	266	2300	124
	721MD00301	04/23/03	132	266	2300	124
	721MD00401	04/23/03	202	266	2300	124
	721MD00501	04/23/03	311	266	2300	124
	721MD00601	04/23/03	65.7	266	2300	124
	721MD00701	04/23/03	385	266	2300	124
	721MD00801	04/23/03	357	266	2300	124
	721MD00901	04/23/03	85.5	266	2300	124
	721MD01001	04/23/03	669	266	2300	124
	721MD01101	04/23/03	113	266	2300	124
	721MD01201	04/23/03	40.5	266	2300	124
	721MD01301	04/23/03	31.7	266	2300	124
Mercury (Hg)	721MD00101	04/23/03	0.33	1.5	2.3	0.13
	721MD00201	04/23/03	0.43	1.5	2.3	0.13
	721MD00301	04/23/03	0.78	1.5	2.3	0.13
	721MD00401	04/23/03	0.35	1.5	2.3	0.13
	721MD00501	04/23/03	0.32	1.5	2.3	0.13
	721MD00601	04/23/03	0.04	1.5	2.3	0.13
	721MD00701	04/23/03	0.46	1.5	2.3	0.13
	721MD00801	04/23/03	0.46	1.5	2.3	0.13
	721MD00901	04/23/03	0.071	1.5	2.3	0.13

Table 2.3
AOC 721 Analytes Detected in Sediment
Charleston Naval Complex

Parameter	Sample ID	Date Sampled	Result	BKG AOC 721 Surface Soil	RBC	SSV
	721MD01001	04/23/03	1.1	1.5	2.3	0.13
	721MD01101	04/23/03	0.27	1.5	2.3	0.13
	721MD01201	04/23/03	0.36	1.5	2.3	0.13
	721MD01301	04/23/03	0.044	1.5	2.3	0.13
Semivolatile Compounds (μg/kg)						
2-Methylnaphthalene	721MD00201	04/23/03	30	NA	160000	330
	721MD00301	04/23/03	57	NA	160000	330
	721MD00401	04/23/03	240	NA	160000	330
	721MD00501	04/23/03	720	NA	160000	330
	721MD00601	04/23/03	74	NA	160000	330
	721MD00701	04/23/03	820	NA	160000	330
	721MD00801	04/23/03	520	NA	160000	330
	721MD00901	04/23/03	940	NA	160000	330
	721MD01001	04/23/03	900	NA	160000	330
	721MD01101	04/23/03	380	NA	160000	330
	721MD01201	04/23/03	170	NA	160000	330
	721MD01301	04/23/03	230	NA	160000	330
Benzo(A)Anthracene	721MD00101	04/23/03	310	NA	870	330
	721MD00201	04/23/03	130	NA	870	330
	721MD00301	04/23/03	310	NA	870	330
	721MD00401	04/23/03	220	NA	870	330
	721MD00501	04/23/03	340	NA	870	330
	721MD00601	04/23/03	48	NA	870	330
	721MD00701	04/23/03	425	NA	870	330
	721MD00801	04/23/03	320	NA	870	330
	721MD00901	04/23/03	1400	NA	870	330
	721MD01001	04/23/03	540	NA	870	330
	721MD01101	04/23/03	120	NA	870	330

Table 2.3
AOC 721 Analytes Detected in Sediment
Charleston Naval Complex

Parameter	Sample ID	Date Sampled	Result	BKG AOC 721 Surface Soil	RBC	SSV
	721MD01201	04/23/03	38	NA	870	330
	721MD01301	04/23/03	1100	NA	870	330
Chrysene	721MD00101	04/23/03	460	NA	87000	330
	721MD00201	04/23/03	160	NA	87000	330
	721MD00301	04/23/03	320	NA	87000	330
	721MD00401	04/23/03	290	NA	87000	330
	721MD00501	04/23/03	520	NA	87000	330
	721MD00601	04/23/03	83	NA	87000	330
	721MD00701	04/23/03	635	NA	87000	330
	721MD00801	04/23/03	500	NA	87000	330
	721MD00901	04/23/03	1500	NA	87000	330
	721MD01001	04/23/03	820	NA	87000	330
	721MD01101	04/23/03	150	NA	87000	330
	721MD01201	04/23/03	66	NA	87000	330
	721MD01301	04/23/03	1300	NA	87000	330
Fluoranthene	721MD00101	04/23/03	570	NA	310000	330
	721MD00201	04/23/03	290	NA	310000	330
	721MD00301	04/23/03	610	NA	310000	330
	721MD00401	04/23/03	580	NA	310000	330
	721MD00501	04/23/03	1000	NA	310000	330
	721MD00601	04/23/03	160	NA	310000	330
	721MD00701	04/23/03	945	NA	310000	330
	721MD00801	04/23/03	710	NA	310000	330
	721MD00901	04/23/03	4600	NA	310000	330
	721MD01001	04/23/03	1400	NA	310000	330
	721MD01101	04/23/03	230	NA	310000	330
	721MD01201	04/23/03	79	NA	310000	330
	721MD01301	04/23/03	5400	NA	310000	330

Table 2.3
AOC 721 Analytes Detected in Sediment
Charleston Naval Complex

Parameter	Sample ID	Date Sampled	Result	BKG AOC 721 Surface Soil	RBC	SSV
Naphthalene	721MD00401	04/23/03	130	NA	160000	330
	721MD00501	04/23/03	390	NA	160000	330
	721MD00701	04/23/03	430	NA	160000	330
	721MD00801	04/23/03	300	NA	160000	330
	721MD00901	04/23/03	570	NA	160000	330
	721MD01001	04/23/03	400	NA	160000	330
	721MD01101	04/23/03	190	NA	160000	330
	721MD01201	04/23/03	81	NA	160000	330
	721MD01301	04/23/03	470	NA	160000	330
Phenanthrene	721MD00101	04/23/03	150	NA	NL	330
	721MD00201	04/23/03	74	NA	NL	330
	721MD00301	04/23/03	140	NA	NL	330
	721MD00401	04/23/03	290	NA	NL	330
	721MD00501	04/23/03	830	NA	NL	330
	721MD00601	04/23/03	93	NA	NL	330
	721MD00701	04/23/03	755	NA	NL	330
	721MD00801	04/23/03	500	NA	NL	330
	721MD00901	04/23/03	1100	NA	NL	330
	721MD01001	04/23/03	840	NA	NL	330
	721MD01101	04/23/03	300	NA	NL	330
	721MD01201	04/23/03	130	NA	NL	330
	721MD01301	04/23/03	4700	NA	NL	330
Pyrene	721MD00101	04/23/03	760	NA	230000	330
	721MD00201	04/23/03	310	NA	230000	330
	721MD00301	04/23/03	480	NA	230000	330
	721MD00401	04/23/03	440	NA	230000	330
	721MD00501	04/23/03	820	NA	230000	330
	721MD00601	04/23/03	120	NA	230000	330

Table 2.3
AOC 721 Analytes Detected in Sediment
Charleston Naval Complex

Parameter	Sample ID	Date Sampled	Result	BKG AOC 721 Surface Soil	RBC	SSV
	721MD00701	04/23/03	975	NA	230000	330
	721MD00801	04/23/03	690	NA	230000	330
	721MD00901	04/23/03	3700	NA	230000	330
	721MD01001	04/23/03	1200	NA	230000	330
	721MD01101	04/23/03	230	NA	230000	330
	721MD01201	04/23/03	76	NA	230000	330
	721MD01301	04/23/03	4200	NA	230000	330

Notes:

BKG	=	Background
RBC	=	Risk Based Concentration
SSV	=	Sediment Screening Value
µg/kg	=	micrograms/kilogram
mg/kg	=	milligrams/kilogram
NL	=	Not Listed
NA	=	Not Applicable

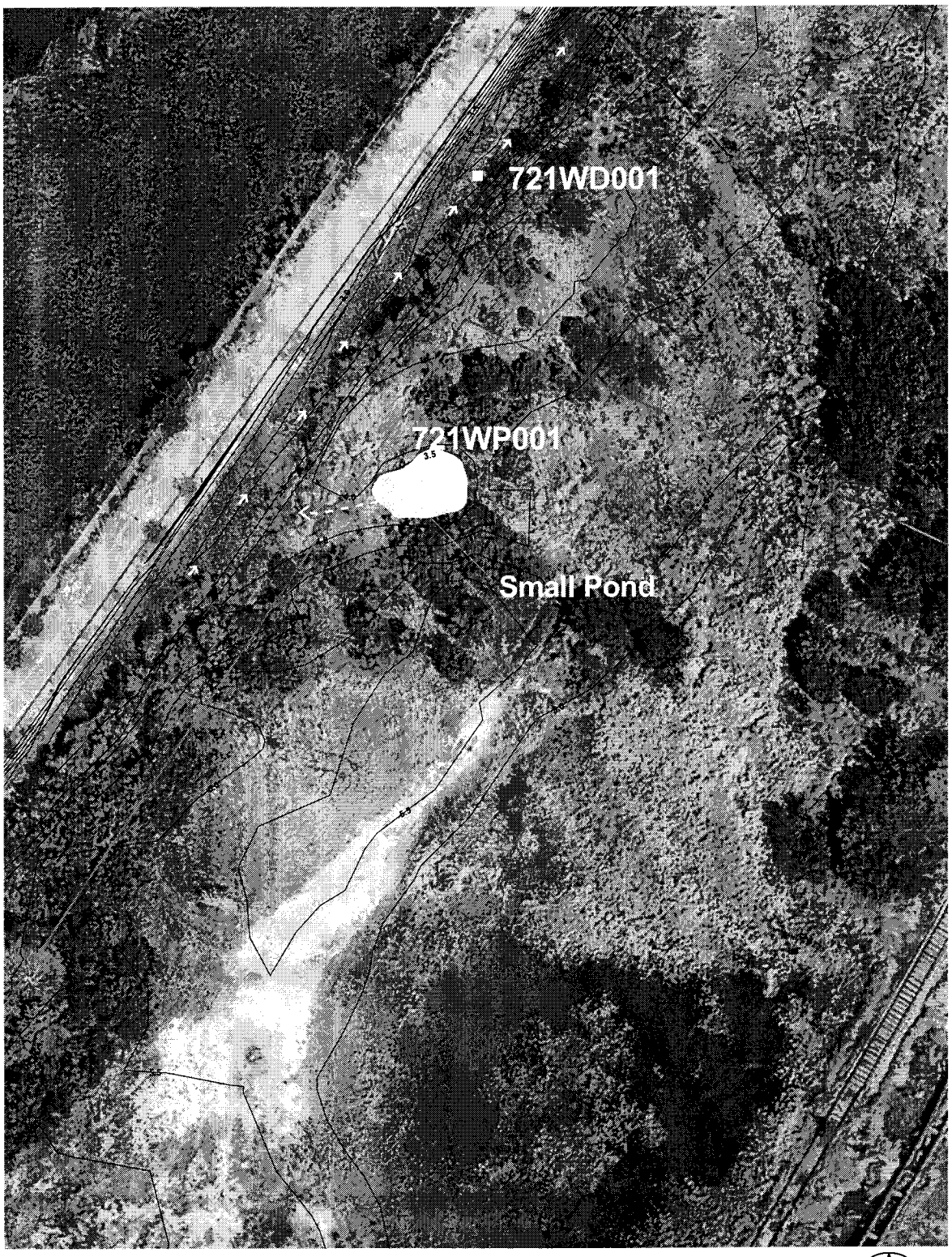
2.4 Surface Water Sampling

Two surface water sample locations (721WP001 and 721WD001) were proposed for AOC 721 (Figure 2-4). Sample 721WP00101 was collected at mid-tide from the small pond that adjoins the AOC 721 drainage ditch. Two samples (one at low tide (721WD00101) and a second at high tide (721WD00102)) were collected from the ditch at location 721WD001. Table 2.4 compares AOC 721 analytes detected in surface water to appropriate screening criteria.

Analytical results of surface water collected from the small pond and both tidal events in the AOC 721 ditch are similar with respect to calcium, magnesium, chloride, sulfate, TDS, conductance, and salinity. These data indicate that water in the small pond is the result of occasional flooding of the depression during high tide events that rise above the mean high water elevation of 3.5 feet (msl) and not from groundwater discharge.

Pond water samples were also analyzed for arsenic, cobalt, thallium, 2-methylnaphthalene, benzo(a)anthracene, chrysene, fluoranthene, naphthalene, phenanthrene, and pyrene due to the potential for sheet-flow runoff from the 721SB006 area. There were no detections of semivolatile compounds in samples collected from the small pond. However, arsenic, cobalt, and thallium were detected. Arsenic and thallium detections were at concentration values an order of magnitude less than the listed Saltwater Surface Water Chronic and Acute values (Table 2.4). There are no Saltwater Surface Water Chronic and Acute values listed for cobalt.

AOC 721 ditch samples were also analyzed for arsenic, beryllium, cobalt, selenium, thallium, zinc, 2-methylnaphthalene, benzo(a)anthracene, chrysene, fluoranthene, naphthalene, phenanthrene, and pyrene due to the potential for sheet-flow runoff from AOC 721 and portions of SWMU 44. There were no detections of semivolatile compounds in samples collected from the ditch. The only detection was of beryllium (0.32 and 0.33 μg/L), which has no listed Saltwater Surface Water Chronic and Acute value (Table 2.4). The detections for both low tide and high tide are essentially identical indicating that the detection of beryllium is not related to AOC 721.



30 0 30 Feet

LEGEND

AOC 721 Surface Water Sample Location

Ditch Drainage

Small Pond

Surface Topographic Contours

AOC 721
RCRA FACILITY INVESTIGATION
CHARLESTON NAVAL COMPLEX
CHARLESTON, SC

FIGURE 2-4
Surface Water Detection Excedances

Date: JUNE 2003 | AOC 721 TECH MEMO.apr

Table 2.4
AOC 721 Analytes Detected in Surface Water
Charleston Naval Complex, Charleston SC

Parameter	Sample ID	Date Sampled	Result	Saltwater Surface Water Chronic	Saltwater Surface Water Acute
Inorganic Elements (μg/l)					
Arsenic (As)	721WP00101	04/21/03	3.6	36	69
Beryllium (Be)	721WD00101	04/22/03	0.32	NL	NL
	721WD00102	04/21/03	0.33	NL	NL
Calcium (Ca)	721WD00101	04/22/03	169000	NL	NL
	721WD00102	04/21/03	125000	NL	NL
	721WP00101	04/21/03	164000	NL	NL
Cobalt (Co)	721WP00101	04/21/03	1.1	NL	NL
Magnesium (Mg)	721WD00101	04/22/03	331000	NL	NL
	721WD00102	04/21/03	382000	NL	NL
	721WP00101	04/21/03	403000	NL	NL
Potassium (K)	721WD00101	04/22/03	126000	NL	NL
	721WD00102	04/21/03	147000	NL	NL
	721WP00101	04/21/03	152000	NL	NL
Sodium (Na)	721WD00101	04/22/03	2340000	NL	NL
	721WD00102	04/21/03	2680000	NL	NL
	721WP00101	04/21/03	284500	NL	NL
Thallium (Tl)	721WP00101	04/21/03	4.3	21.3	213
Miscellaneous Analyses					
Salinity (g/l)	721WD00101	04/22/03	9.6	NA	NA
	721WD00102	04/21/03	11.2	NA	NA
	721WP00101	04/21/03	11.15	NA	NA
Total Suspended Solids (mg/l)	721WD00101	04/22/03	20.0	NA	NA
	721WP00101	04/21/03	47	NA	NA
Chloride (mg/l)	721WD00101	04/22/03	5280	NA	NA
	721WD00102	04/21/03	6170	NA	NA
	721WP00101	04/21/03	6165	NA	NA
Sulfate, Turbid (mg/l)	721WD00101	04/22/03	667	NA	NA

Table 2.4
AOC 721 Analytes Detected in Surface Water
Charleston Naval Complex, Charleston SC

Parameter	Sample ID	Date Sampled	Result	Saltwater Surface Water Chronic	Saltwater Surface Water Acute
	721WD00102	04/21/03	791	NA	NA
	721WP00101	04/21/03	864	NA	NA
Conductance (umhos)	721WD00101	04/22/03	16000	NA	NA
	721WD00102	04/21/03	18000	NA	NA
	721WD00102	04/21/03	18000	NA	NA
	721WP00101	04/21/03	17950	NA	NA
TDS (mg/l)	721WD00101	04/22/03	10300	NA	NA
	721WD00102	04/21/03	11500	NA	NA
	721WP00101	04/21/03	11500	NA	NA

Notes:

µg/L	=	micrograms/liter
mg/L	=	milligrams/liter
g/L	=	gram/liter
µmhos	=	micromhos
NL	=	Not Listed
NA	=	Not Applicable

3.0 CONCLUSIONS and RECOMMENDATIONS

SOIL

Two areas (721SB002-721SB005 and 721SB006) remain that exceed AOC 721 background values for arsenic. The area associated with 721SB002-721SB005 samples has been delineated to the west by 721SB06F, to the north by 721SB08C, to the east by 721SB04A, and to the south it is bounded by the north removal pond area. The 721SB006 series area is delineated to the east by locations 721SB06B and 721SB07D. Arsenic concentration at 721SB06E to the north is one-third that of location 721SB06A and to the south at 721SB06G it is approximately one-half of 721SB06C. Delineation to the west is by AOC 721 ditch locations 721MD004 and 721MD005. Although both ditch sample locations had arsenic concentrations greater than background, they are bounded upstream and down by less than background.

The detected semivolatile compounds are the result of coal dust contained in soil samples. Coal removal to visual standards during the 1996 IM was non-uniform leaving residual coal in the soil matrix as indicated by distribution of semivolatile compound concentrations. Therefore, soil at AOC 721 has been sufficiently characterized to proceed with the RFI Report without collection of additional soil samples.

GROUNDWATER

AOC 721 RFI sampling has reduced the analytes of concern to arsenic in groundwater at well 044007. Arsenic concentrations in groundwater samples from well 044007 have been shown to vary widely in a six week time period, ranging from 66.9 mg/L to 206 mg/L. The release of arsenic from soil to groundwater is due to natural geochemical conditions and not an anthropomorphic source from AOC 721 based upon trends in analytical data and Fe^{2+} redox conditions. The average of four arsenic concentrations detected during the AOC 721 RFI is 92.4μg/L and only one of the four detections exceeded the maximum base wide background concentration of 166μg/L. AOC 721 groundwater has been sufficiently characterized to proceed with the RFI Report without collection of additional samples.

SEDIMENT

Data from sediment sample analyses has sufficiently characterized and delineated contamination in AOC 721 ditch sediments to proceed with the RFI Report without collection of additional samples.

SURFACE WATER

Based on topography and analytical data, the small pond in AOC 721 is the result of tidal inundation by high tides that exceed the mean high water elevation and is not a groundwater discharge point. Sample data also indicate that there are no contamination issues associated with either of the two surface-water bodies and AOC 721. Analytical data from the analysis of surface-water samples collected from the small pond and the AOC 721 ditch have sufficiently characterized surface water to proceed with the RFI Report without collection of additional samples.

4.0 REFERENCES

CH2M-Jones. (May 2002). *CMS Work Plan/Interim Measure Completion Report, SWMU 44. Zone C. Revision 1* Charleston, South Carolina.

EnSafe/Allen & Hoshall. (1995). *Zone C RFI Work Plan.* Charleston, South Carolina.

EnSafe/Allen & Hoshall. (July 1996). *Comprehensive Sampling and Analysis Plan.* Charleston, South Carolina.

EnSafe Inc. (November 14, 1997). *Zone C RFI Report.* Charleston, South Carolina.

5.0 SIGNATORY REQUIREMENT

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

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

_____ _____

Robert A. Harrell, Jr., P.E. Date
Engineer-In-Charge